RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Environmental Statement
Volume 7
Chapter 30 – Climate Change

June 2024

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Company:	**RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited**	Asset:	**Development**
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Glossary

Term	Definition
Array Areas	The DBS East and DBS West offshore Array Areas, where the wind turbines, offshore platforms and array cables would be located. The Array Areas do not include the Offshore Export Cable Corridor or the Inter-Platform Cable Corridor within which no wind turbines are proposed. Each area is referred to separately as an Array Area.
Array cables	Offshore cables which link the wind turbines to the Offshore Converter Platform(s).
Baseline	The existing conditions as represented by the latest available survey and other data which is used as a benchmark for making comparisons to assess the impact of the Projects.
Climate change	A change in global or regional climate patterns. Within this chapter this usually relates to any long-term trend in mean sea level, wave height, wind speed etc, due to climate change.
Coastal/tidal flooding	When high tide events overtop the shoreline to cause flooding to land behind.
Commitments Register	An Excel spreadsheet which identifies all of the Project's commitments and mitigation relating to each technical topic under consideration in the EIA process and where each commitment is secured in the DCO.
Concurrent Scenario	A potential construction scenario for the Projects where DBS East and DBS West are both constructed at the same time.
Cumulative Effects	The combined effect of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor / resource.

Term	Definition
Cumulative Effects Assessment	The assessment of the combined effect of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor/resource.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Project (NSIP).
Development Scenario	Description of how the DBS East and/or DBS West Projects would be constructed either in isolation, sequentially or concurrently.
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the value, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
EIA	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement (ES).
EIA regulations	The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.
Fluvial flooding	When flows within watercourses exceed the capacity of the watercourse causing out of bank flows.
Groundwater	Water stored below the ground in rocks or other geological strata.

Term	Definition
Health	State of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity.
Heavy Goods Vehicle (HGV)	HGV is the term for any vehicle with a Gross Weight over 3.5 tonnes. This is also used as a proxy for HGVs and buses / coaches recognising the similar size and environmental characteristics of the respective vehicle types.
High Voltage Alternating Current (HVAC)	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
High Voltage Direct Current (HVDC)	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.
High water	Maximum level reached by the rising tide.
Impact	Used to describe a change resulting from an activity via the Projects, i.e. increased suspended sediments / increased noise.
In Isolation Scenario	A potential construction scenario for one Project which includes either the DBS East or DBS West array, associated offshore and onshore cabling and only the eastern Onshore Converter Station within the Onshore Substation Zone and only the northern route of the onward cable route to the proposed Birkhill Wood National Grid Substation.
Inter-Platform Cables	Buried offshore cables which link offshore platforms.
Landfall	The point on the coastline at which the Offshore Export Cables are brought onshore, connecting to the Onshore Export Cables at the Transition Joint Bay (TJB) above mean high water.

Term	Definition
Landfall Zone	The generic term applied to the entire landfall area between Mean Low Water Spring (MLWS) and the Transition Joint Bays (TJBs) inclusive of all construction works, including the landfall compounds, Onshore Export Cable Corridor and intertidal working area including the Offshore Export Cables.
Mean sea level	The average level of the sea surface over a defined period (usually a year or longer), taking account of all tidal effects and surge events.
National Policy Statement (NPS)	A document setting out national policy against which proposals for NSIPs will be assessed and decided upon.
Onshore Converter Stations	A compound containing electrical equipment required to transform HVDC and stabilise electricity generated by the Projects so that it can be connected to the electricity transmission network as HVAC. There will be one Onshore Converter Station for each Project.
Onshore Development Area	The Onshore Development Area for ES is the boundary within which all onshore infrastructure required for the Projects would be located including Landfall Zone, Onshore Export Cable Corridor, accesses, Temporary Construction Compounds and Onshore Converter Stations.
Onshore Export Cable Corridor	This is the area which includes cable trenches, haul roads, spoil storage areas, and limits of deviation for micro-siting. For assessment purposes, the cable corridor does not include the Onshore Converter Stations, Transition Joint Bays or temporary access routes; but includes Temporary Construction Compounds (purely for the cable route).
Onshore Export Cables	Onshore Export Cables take the electric from the Transition Joint Bay to the Onshore Converter Stations.

Term	Definition
Onshore Substation Zone	Parcel of land within the Onshore Development Area where the Onshore Converter Station infrastructure (including the Haul Roads, Temporary Construction Compounds and associated cable routeing) may be located.
Ordinary watercourse	Rivers which are not Main Rivers are called 'ordinary watercourses'. Lead local flood authorities, district councils and internal drainage boards carry out flood risk management work on ordinary watercourses.
Planning Inspectorate (PINS)	The agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
Project Team	A multi-disciplinary team consisting of individuals from RWE who are ultimately responsible for the construction, operation and maintenance and decommissioning phases of DBS East and DBS West, who are supported by a wider group of contractors and sub-contractors.
Receptor	"A distinct part of the environment on which effects could occur and can be the subject of specific assessments. Examples of Receptors include species (or groups) of animals, plants, people (often categorised further such as 'residential' or those using areas for amenity or recreation), watercourses etc."
Scoping report	The report that was produced in order to request a Scoping Opinion from the Secretary of State.
Scour protection	Protective materials to avoid sediment erosion from the base of the wind turbine foundations and offshore substation platform foundations due to water flow.

Term	Definition
Sea level	Generally, refers to 'still water level' (excluding wave influences) averaged over a period of time such that periodic changes in level (e.g. due to the tides) are averaged out.
Sea level rise	The general term given to the upward trend in mean sea level resulting from a combination of local or regional geological movements and global climate change.
Sequential Scenario	A potential construction scenario for the Projects where DBS East and DBS West are constructed with a lag between the commencement of construction activities. Either Project could be built first.
Statutory consultation	The statutory consultation ran in two periods. The first period ran between 6th June and 17th July 2023, with a second period running between 4th August and 15th September 2023 to gather responses from third-parties missed during the initial consultation period. The PEIR was presented as part of this consultation.
Surge	Changes in water level as a result of meteorological forcing (wind, high or low barometric pressure) causing a difference between the recorded water level and the astronomical tide predicted using harmonic analysis.
Temporary Construction Compound	An area set aside to facilitate construction of the Projects. These will be located adjacent to the Onshore Export Cable Corridor and within the Onshore Substation Zone, with access to the highway.
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).

Term	Definition
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).
Transition Joint Bay (TJB)	The Transition Joint Bay (TJB) is an underground structure at the landfall that houses the joints between the Offshore Export Cables and the Onshore Export Cables.
Wave height	The vertical distance between the crest and the trough.
Wind turbine	Power generating device that is driven by the kinetic energy of the wind.

Acronyms

Term	Definition
BEIS	Department for Business, Energy and Industrial Strategy
BSI	The British Standards Institution
CCC	Climate Change Committee
CCRA	Climate Change Resilience Assessment
CH_4	Methane
CEMP	Construction Environmental Management Plan
CoCP	Code of Construction Practice
COP	Conference of Parties
CO_2	Carbon dioxide
CO_2e	Carbon dioxide-equivalent
CTV	Crew Transfer Vessel
DBS	Dogger Bank South
DCO	Development Consent Order
DEFRA	Department for Environment, Food & Rural Affairs
DESNZ	Department for Energy Security and Net Zero
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
ES	Environmental Statement
EU	European Union
FRA	Flood Risk Assessment

Term	Definition
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
HGV	Heavy Goods Vehicle
HVDC	High-Voltage Direct Current
ICE	Inventory of Carbon and Energy
IEMA	Institute of Environmental Management & Assessment
IPCC	Intergovernmental Panel on Climate Change
JUV	Jack-up installation vessels
LCA	Life Cycle Analysis
LULUCF	Land Use, Land Use Change and Forestry
LV	Light Vehicles
MTO	Material Take Off
NAP3	Third National Adaptation Programme
N_2O	Nitrous Oxide
NF_3	Nitrogen Trifluoride
NPPF	National Planning Policy Framework
NPS	National Policy Statements
NRMM	Non-Road Mobile Machinery
NSIP	Nationally Significant Infrastructure Projects
OCP	Offshore Converter Platforms

Term	Definition
OSP	Offshore Substation Platforms
PEIR	Preliminary Environmental Information Report
PFCs	Perfluorocarbons
RCP	Representative Concentration Pathways
SF_6	Sulphur Hexafluoride
SOV	Service Operations Vessel
SuDS	sustainable drainage system
UNFCCC	United Nations Framework Convention on Climate Change

30 Climate Change

30.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the likely significant effects of the Projects on Climate Change and comprises a Greenhouse Gas (GHG) assessment and a climate change resilience assessment (CCRA). The chapter provides an overview of the existing environment for the Onshore and Offshore Development Areas, followed by an assessment of likely significant effects for the construction, operation, and decommissioning phases of the Projects.

2. This chapter considers (a) the impacts of the Projects on climate change, through a GHG assessment, and (b) any potential impact of climate change on the Projects, through a CCRA. The GHG assessment quantifies GHG savings resulting from the implementation of the Projects, accounting for emissions released during their lifecycle. The GHG assessment quantifies the contribution of the Projects to national and regional GHG emissions in England and the UK, and its 'net effect' compared to a baseline of 'do nothing'.

3. The GHG assessment has been undertaken in accordance with the Institute of Environmental Management and Assessment (IEMA) guidance *'Guide: Assessing Greenhouse Gas Emissions and Evaluating their Significance'* (IEMA 2022). This document provides topic-specific methodology to assess GHGs and determine the significance of emissions generated by a project. The assessment methodology in this chapter, therefore, differs from that presented in **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)**.

4. The CCRA considers the resilience of the Projects' design and infrastructure to the projected effects of climate change over the lifespan of the Projects. The assessment has been undertaken in accordance with methodology provided in IEMA's *'Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation'* guidance (IEMA 2020).

5. This assessment has been undertaken with specific reference to the relevant policy, legislation, and guidance, which are summarised in section 30.4.1 of this chapter. Further detail on the legislative context for the Projects relating to the international, national, and local planning policy and legislation is provided in **Volume 7, Chapter 3 Policy and Legislative Context (application ref: 7.3)**.

6. This chapter should be read in conjunction with the following linked chapters:

- **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)**
- **Volume 7, Chapter 24 Traffic and Transport (application ref: 7.24)**; and
- **Volume 7, Chapter 26 Air Quality (application ref: 7.26)**.

7. Additional information to support the GHG and CCRA assessment include:

- **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref 7.30.30.2)**; and
- **Volume 7, Appendix 30-3 Climate Change Resilience Assessment (application ref: 7.30.30.3)**.

30.2 Consultation

8. Consultation with regard to Climate Change has been undertaken in line with the general process described in **Volume 7, Chapter 7 Consultation (application ref: 7.7)** and the **Consultation Report (Volume 5, application ref: 5.1)**. The key elements include scoping and the Preliminary Environmental Information Report (PEIR) under section 42 of the Planning Act 2008.

9. The feedback received throughout this process has been considered in preparing the ES. This chapter has been updated following consultation in order to produce the final assessment submitted within the Development Consent Order (DCO) application. **Volume 7, Appendix 30-1 Consultation Responses (application ref: 7.30.30.1)** provides a summary of the consultation responses received to date relevant to this topic, and details how the comments have been addressed within this chapter.

30.3 Scope

30.3.1 Effects Scoped In and Scoped Out

10. This chapter considers (a) the impacts of the Projects on climate change, through a GHG assessment, and (b) any potential impact of climate change on the Projects, through a CCRA. Cumulative impacts and transboundary impacts are scoped out of the EIA.

11. The purpose of the GHG assessment is to consider the potential effects of the Projects on climate change via GHG emissions created and avoided. The assessment accounts for emissions arising from construction, operation and decommissioning activities associated with the Projects.

12. The CCRA evaluates the resilience and vulnerability of the design and infrastructure to the projected effects of climate change over the construction, operational and maintenance, and decommissioning phases of the Projects.

30.3.2 Study Area

13. The Projects' Array Areas (referred to as DBS Array Areas) are located more than 100km offshore on the Dogger Bank in the southern North Sea. The total developable area for the DBS E Array Areas covers approximately 704 km^2. The Offshore Development Area of the Projects would consist of up to 200 offshore wind turbines, offshore platforms, Inter-Platform Cables, array cables and Offshore Export Cables to connect the Array Areas with the landfall. The Projects would make landfall on the East Riding of Yorkshire coastline near Skipsea. The onshore aspects of the Projects include the buried Onshore Export Cables from the Landfall Zone and the Onshore Convertor Stations. Further details of the location of the Projects and the onshore and offshore aspects of the Projects are set out within **Volume 7, Chapter 5 Project Description (application ref: 7.5)**.

30.3.2.1 GHG Assessment

14. The GHG assessment determines the change in GHG emissions resulting from the implementation of the Projects and considers the impact of replacing electricity from fossil fuel sources with electricity from offshore wind. The study area of the GHG assessment is not geographically defined because emissions released or avoided due to the Projects have the same effect on atmospheric GHG concentrations and the net effect on climate change regardless of where they occur.

15. The scope of the assessment encompasses the quantification of GHG emissions from both the onshore and offshore elements of the Projects, and includes material extraction and manufacturing, transport and installation, operation and maintenance and end of life and decommissioning. A schematic diagram of the Projects' system boundary is provided in **Plate 30-1**; where emissions from activities within the pale green box are included within the assessment.

16. The Study Area for the GHG assessment includes activities within the Onshore and Offshore Development Areas, and activities with no geographic boundary including processes inherent in its construction such as raw material extraction, manufacturing, transport, and installation. The Study Area also includes the UK wide electricity grid, where the beneficial effect of the provision of renewable energy can be quantified.

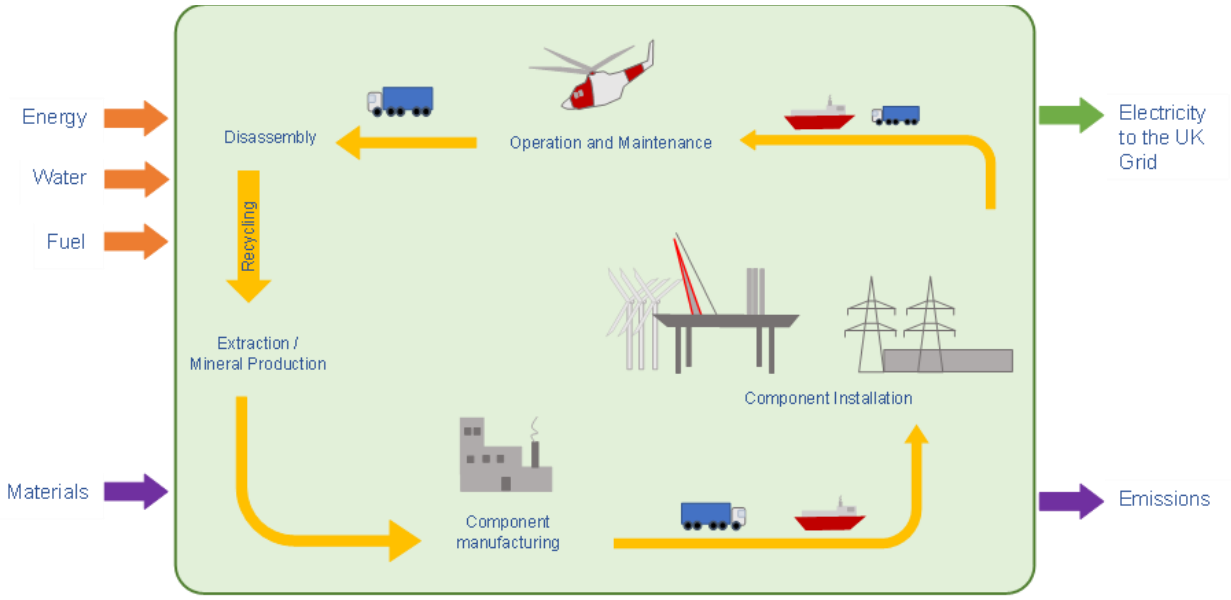

Plate 30-1 System Boundary for the Projects' GHG Assessment

30.3.2.2 CCRA

17. The study area for the CCRA is defined as the Onshore and Offshore Development Areas, and the temporal scope includes the construction, operation and maintenance and decommissioning phases of the Projects. The study area includes the main infrastructure components associated with the Projects, including the buried Onshore Export Cables from the Landfall Zone to the Onshore Substation Zone, offshore wind turbines, offshore platforms, Inter-Platform Cables, array cables and Offshore Export Cables, and is reflected in **Volume 7, Figure 5-1 (application ref: 7.5.1)** and **Volume 7, Figure 5-2 (application ref: 7.5.1)**.

30.3.3 Realistic Worst Case Scenario

30.3.3.1 General Approach

18. The realistic worst case design parameters for likely significant effects scoped into the ES for the Climate change GHG assessment are summarised in **Table 30-1**. These are based on the project parameters described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**, which provides further details regarding specific activities and their durations.

19. In addition to the design parameters set out in **Table 30-1**, consideration is also given to the different Development Scenarios still under consideration as set out in sections 30.3.3.2 to 30.3.3.4.

Table 30-1 Realistic Worst Case Design Maximum Parameters

	Parameter			
	In Isolation scenario	**Concurrent scenario**	**Sequential scenario**	**Notes and rationale**
Construction				
GHG emission during construction	Indicative construction programme: • Five years combined onshore and offshore construction programme • Wind turbine installation – approximately 30 months • Wind turbine foundation installation – approximately 18 months • Offshore substation platform installation – approximately 24 months • Array cables installation – approximately 30 months • Onshore substation construction and installation – 4 years • Onshore cable route construction – approximately 33 months • Landfall trenchless crossing and TJB construction – approximately 18 months	Indicative construction programme: • Five years combined onshore and offshore construction programme • Wind turbine installation – approximately 30 months • Wind turbine foundation installation – approximately 18 months • Offshore substation platform installation – approximately 24 months • Array cables installation – approximately 30 months • Onshore substation construction and installation – 4 years • Onshore cable route construction – approximately 33 months • Landfall trenchless crossing and TJB construction – approximately 18 months	Indicative construction programme: • Seven years combined onshore and offshore construction campaign • Wind turbine installation – approximately 54 months • Wind turbine foundation installation – approximately 36 months • Offshore substation platform installation – approximately 36 months • Array cable installation – 54 months • Onshore substation construction and installation – 6 years • Onshore cable route construction – approximately 57 months • Landfall trenchless crossing and TJB construction – approximately 48 months	n/a
	Infrastructure: Installation of up to: • 100 x wind turbines on monopile foundations • 5 x offshore platforms • 2 x Offshore Export Cables - 376km of total cable length • 325km of array cables • 129km of Inter-Platform Cables	Infrastructure: Installation of up to: • 200 x wind turbines on monopile foundations • 5 x offshore platforms • 4 x Offshore Export Cables - 682km of total cable length • 650km of array cables • 342km of Inter-Platform Cables	Infrastructure: Installation of up to: • 200 x wind turbines on monopile foundations • 8 x offshore platforms • 4 x Offshore Export Cables - 682km of total cable length • 650km of array cables • 342km of Inter-Platform Cables	Maximum quantities of construction materials required. Monopile jacket foundations are the worst case for wind turbines based on the foundation footprint and scour protection requirements compared with other applicable foundation

	Parameter			
	In Isolation scenario	**Concurrent scenario**	**Sequential scenario**	**Notes and rationale**

	• 1,067,800m³ scour protection for the wind turbines foundations
	• 785,300m³ scour protection for offshore platform foundations within the Array Areas
	• 205,650m³ scour protection for offshore platform foundations within the Offshore Export Cable Corridor
	• 907,472m³ of rock berm protection per project for unburied Offshore Export Cables
	• 133,650m³ of rock berm crossing protection for Offshore Export Cables
	• 186,441m³ of rock berm protection for unburied Inter-Platform Cables
	• 22,200m³ of rock berm crossing protection for Inter-Platform Cables
	• 181,125m³ of rock berm protection for unburied array cables
	• 35,600m3 of rock berm crossing protection for array cables
	• 1 x Onshore Converter Stations
	• Number of completed trenchless crossing ducts (maximum): 3 (2 for power cables, 1 for fibre optic cables)
	• 1 x fibre optic cable
	• No. of compounds (est.):
	    ○ Main compounds – 2
	    ○ Satellite compounds – up to 15
		• 1,067,800m³ scour protection for the wind turbines foundations
		• 785,300m³ scour protection for offshore platform foundations within the Array Areas
		• 205,650m³ scour protection for offshore platform foundations within the Offshore Export Cable Corridor
		• 1,623,248m³ of rock berm protection per project for unburied Offshore Export Cables
		• 267,350m³ of rock berm crossing protection for Offshore Export Cables
		• 486,718m³ of rock berm protection for unburied Inter-Platform Cables
		• 116,700m³ of rock berm crossing protection for Inter-Platform Cables
		• 363,650m³ of rock berm protection for unburied array cables
		• 57,000m³ of rock berm crossing protection for array cables
		• 2 x Onshore Converter Stations
		• Number of completed trenchless crossing ducts (maximum): 6 (4 for power cables, 2 for fibre optic cables)
		• 4 x Transition Joint Bays
		• No. of compounds (est.):
		• Main compounds – 2
		• Satellite compounds – up to 15
		• No. of trenchless crossing compounds:
			• 1,067,800m³ scour protection for the wind turbines foundations
			• 785,300m³ scour protection for offshore platform foundations within the Array Areas
			• 205,650m³ scour protection for offshore platform foundations within the Offshore Export Cable Corridor
			• 1,623,248m³ of rock berm protection per project for unburied Offshore Export Cables
			• 267,350m³ of rock berm crossing protection for Offshore Export Cables
			• 486,718m³ of rock berm protection for unburied Inter-Platform Cables
			• 116,700m³ of rock berm crossing protection for Inter-Platform Cables
			• 363,650m³ of rock berm protection for unburied array cables
			• 57,000m³ of rock berm crossing protection for array cables
			• 2 x Onshore Converter Stations
			• Number of completed trenchless crossing ducts (maximum): 6 (4 power cables, 2 for fibre optic cables)
			• 4 x Transition Joint Bays
			• No. of compounds (est.):
			• Main compounds – 2
			• Satellite compounds – up to 15
			• No. of trenchless crossings compounds:
				options. The offshore platforms worst case foundation is monopile foundations due the quantities of scour protection required.

	Parameter			
	In Isolation scenario	**Concurrent scenario**	**Sequential scenario**	**Notes and rationale**
	○ No. of trenchless crossing compounds: ▪ Minimum 36 and up to maximum of 147 entry compounds ▪ Minimum 36 and up to maximum of 147 exit compounds ○ Substation compound – 1 • 103 x link boxes (est.)	○ Minimum 72 and up to maximum of 294 entry compounds ○ Minimum 72 and up to a maximum of 294 exit compounds • Substation compound – 2 • 205 x link boxes (est.)	○ Minimum 72 and up to a maximum 294 entry compounds ○ Minimum 72 and up to a maximum 294 exit compounds • Substation compound – 2 • 205 x link boxes (est.)	
	• Vessel movements – 5745 maximum return trips for construction activity vessels	• Vessel movements – 11,489 maximum return trips for construction activity vessels	• Vessel movements – 11,489 maximum return trips for construction activity vessels	Indicative vessels associated with construction are included in the GHG assessment. The different types of vessels associated with each activity is detailed in **Volume 7**, **Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**.
	• Helicopter movements – 365 maximum helicopter return trips per year per project	• Helicopter movements – 730 maximum helicopter return trips per year per project	• Helicopter movements – 730 maximum helicopter return trips per year per project	n/a
	• Road traffic movements – ○ Heavy Goods Vehicle (HGV) – 5,672,571km ○ Light Vehicles (LV) – 9,902,083km	• Road traffic movements – ○ Heavy Goods Vehicle (HGV) – 7,913,696km ○ Light Vehicles (LV) – 11,470,559km	• Road traffic movements – ○ Heavy Goods Vehicle (HGV) – 17,920,469km ○ Light Vehicles (LV) – 10,605,379km	n/a

	Parameter			
	In Isolation scenario	**Concurrent scenario**	**Sequential scenario**	**Notes and rationale**
Climate change resilience during construction	• Earliest construction start date: 2026 • Construction duration: 5 years • The CCRA considers the high emission scenario, Representative Concentration Pathways (RCP) 8.5, for the UK Climate Projection 2018 (UKCP18) 2030s (2020 to 2039) period (Met Office, 2018).	• Earliest construction start date: 2026 • Construction duration: 5 years • The CCRA considers the high emission scenario (RCP8.5) for the UKCP18 2030s (2020 to 2039) period (Met Office, 2018).	• Earliest construction start date: 2026 • Construction duration: 7 years • The CCRA considers the high emission scenario (RCP8.5) for the UKCP18 2030s (2020 to 2039) period (Met Office, 2018).	Climate projection data is available for various emission scenarios. RCP8.5 is commonly used to represent worst case climate change outcomes.
Operation and Maintenance				
GHG emissions during operation and maintenance	• Operational life - 30 years, up to 100 wind turbines • Operational and maintenance vessels annual return trips o Jack-Up vessels – 9 trips o Service Operations vessels (SOV) – 52 trips o Accommodation vessels – 52 trips o Crew Transfer Vessel (CTV) – 52 trips o Lift vessels – 9 trips o Cable maintenance vessels – 1 trip o Auxiliary vessel – 64 trips • Annual helicopter return trips during operational and maintenance o General operations – 10 trips • Spare parts (information derived from literature), offshore and onshore	• Operational life - 30 years, up to 200 wind turbines • Operational and maintenance vessels annual return trips o Jack-Up vessels – 16 trips o Service Operations vessels (SOV) – 104 trips o Accommodation vessels – 104 trips o CTV – 104 trips o Lift vessels – 16 trips o Cable maintenance vessels – 1 trip o Auxiliary vessel – 128 trips • Annual helicopter return trips during operational and maintenance o General operations – 20 trips • Spare parts (information derived from literature), offshore and onshore	• Operational life - 32 years, up to 200 wind turbines • Operational and maintenance vessels annual return trips o Jack-Up vessels – 16 trips o Service Operations vessels (SOV) – 104 trips o Accommodation vessels – 104 trips o CTV – 104 trips o Lift vessels – 16 trips o Cable maintenance vessels – 1 trip o Auxiliary vessel – 128 trips • Annual helicopter return trips during operational and maintenance o General operations – 20 trips • Spare parts (information derived from literature), offshore and onshore.	

	Parameter			
	In Isolation scenario	**Concurrent scenario**	**Sequential scenario**	**Notes and rationale**
	• 416 annual traffic movements associated with operational and maintenance activities for each Onshore Converter Station • 412 annual traffic movements associated with operational and maintenance activities along the cable route	• 416 annual traffic movements associated with operational and maintenance activities for each Onshore Converter Station • 820 annual traffic movements associated with operational and maintenance activities along the cable route	• 416 annual traffic movements associated with operational and maintenance activities for each Onshore Converter Station • 820 annual traffic movements associated with operational and maintenance activities along the cable route	
Climate change resilience during operation and maintenance	Earliest operational start date: 2029 Operation duration: 30 years The CCRA considers the high emission scenario (RCP8.5) for the UKCP18 2050s (2040 to 2059) period (Met Office, 2018a).	Earliest operational start date: 2029 Operation duration: 30 years The CCRA considers the high emission scenario (RCP8.5) for the UKCP18 2050s (2040 to 2059) period (Met Office, 2018a).	Earliest operational start date: 2029 Operation duration: 30 years per project over an overall 32 year time frame The CCRA considers the high emission scenario (RCP8.5) for the UKCP18 2050s (2040 to 2059) period (Met Office, 2018a).	Climate projection data is available for various emission scenarios. RCP8.5 is commonly used to represent worst case climate change outcomes.
Decommissioning				
No final decision regarding the final decommissioning plan for the onshore project infrastructure including landfall, Onshore Export Cable Corridor and Onshore Converter Stations has yet been made. In addition, no final decision regarding the final decommissioning programme for the offshore project infrastructure including the landfall has yet been made. It is also recognised that legislation and industry best practice change over time. However, it is likely that the onshore project equipment, including the cable, will be removed, reused or recycled whenever possible and the transition bays and cable ducts being left in place. It is also likely that offshore project infrastructure would be removed above the seabed and reused or recycled where practicable. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. It is anticipated that for the worst case scenario, the impacts will be no greater than those identified for the construction phase. A Decommissioning Programme for the offshore works would be submitted to the Secretary of State for approval prior to commencement of offshore works. A Decommissioning Plan for the onshore works would be submitted to the relevant planning authority for approval within 6 months of the permanent cessation of commercial operations of the Project(s). The contribution from the decommissioning phase has been determined from the total GHG contribution in construction and operation, as detailed in section 30.4.3.1.4. The CCRA considers the high emission scenario (RCP8.5) for the UKCP18 2060s (2050 to 2069) period (Met Office. 2018a) which is deemed representative of the decommissioning phase.				

30.3.3.2 Development Options

20. Following Statutory Consultation high voltage alternating current (HVAC) technology (previously assessed in PEIR) was removed from the Projects' design envelope (see **Volume 7, Chapter 4 Site Selection and Assessment of Alternatives (application ref: 7.4)** for further information). As a result, only high voltage direct current (HVDC) technology has been taken forward for assessment purposes. The ES considers the following development scenarios:

- Either DBS East or DBS West is built in isolation; or
- DBS East and DBS West are both built either sequentially or concurrently.

21. An In Isolation Scenario has been assessed within the ES on the basis that only one Project may be taken forward based on the Secretary of State decision on the DCO application or due to commercial decisions taken by the Applicants at a future date. If an DBS East or DBS West In Isolation Scenario is taken forward, either DBS East or DBS West may be constructed. As such the onshore assessment will consider both DBS East and DBS West in isolation.

22. If an In Isolation Scenario is taken forward, only the eastern converter station within the Onshore Substation Zone would be constructed. As such the onshore assessment considers only that situation. In either the Concurrent or Sequential Scenarios, both converter station locations within the Onshore Substation Zone would be taken forward for the onshore assessment.

23. In order to ensure that a robust assessment has been undertaken, all Development Scenarios have been considered to ensure the realistic worst-scenarios for each topic has been assessed. A summary is provided here, and further details are provided in **Volume 7**, **Chapter 5 Project Description (application ref: 7.5)**.

24. The three Development Scenarios to be considered for assessment purposes are outlined in **Table 30-2**.

Table 30-2 Development Scenarios and Construction Durations

Development scenario	Description	Total Maximum Construction Duration (Years)	Maximum Construction Duration Offshore (Years)	Maximum construction Duration Onshore (Years)
In Isolation	Either DBS East or DBS West is built In Isolation	Five	Five	Four
Sequential	DBS East and DBS West are both built Sequentially, either Project could commence construction first with staggered / overlapping construction	Seven	A five year period of construction for each project with a lag of up to two years in the start of construction of the second project (excluding landfall duct installation) – reflecting the maximum duration of effects of seven years.	Construction works (i.e. onshore cable civil works, including duct installation) to be completed for both Projects simultaneously in the first four years, with additional works at the landfall, substation zone and cable joint bays in the following two years. Maximum duration of effects of six years.
Concurrent	DBS East and DBS West are both built Concurrent reflecting the maximum peak effects	Five	Five	Four

25. The In Isolation, Concurrent and Sequential Scenarios all allow for flexibility to build out either or both Projects using a phased approach offshore. Under a phased approach, the maximum timescales for individual elements of the construction are assessed.

26. Any differences between the Projects, or differences that could result from the way the first and the second Projects are built (concurrent or sequential and the length of any lag) are identified and discussed where relevant in section 30.1. For each potential impact, the worst case construction scenario for all Development Scenarios are presented. The worst case scenario presented for the Concurrent or Sequential Scenario will depend on which of these is the worst case for the potential impact being considered. The justification for what constitutes the worst case is provided, where necessary in sections 30.3.3.2.1 and 30.3.3.2.2 below.

30.3.3.2.1 GHG Assessment Worst Case Scenario

27. The principal aim of the GHG assessment is to determine the emissions associated with the implementation of all Development Scenarios presented in section 30.3.3.2. The worst case design parameters for the In Isolation, Concurrent, and Sequential Scenarios, which are likely to release the greatest quantity of GHG emissions for each scenario are detailed in **Table 30-1**.

28. Defining the worst case scenario for the GHG assessment requires consideration of activities likely to result in the highest quantity of emissions, but also the potential for emissions avoided from the provision of renewable energy to the grid.

29. The In Isolation Scenario yields lower embodied emissions in construction and operational phases compared to sequential or Concurrent Scenarios. This is attributed to the need for less infrastructure, fewer offshore marine movements, and less road traffic as highlighted in **Table 30-1**. During decommissioning, the In Isolation Scenario is expected to produce fewer emissions, however, lower renewable generation capacity, limits potential emission savings compared to sequential or Concurrent Scenarios.

30. Concurrent and Sequential Scenarios offer greater potential for emission savings. Although these scenarios share similar worst-case parameters (**Table 30-1**), the Sequential Scenario involves more road vehicle movements and a longer construction duration, making it the worst-case scenario for GHG emissions release.

31. The differences between the Sequential Scenario and the Concurrent Scenario are not considered to be material to the outcomes of the assessment. Therefore, the outcomes of the assessment for the Sequential Scenario presented in this chapter are considered representative of the Concurrent Scenario.

32. Therefore, the In Isolation, and the Sequential Scenarios are considered in the assessment.

30.3.3.2.2 CCRA Worst Case Scenario

33. The principal aim of the CCRA assessment is to determine the resilience and vulnerability of all Development Scenarios presented in section 30.3.2.2 to the projected effects of climate change. The worst case design parameters for the In Isolation, Concurrent, and Sequential Scenarios which are likely to be most impacted by future climatic changes are detailed in **Table 30-1**.

34. The worst case scenario for the CCRA is a function of the amount of infrastructure associated with each Development Scenario, and for how long into the future it would be in place.

35. The Concurrent and Sequential Scenarios would result in more infrastructure that can be impacted by future climatic hazards compared to the In Isolation Scenario. The Sequential Scenario has an additional two years for the construction and operation and maintenance phases as outlined in section 30.3.3.2.

36. Therefore, the Sequential Scenario has a greater potential exposure to climate hazards and their associated impacts and is considered the worst case Development Scenario for CCRA. However, as the temporal scope of the Sequential Scenario is only two years (due to the longer construction period) greater than the In Isolation and Concurrent Scenario, the outcomes of the CCRA are not considered to be materially different between all Development Scenarios. Therefore, for the CCRA presented in section 30.6, the impacts of climate change on the Projects are based on the Sequential Scenario, but the outcomes are considered representative for all Development Scenarios.

30.3.3.3 Operation Scenarios

37. Operation scenarios are described in detail in **Volume 7**, **Chapter 5 Project Description (application ref: 7.5)**. The assessment considers the following scenarios:

- Only DBS East in operation;
- Only DBS West in operation; and
- DBS East and DBS West operating concurrently with or without a lag of up to two years between each Project commencing operation.

38. If the Projects are built using a phased approach, there would also be phased approach to starting the operational phase. The worst case scenario for the operational phases for the Projects have been assessed. See section 5.1.1 of **Volume 7**, **Chapter 5 Project Description (application ref: 7.5)** for further information on phasing scenarios for the Projects.

39. The operational lifetime of each Project's is expected to be 30 years.

30.3.3.4 Decommissioning Scenarios

40. Decommissioning scenarios are described in **Volume 7**, **Chapter 5 Project Description (application ref: 7.5)**. Decommissioning arrangements for the onshore elements of the project would be agreed through the submission of a Decommissioning Plan to be submitted and approved following cessation of commercial operation prior to decommissioning commencing. A Decommissioning Programme for the offshore works would be submitted to the Secretary of State for approval prior to commencement of offshore works. For the purpose of this assessment, it is assumed that decommissioning of the Projects could be conducted separately, or at the same time.

30.3.4 Embedded Mitigation

41. This section outlines the embedded mitigation relevant to the Climate Change assessment, which has been incorporated into the design of the Projects or constitutes standard mitigation measures for this topic and standard mitigation secured in management plans (**Table 30-3**). Mitigation is also detailed within the **Commitments Register (Volume 8, application ref: 8.6)**. Where additional mitigation measures are proposed, these are detailed in the impact assessment (section 1.4).

30.3.4.1 GHG Assessment

42. The IEMA GHG guidance (2022) notes the importance of embedded mitigation in minimising GHG emissions from a proposed development. The IEMA GHG Management Hierarchy sets out a structure to eliminate, reduce, substitute, and compensate (IEMA 2022).

43. In response to these principles, the need for the Projects 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 **Volume 7**, **Chapter 2 Need for the Project (application ref: 7.2)**. Furthermore, project-level GHG mitigation is being incorporated into the design development process for the Projects wherever it is practicable to do so. At each stage of the design, steps will be taken to determine the climate change impact of the offshore wind farms, providing a better understanding of which measures will be effective in reducing it. Through this process the Projects will reduce GHG emissions associated with the offshore foundation structures, which will be optimised with the aim of minimising steel mass. The Applicants also seek to adopt recent advances in technology where possible on the Projects, such as the use of recycled materials in wind turbines.

44. Considering that the primary purpose of the Projects is to generate low carbon renewable energy, the process of reducing GHG emissions from the Projects is guided by the hierarchy summarised in **Table 30-3**.

45. The Applicants have a circularity framework which has three core circular principles, namely:

- Reducing consumption & increasing inflow of circular materials;
- Enhancing material (re)use and lifetime; and
- Minimising end-of-life treatment.

46. In addition, the Applicants have integrated sustainability guidelines and continuously develop their approaches and processes to ensure a resource-conserving and future-oriented energy supply under the condition of economic efficiency.

Table 30-3 IEMA GHG Guidance (IEMA, 2022) – Mitigation Hierarchy Specific to the Projects

	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 Projects is to tackle climate change by replacing existing high carbon energy generation. Therefore, a 'do not build' scenario 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 wind farms by their design are efficient in their use of materials. Minimising the use of steel is a key design feature of the approach to Projects' design and procurement.

	Hierarchy	Principle	Project Response
	Build clever (Substitute)	Apply low carbon solutions (including technologies, materials and products) to minimise resource consumption and embodied carbon during the construction, operation, user's use of the project, and at end-of-life.	The Projects would use the latest, most efficient and effective turbines, offshore substation and/or converter platforms, and onshore components such as the onshore substations.
	Construct 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 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. Similarly, onshore construction requires the use of specialised plant and equipment, vehicles with a dedicated and skilled workforce. In addition, the Projects will be seeking to maximise the efficiency of the use of vessels and road vehicles, not only to minimise emissions but also to save on fuel costs. Opportunities to construct and operate efficiently to minimise resource consumption and reduce GHG emissions from activities associated with the Projects will be considered as the design progresses.

30.3.4.2 CCRA

47. This section outlines the embedded mitigation relevant to the CCRA which has been incorporated into the design of the Projects and standard mitigation measures secured in management plans. Where other mitigation measures are proposed, these are detailed in the impact assessment (section 30.6).

48. Projects will be designed in accordance with the Applicants' technical requirements and specifications, which are based on industry-leading engineering codes and standards in the offshore wind sector. The design will prioritise resilience against hazards posed by existing extreme weather events and climate conditions. Additionally, where relevant, the design will incorporate adaptations to address future impacts of climate change.

49. Climate change resilience measures which are secured into to the Projects' design include:

- Based on standard industry practice and occupational health and safety regulations and standards, construction management plans such as the **Outline Project Environmental Management Plan (PEMP) (Volume 8, application ref: 8.21)** and **Outline Code of Construction Practice (OCoCP) (Volume 8, application ref: 8.9)** include provisions relating to risk assessments and health and safety protocols which will be prepared prior to the commencement of the construction works as part of the final PEMP(s) and COCP(s).
- The management plans will be implemented to cover the construction, operation and maintenance, and decommissioning phases of the Projects. The management plans will account for exposure of site workers and construction plant to extreme weather events and ensure appropriate preparation and response measures are in place to minimise their impacts. These measures include, but are not limited to, the following:
    - Scheduling construction activities based on seasonality and timely weather forecasts;
    - Monitoring of on-site weather conditions and severe weather alert services;
    - A comprehensive flood warning and evacuation plan;
    - Incorporating a severe weather protocol into construction management plans and assigning clear responsibilities in the event of an emergency;
    - Requiring contractors to include additional provisions in their management plans based on weather conditions at the time of

works such as additional rest breaks during heatwaves, securing stored equipment and material during high wind events and specifying de-icing equipment during cold spells.

- Mitigation against flooding due to climate change impacts are considered in the design of the onshore components, including drainage for the Onshore Converter Station, detailed in the **Outline Drainage Strategy (Volume 8, application ref: 8.12)**. The construction of landfall will be completed using trenchless techniques to mitigate the risk of tidal and coastal flooding. In addition, at the Landfall Zone, the siting of the Transition Joint Bays (TJBs) has taken into account coastal erosion rates and have been set back to account for coastal retreat;
- The resilience of offshore structures against more challenging conditions resulting from climate change is implicitly addressed in the limit state analyses for the Projects. These analyses, specifically the Ultimate Limit State analyses, consider extreme weather events, including those caused by climate change, such as heightened wave heights. The design of offshore structures incorporates an estimated sea level rise attributed to climate change, which is factored into the analyses. Furthermore, the mobility of the seabed at the offshore wind farm is considered throughout the design lifespan;
- Regular inspections and maintenance of offshore and onshore components of the Projects will be carried out over the Projects operational lifetime to identify and remediate any damage and to ensure optimal working conditions.

30.4 Assessment Methodology

30.4.1 Policy, Legislation and Guidance

30.4.1.1 International Agreements

50. The international agreements relevant for climate change and renewable energy are detailed in section 3.2.1 of **Volume 7**, **Chapter 3 Policy and Legislative Context (application ref: 7.3)**. This highlights the United Nations Framework Convention on Climate Change (UNFCCC), the implementation of measures under the UNFCCC such as the Kyoto Protocol, the Paris Agreement and the UK's climate goals. Section 3.2.1 of **Volume 7**, **Chapter 3 Policy and Legislative Context (application ref: 7.3)** also presents the European Union (EU) Renewable Energy Directive. Following the UK's withdrawal from the EU the UK remains committed to reducing GHG emissions, in particular through the requirements of the Climate Change Act 2008.

30.4.1.2 National Policy Statements

51. The assessment of potential impacts upon *climate change* has been made with specific reference to the relevant National Policy Statements (NPS) including the Overarching NPS for Energy (EN-1), the NPS for Renewable Energy Infrastructure (EN-3) and the NPS for Electricity Networks Infrastructure (EN-5). These were published in November 2023 and were designated in January 2024. The specific assessment requirements for *climate change*, as detailed in the NPS, are summarised in **Table 30-4** together with an indication of the section of this chapter where each is addressed.

Table 30-4 NPS Assessment Requirements

NPS Requirement	NPS Reference	ES Section Reference
EN-1 NPS for Energy (DESNZ, 2023a)		
3.3 The need for new nationally significant energy infrastructure projects To ensure that there is sufficient electricity to meet demand, new electricity infrastructure will have to be built to replace output from retiring plants and to ensure we can meet increased demand. Our analysis suggests that even with major improvements in overall energy efficiency, and increased flexibility in the energy system, demand for electricity is likely to increase significantly over the coming years and could more than double by 2050 as large parts of transport, heating and industry decarbonise by switching from fossil fuels to low carbon electricity. Wind and solar are the lowest cost ways of generating electricity, helping reduce costs and providing a clean and secure source of electricity supply (as they are not reliant on fuel for generation). Our analysis shows that a secure, reliable, affordable, net zero consistent system in 2050 is likely to	Paragraph 3.3.3 Paragraphs 3.3.20, 3.3.21 and 3.3.24	The purpose of the Projects is to contribute to climate change mitigation by replacing existing high carbon energy generation with a renewable form of energy which would improve energy security and help the UK meet its net zero commitments.

NPS Requirement	NPS Reference	ES Section Reference
be composed predominantly of wind and solar. As part of delivering this, UK government announced in the British Energy Security Strategy an ambition to deliver up to 50 gigawatts (GW) of offshore wind by 2030, including up to 5GW of floating wind, and the requirement in the Energy White Paper for sustained growth in the capacity of onshore wind47 and solar in the next decade. Applications for offshore wind above 100MW or solar above 50MW in England, or 350MW for either in Wales, will continue to be defined as NSIPs, requiring consent from the Secretary of State (see EN-3).		
4.10 Climate Change Adaptation and Resilience *Applicant assessment* New energy infrastructure will typically need to remain operational over many decades, in the face of a changing climate. Consequently, applicants must consider the direct (e.g. site flooding, limited water availability, storms, heatwave and wildfire threats to infrastructure and operations) and indirect (e.g. access roads or other critical dependencies impacted by flooding, storms, heatwaves or wildfires) 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, using	Paragraphs 4.10.8 to 4.10.13	The impacts of climate change on the Projects are considered in the CCRA which is provided in section 30.6.2.

NPS Requirement	NPS Reference	ES Section Reference
government guidance and industry standard benchmarks such as the Climate Change Allowances for Flood Risk Assessments, Climate Impacts Tool, and British Standards for climate change adaptation, in accordance with the EIA Regulations. Applicants should assess the impacts on and from their proposed energy project across a range of climate change scenarios, in line with appropriate expert advice and guidance available at the time. Applicants should demonstrate that proposals have a high level of climate resilience built-in from the outset and should also demonstrate how proposals can be adapted over their predicted lifetimes to remain resilient to a credible maximum climate change scenario. These results should be considered alongside relevant research which is based on the climate change projections. Where energy infrastructure has safety critical elements, the applicant should apply a credible maximum climate change scenario. It is appropriate to take a risk-averse approach with elements of infrastructure which are critical to the safety of its operation. *Secretary of State decision making* The Secretary of State 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 and associated research and expert guidance (such as the EA's Climate Change Allowances for Flood Risk Assessments [or the Welsh		

NPS Requirement	NPS Reference	ES Section Reference
Government's Climate change allowances and flood consequence assessments)] available at the time the ES was prepared to ensure they have identified appropriate mitigation or adaptation measures. This should cover the estimated lifetime of the new infrastructure, including any decommissioning period.		
5.3 Greenhouse Gas Emissions *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. 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.	Paragraphs 5.3.8 to 5.3.10	The GHG assessment and any recommended mitigation measures are presented in section 30.6.1.
EN-3 NPS for Renewable Energy Infrastructure (DESNZ, 2023b)		
2.4 Climate change adaptation and resilience Part 2 of EN-1 covers the Government's energy and climate change strategy, including policies for mitigating climate change. Section 4.10 of EN-1 sets out generic considerations that applicants and the Secretary of State should take into account to help ensure that renewable energy infrastructure is safe and resilient to climate change, and that necessary action can be taken to ensure the operation of the infrastructure over its estimated lifetime.	Paragraphs 2.4.1 to 2.4.3, and 2.4.8	The impacts of climate change to the Projects are considered in the CCRA in section 30.6.2.

NPS Requirement	NPS Reference	ES Section Reference
Section 4.10 of EN-1 advises that the resilience of the project to climate change should be assessed in the Environmental Statement (ES) accompanying an application. *Offshore wind* Offshore wind farms will not be affected by flooding. However, applicants should demonstrate that any necessary land-side infrastructure (such as cabling and onshore substations) will be appropriately resilient to climate-change induced weather phenomena. Similarly, applicants should particularly set out how the proposal would be resilient to storms.		

30.4.1.3 Other

52. In addition to the NPS, there are several pieces of legislation, policy and guidance applicable to the assessment of GHGs which are discussed in the following sections. Further details are provided in the **Volume 7**, **Chapter 3 Policy and Legislative Context (application ref: 7.3)**.

30.4.1.3.1 National Planning Policy Framework

53. The National Planning Policy Framework (NPPF) is the primary source of national planning guidance in England. The revised NPPF published in September 2023 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 30-5**.

Table 30-5 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 (Paragraph 153).	The implementation of the Projects would result in the provision of renewable energy to the grid, and contribute to the decarbonisation of the UK, therefore inherently contributes to the mitigation of climate change. The GHG assessment, demonstrating this is provided in section 30.6.1. The CCRA considers the measures outlining how the design of the Projects has accounted for the requirement to adapt to climate change, which is presented in section 30.6.2.
New development should be planned for in ways that (paragraph 154): 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.	The Projects' vulnerability to the impact of climate change and avoidance of GHG emissions are considered in the CCRA and GHG assessment in this chapter, in section 30.6.2 and section 30.6.1 respectively.

30.4.1.3.2 Local Policies

54. This section considers local policies and their relevance to the climate change assessment. As detailed in **Volume 7**, **Chapter 3 Policy and Legislative Council (application ref: 7.3)**, the Onshore Development Area of the Projects falls under the jurisdiction of the East Riding of Yorkshire Council. **Table 30-6** presents the relevant policies from the East Riding of Yorkshire Local Plan (East Riding of Yorkshire Council 2016).

Table 30-6 Summary of Local Policies Relevant to Climate Change

Policy	Summary	How and where this is considered in the ES
S2: Addressing Climate Change	The Local Plan and development decisions will support a reduction in greenhouse gas emissions and adaptation to the expected impacts of climate change.	The GHG assessment and the CCRA for the Projects are presented in section 30.6.1 and section 30.6.2.

30.4.1.3.3 Legislative background

55. The requirement to consider climate and GHG emissions arises from the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. 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 construction and operation.

30.4.1.3.3.1 The Climate Change Act 2008

56. 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, introduced to drive progress towards this target.

57. The Climate Change Act 2008 implements the UK's commitments to reduce GHG emissions based on its obligation under the UNFCCC. The UK's targets for reducing GHG emission are in line with the global goals established by the UNFCCC as detailed in section 3.2.1 of **Volume 7**, **Chapter 3 Policy and Legislative Context (application ref: 7.3)**.

58. Following the 21st Climate Change Conference of the Parties (COP21), the UK signed the Paris Agreement in 2016, a legally binding international treaty on climate change committing all parties to the goal of limiting global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels. The Agreement requires all parties to submit plans to reduce their emissions (along with other climate action) every five 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 are identified in **Table 30-7**.

Table 30-7 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	32%	38%
3rd Carbon Budget (2018 to 2022)	2,544	38% by 2020	44%
4th Carbon Budget (2023 to 2027)	1,950	52% by 2025	-
5th Carbon Budget (2028 to 2032)	1,725	58% by 2030	-
6th Carbon Budget (2033 to 2037)	965	77% by 2035	-

59. 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.

60. In December 2020, the UK set a sixth carbon budget, recommending a reduction in UK GHG emissions of 77% by 2035 relative to a 1990 baseline (a 63% reduction from 2019) (Climate Change Committee (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.

61. As part of the sixth carbon budget, the role of the offshore wind sector and the construction industry are both the focus of action to contribute to meeting these targets. **Volume 7**, **Chapter 2 Need for the Project (application ref: 7.2)** provides further details on the need for the Projects in contributing to meeting these targets.

62. The CCC publishes annual progress reports on UK's progress against GHG emissions reduction targets to 2050. The most recent published report 'Progress in reducing emissions: 2023 Report to Parliament' (CCC 2023) identified that emissions in 2022 rose by 0.8% since 2021 but remain 9% below the Covid-19 pre-pandemic (2019) levels. The report outlined the key challenges in achieving net zero targets, including highlighting the need for further policy progress to ensure the Government's commitment to 95% low-carbon generation by 2023 and electricity generation being fully decarbonised by 2035. The report also acknowledged the Government's ambition for 50 gigawatt (GW) offshore wind generation by 2030. However, an additional provision of 2.7 GW of offshore wind in 2022 is slightly off track to meet the Government's 50 GW target. The report outlines that an average annual deployment rate of 4.5 GW is required to deliver the targets 50 GW of offshore wind by 2030.

63. 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).

30.4.1.3.3.2 Climate Change Risk Assessment 2022

64. 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.

30.4.1.3.3.3 National Adaptation Programme

65. The third National Adaptation Programme (NAP3) (Defra 2023) sets out the actions that the government will take to adapt to the impacts of climate change in the UK. The NAP3 forms part of the five-yearly cycle of requirements detailed in the Climate Change Act 2008. The NAP3 sets out the key actions for 2023 to 2028 which includes:

- Protecting the natural environment;
- Supporting business in adapting to climate change;
- Adapting infrastructure;
- Protecting buildings and their surroundings;
- Protecting public health and communities;
- Pitigating international impacts on the UK.

30.4.1.3.4 Guidance

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

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

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

67. IEMA's recently published guidance document 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (2022) informs the evaluation and significance of GHG emission from the Projects. This guidance is a revision of the first iteration of the guidance released in 2017 (IEMA 2017).

68. The 2022 IEMA guidance presents guidelines for undertaking GHG assessments to distinguish different levels of significance. The guidance does not update 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 30.4.3.1.7).

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

69. IEMA has also published a framework for the consideration of climate change resilience and adaptation in the EIA process. The guidance advises that future climate conditions within the study area should be identified and assessed with consideration of how adaptation and resilience measures have been built into the design of a development (IEMA 2020).

30.4.1.3.4.3 BSI PAS 2080:2023 Carbon Management in Building and Infrastructure (2023)

70. BSI published standard, PAS 2080:2023, outlines a carbon management process applicable for building and infrastructure to support organisations to reduce their GHG emissions and meet climate change commitments (British Standards Institution 2023).

30.4.2 Data and Information Sources

71. The sources that have been used to inform the assessment are listed in **Table 30-8**.

Table 30-8 Available Data and Information Sources

Data Source	Data Set	Year	Notes
Department for Energy Security and Net Zero (DESNZ)	Conversion factors for reporting of GHG emissions	2023	Emission factors for use in the GHG assessment, for fuel consumption.
Dolan and Heath, 2012	Life Cycle Greenhouse Gas Emissions of Utility Scale Wind Power	2012	Benchmarking of results from the GHG assessment.

Data Source	Data Set	Year	Notes
Jones and Hammond, 2019	Inventory of Carbon and Energy (ICE)	2019	Emission factors for embodied carbon in materials used in construction.
DESNZ	Digest of UK Energy Statistics: Electricity	2023	Up-to-date energy statistics for the UK, including the estimated carbon intensity of current grid-supplied electricity.
DESNZ	Treasury Green Book supplementary appraisal guidance on valuing energy use and GHG emissions supporting data tables	2023	Grid-average emission factors for the UK grid and future projections.
Thompson and Harrison, 2015	Life Cycle Costs and Carbon Emissions of Offshore Wind Power	2015	Data for the likely GHG emissions contribution of decommissioning activities to the overall Projects' footprint was obtained from this source. In addition, information within this paper was used to benchmark the outcomes of the GHG assessment.
Met Office, 2018	UK Climate Projections (UKCP) Database	2018	Climate change projection data. IEMA (2020) guidance recommends the use of these in climate change resilience assessment, however they are most applicable to coastal and onshore areas.

30.4.3 Impact Assessment Methodology

72. The climate change assessment comprises two separate assessments: a GHG assessment and a CCRA. The methodologies for both assessments are detailed in the following sections.

30.4.3.1 GHG Assessment Methodology

73. The purpose of the GHG assessment is to consider the potential effects of the Projects on climate change via GHG emissions created and avoided. The assessment accounts for emissions arising from construction, operation and decommissioning activities associated with the Projects.

74. To help determine the significance and contextualise the outcomes of the GHG assessment, emissions from a 'Do Nothing' scenario are also quantified (see section 30.5.1). Emissions from this scenario are compared to the GHG assessment for the Projects to determine the GHG savings or avoided because of the Projects, the GHG payback period and the GHG intensity of electricity produced.

30.4.3.1.1 Climate Change Benefits of Offshore Wind

75. Emissions from electricity generation in the UK have decreased significantly since 1990, the majority of which occurred within the last decade (CCC 2023). This decrease reflects a move away from coal to gas and low-carbon generation, of which the renewables and offshore wind sector has been a key player. Further reductions are necessary which will require an increase in the role of renewables, along with other supply and demand-side responses.

76. The UK increased its offshore wind operational capacity to 13.7 GW in 2022 (RenewableUK 2023), with another 13 GW under construction at the time of writing. The UK government has a target to achieve 50 GW of offshore wind capacity by 2030 (CCC 2023), which will include development such as the Projects.

77. Recent advances in technology and improved construction and operation and maintenance practices have led to an increase in the efficiency of electricity generation. Increases in turbine size yield higher capacity factors. As a result, the former Department for Business, Energy and Industrial Strategy (BEIS), advised that the load factor for new build offshore wind from 2023-2025 is likely to be 58.4%, which is a significant improvement from 10 years ago (BEIS 2021).

30.4.3.1.2 GHG Emission Sources for Offshore Wind Farms

78. The construction, operation, maintenance, repowering, and decommissioning of wind farm projects entail the generation of GHG emissions, from:

- Embedded carbon and GHGs from the offshore and onshore components. These are the emissions caused by the extraction and refinement of raw materials and their manufacture into the commodities and products that make up the components of the wind turbines (and their associated physical infrastructure), cables, etc.; and

- Carbon and other GHG emissions arising from the combustion of fuels and energy used over a project's lifetime. Emissions in this assessment are associated with marine vessels, helicopters, road transport vehicles and onshore plant equipment.

79. The release of emissions from these sources is 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 those released from the activities listed above.

80. There are inherent uncertainties associated with carrying out GHG footprint assessments for offshore wind farm projects such as the embodied emission from materials being dependent on the specific manufacturer/supplier, and emissions 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 is adopted in this assessment. In addition, the assumption and limitations of the approach to calculating GHG emissions in the assessment are detailed in section 30.4.4.

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

82. **Table 30-9** provides a summary of the percentage of the total GHG emissions associated with the different phases of an offshore wind farm development as provided within Thomson and Harrison (2015).

Table 30-9 Summary of Offshore Wind Farm GHG Emissions (Thomson and Harrison, 2015)

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

83. The report highlights that the greatest proportion of emissions are associated with the manufacture and installation of the wind farm components. Decommissioning accounts for the smallest proportion, only 1.2%, of total life cycle GHG emissions. A more detailed breakdown of emissions is given in Thomson and Harrison (2015) for an offshore wind farm with steel foundations. This is reproduced in **Plate 30-2**.

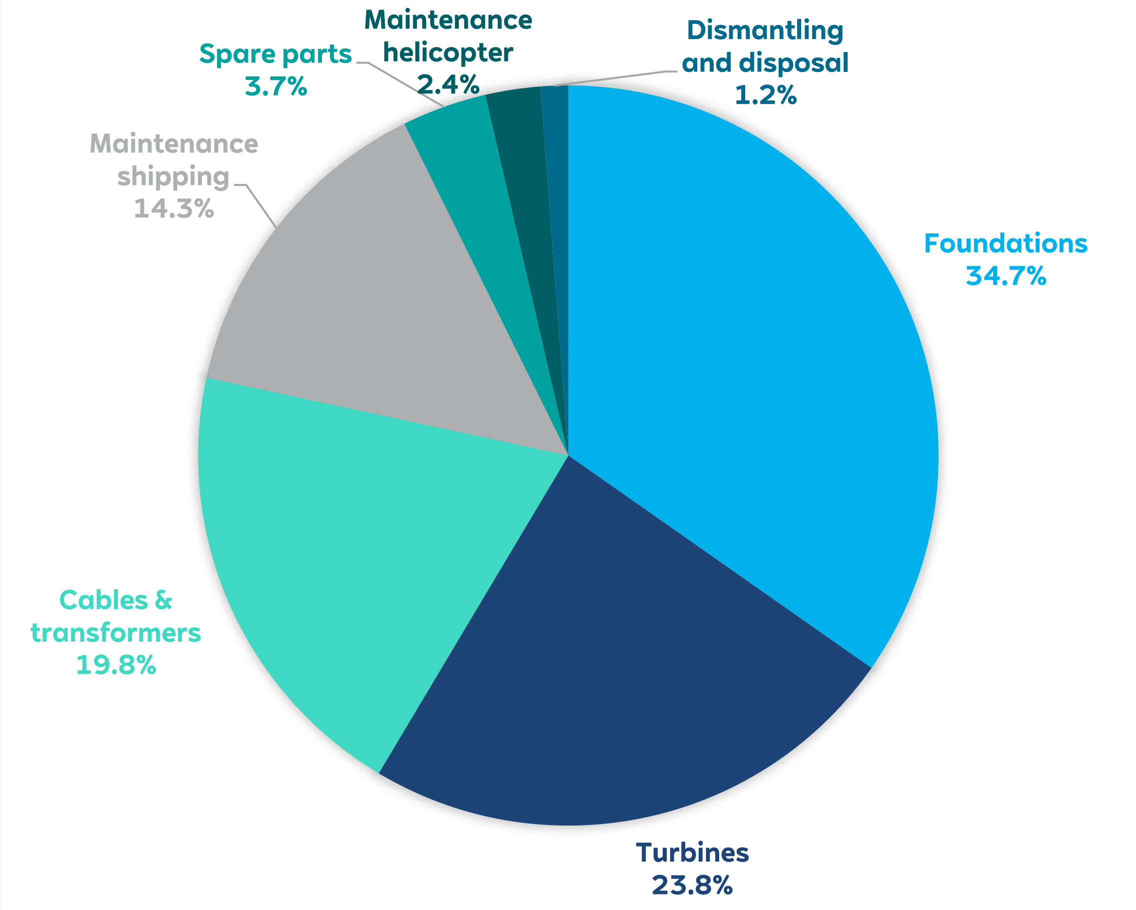

Plate 30-2 Summary of offshore wind farm GHG emissions (Thomson and Harrison, 2015)

84. Of the components or phases shown in **Plate 30-2**, GHG emissions associated with foundation fabrication and installation accounts for the largest proportion of emissions (34.7%), followed by manufacture and installation of the turbines (23.8%) and the cables and transformers (19.8%).

85. GHG emissions from shipping movements during maintenance operations over the operational lifetime of the example wind farm contributed 14.3%. This value may appear to be unexpectedly high, but the contribution of vessel movements is associated with an assumed 20-year operational lifespan of the wind farms considered in the studies. Emissions derived from spare parts (3.7%), helicopter movements (2.4%) and dismantling and disposal (1.2%) are all small in comparison. The operation and maintenance phase of the Projects is anticipated to be 30 years and is therefore longer than the wind farms considered in these studies.

86. A report by Offshore Renewable Energy Catapult (Spyroudi 2021) 'End-of-life planning in offshore wind' investigated the carbon and GHG implications of end-of-use management after decommissioning and gave context to carbon Life Cycle Analysis (LCA) for offshore wind farms. Within the studies, turbines were predicted to contribute to 50% of the total GHG footprint of materials used in wind farm components. The Catapult report references the National Renewable Energy Laboratory (NREL) report (NREL, 2015) which states that wind turbines are predominantly made of steel (71-79% of total turbine mass), fiberglass, resin or plastic (11-16%), iron or cast iron (5-17%), copper (1%) and aluminium (0-2%). The Catapult report (Spyroudi 2021) advises that recycling can save, on average, at least 35% of CO_2e per kWh of generation from assets in an offshore wind farm (operating 6 MW and 10 MW turbines), as opposed to new manufacturing of components.

30.4.3.1.3 GHG Intensity of Offshore Wind Farm Energy

87. A report investigating carbon emissions of wind power (Thomson and Harrison 2015), analysed the GHG emissions intensity (expressed as grammes (g) of CO_2e per kilowatt-hour (kWh) of electricity generated) of electricity from 18 technical studies. These were found to vary quite widely, between approximately 5 and 33 g CO_2e per kWh. There was no clear relationship between the metrics for either turbine rating (in MW) or capacity factor.

88. A further study in 2012 (Dolan and 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 inconsistences. The harmonised results of this study revealed that the range in GHG emissions per kWh of electricity generated varied between approximately 7 and 23 g CO_2e per kWh, with a mean value of around 12 g CO_2e per kWh.

89. These studies were published in 2012 and 2015, and it is acknowledged that there have subsequently been significant advances in the technology, infrastructure and components used for offshore wind farms. Additional published sources have been reviewed to evaluate the average GHG intensity of energy produced by offshore wind farms, and these are presented in **Table 30-10**. Energy intensities for offshore wind farms across the studies range from 7.8 to 25.5 g CO_2e per kWh.

Table 30-10 Review of Average Carbon Emissions per kWh

Wind Farm sizes	Energy intensity (gCO_2e per kWh)	Source
12 x 5MW	32	Chen *et al.* (2011), referenced in Bhandari *et al.* (2020)
N/A	6	IEA World Energy Outlook (2012), referenced in Siemens Gamesa (n.d.) and Ørsted (2021)
100 x 2.5MW	13.7	Arvesen and Hertwich (2012), referenced in Bhandari *et al.* (2020)
80 x 4MW	10.9*	Bonou *et al.* (2016), referenced in Bhandari *et al.* (2020)
100 x 6MW	7.8*	Bonou *et al.* (2016), referenced in Bhandari *et al.* (2020)
28 x 3.6MW	25.5*	Yang *et al.* (2018), referenced in Bhandari *et al.* (2020)
*Offshore wind farm studies published from 2016 onwards		

90. To place these metrics into context, comparable values for electricity generation by gas and coal are around 372 and 1,002 g CO_2 per kWh (31 and 83.5 times that of offshore wind respectively, using the mean value from Dolan and Heath (2012)) (BEIS 2022a). These values are unlikely to take account of the construction materials (e.g., concrete) required for the power stations.

91. Although robust and fit for the purposes of an EIA, this assessment should not be taken to be a comprehensive, detailed LCA of the Projects. This is because it is not possible to fully define the supply chain for the Projects at this stage, and some information will be refined as the design progresses. Therefore, assumptions and simplifications to the methodology are made in certain areas and a precautionary approach is adopted for the assessment to allow for this. These assumptions and simplifications are referred to in section 30.4.4 and the worst case scenario set out in **Table 30-1**.

30.4.3.1.4 GHG Assessment Approach

92. In this assessment the term 'GHG' or 'carbon' encompasses carbon dioxide (CO_2) and the six other gases as referenced in the Kyoto Protocol, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). The results in this assessment are expressed in carbon dioxide equivalent (CO_2e), which recognises that different gases have notably different global warming potentials (GWPs).

93. GHG emissions arising from activities in the construction, operation and maintenance, and decommissioning phases of the Projects are predicted within a defined project boundary (see section 30.3.1), in accordance with the GHG Protocol (World Resources Institute and World Business Council on Sustainable Development 2015), an international standard for corporate reporting. GHG emissions were quantified using a standard calculation-based methodology, which involves multiplying activity data gathered for the Projects, or developed based on professional judgement using industry benchmarks and assumptions where information gaps exist, with the relevant emission factors, and where applicable calorific and GWP factors.

94. This chapter provides a GHG assessment for the In Isolation and Sequential Scenarios only, as discussed in section 30.3.3.2.1. Emissions were calculated for each phase of the Projects, and then combined across the whole lifecycle. To assist with determining the significance of effects, additional parameters were considered to contextualise the outcomes of the assessment, and the benefits of supplying renewable energy to the UK electricity grid, as listed **Table 30-11**.

Table 30-11 Additional Parameters for the GHG Assessment

Parameter name	Phase	Description
Comparison to UK carbon budgets	• Construction • Operation and maintenance	Construction and operation and maintenance emissions were calculated as a percentage of the UK carbon budget to which the respective phase of the Projects corresponds to.

Parameter name	Phase	Description
Avoided emissions	• Operation and maintenance	Avoided GHG emissions from the provision of renewable energy to the grid, which would have otherwise been generated using natural gas, as discussed in section 30.5.1. The emission factors for the use of natural gas considers operational emissions, and therefore do not account for other lifecycle carbon impacts. To enable a like-for-like comparison, emissions from the construction and decommissioning phases are excluded from this calculation.
GHG intensity of produced electricity	• Operation and maintenance • Whole lifecycle	The amount of GHGs released per unit of electricity generated, typically expressed as grams (g) of CO_2e per kWh.
GHG payback period	• Whole lifecycle	The time it would take for electricity generated by the Projects to offset their respective whole life emissions by displacing an equivalent amount of grid electricity generated using natural gas.

30.4.3.1.5 Emission Calculations

95. GHG emission sources arising from the Projects are categorised into five main source groups, as detailed in **Table 30-12**.

Table 30-12 Emission Source Groups Considered in the Assessment

Source Name	Phase	Onshore or offshore	Definition	Project sources
Embodied emissions in materials	Construction, operation, and maintenance	Both	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 are quantified for the main construction materials to be used for the onshore and offshore components of the Projects including foundations, wind turbines (tower, nacelle, rotor, blades), scour protection, export cables (onshore and offshore), offshore platforms and the onshore substations. The requirement for spare (or replacement) parts during operation is not known at this stage, therefore the likely composition of emissions in terms of the overall footprint of the Projects are obtained from existing literature.
Marine vessels	Construction, operation and maintenance	Offshore	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 component of the Projects are calculated. Emissions from vessels associated with installation of foundations, wind turbines and cables, as well as supply and support, accommodation and

Source Name	Phase	Onshore or offshore	Definition	Project sources
				commissioning vessels are also quantified. Emissions from marine vessel movements during the operation and maintenance phase are also quantified.
Helicopter	Construction, operation and maintenance	Offshore	GHG emissions are released in exhaust gases arising from the combustion of fossil fuels on helicopters.	Emissions associated with helicopter movements during construction, operation and maintenance are quantified in the assessment.
Road vehicles	Construction, operation and maintenance	Onshore	GHG emissions are released from the combustion of fossil fuels by road vehicles.	Emissions associated with the movement of HGVs and staff travel during construction and operation are included within the assessment.
Plant and equipment	Construction	Onshore	Emissions are released from Non-Road Mobile Machinery (NRMM) as a result of fuel combustion.	Emissions from the use of NRMM during construction of the onshore component of the Projects are quantified. This included the landfall, trenchless crossings, cable installation, temporary construction compounds and substation works.

96. Details on all the activities that would 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 30.4.4. In the absence of specific data for the In Isolation and Sequential Scenarios, assumptions that were adopted are based on indicative data from similar projects or professional judgement. Emissions from decommissioning are derived from previous studies (Thomson and Harrison 2015), where it is established that this phase would contribute approximately 1.2% of the carbon footprint.

97. The approach to quantifying GHG emissions for each of the source groups detailed in Table 30-12Table 30-12 is provided in **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**. The total operational life of the Projects is anticipated to be 30 years for the Sequential Scenario.

30.4.3.1.5.1 Embodied Emissions in Materials

98. The list of key offshore components of the Projects for which the embodied emissions are determined is detailed in **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**.

99. The approach to determining embodied emissions from materials used for the Projects is detailed in **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**.

30.4.3.1.5.2 Marine Vessels

100. Marine vessels would be used to bring materials and components to the wind farm site, install infrastructure (wind turbines, offshore substation platforms, foundations and cables), provide crew accommodation and support during construction, commissioning and for operation and maintenance activities. The working assumptions for offshore vessel logistics is detailed in section 30.1.2 of **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**.

101. Full details of the approach undertaken to determine GHG emissions from marine vessels is detailed in **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**.

30.4.3.1.5.3 Helicopters

102. Helicopter movements associated with the Projects would result in the release of GHG emissions. Section 30.3 of **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)** outlines the requirement for helicopter use in support of the Projects.

103. The methodology for determining GHG emissions from helicopter movements associated with the Projects is provided in **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**.

30.4.3.1.5.4 Road Traffic Vehicles

104. Road traffic vehicle movements associated with the construction, operation and maintenance phases of the Projects would result in the release of GHG emissions. GHG emissions are 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 **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**.

30.4.3.1.5.5 Plant and Equipment

105. Fuel consumption associated with the operation of NRMM for the onshore components of the Projects are calculated based on the estimated use of each item of plant and equipment, with representative engine sizes and indicative construction plant and equipment for construction activities at the Landfall Zone and along the Onshore Export Cable Corridor provided.

106. The approach in determining construction plant and equipment GHG emissions is detailed in **Volume 7, Appendix 30-1 Consultation (application ref: 7.30.30.1)**.

30.4.3.1.6 Definitions of Sensitivity and Magnitude - GHG assessment

107. This assessment is undertaken in accordance with the general methodology presented within **Volume 7**, **Chapter 6 EIA Methodology (application ref: 7.6)**; 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.

30.4.3.1.6.1 Sensitivity

108. 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.

30.4.3.1.6.2 Magnitude

109. The magnitude of impact is not defined, as the effect significance for the GHG assessment is not determined by the magnitude of GHG emissions alone (IEMA 2022). However, the Projects' construction, operation and maintenance and decommissioning emissions have been calculated as part of the assessment, both by the project phase and combined over the whole lifecycle.

110. The impact of GHG emission is, by nature, global and long term with low reversibility, owing to the long atmospheric lifetime of GHGs and their prolonged effect on the climate system.

30.4.3.1.7 Effect Significance

111. The 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".

112. 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 (IEMA 2022) recommends that significance criteria align with the Paris Agreement, the UK's Carbon Budgets up to 2037 and net zero commitments: "*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*".

113. The updated IEMA guidance provides relative 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 the 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 in **Table 30-13**.

Table 30-13 Assessment Significance Criteria

Significance	Definition
Major adverse	The Projects' 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.

Significance	Definition
Moderate adverse	The Projects' 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 Projects' 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.
Negligible	The Projects' 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 Projects' 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.

114. The effect significance of the Projects' GHG emissions was evaluated by project phase. For the construction phase, significance was determined by comparing the magnitude of emissions with the 5th UK carbon budget (2028 to 2032) and evaluated on its effect on the UK's ability to meet its future carbon budgets and, by proxy, the emission reduction needed to achieve its international climate commitments and a science-based 1.5°C transition towards net zero.

115. For the operation and maintenance and decommissioning phases, the relevant UK carbon budgets have not been set or do not apply, as the Projects' operational lifetime extends beyond 2050 by which the UK commits to achieving net zero. Therefore, the effect significance for these phases was determined by considering the Projects' effects on the UK's ability to achieve and maintain its net zero status. The first five years of the Projects' operation and maintenance phase aligns with the 6th carbon budget (2033 to 2037). Emissions over this budget period have also been compared for further context.

116. In addition to evaluating effect significance by project phase, overall significance was also determined by considering the Projects' lifecycle emissions with the total emissions avoided from the displacement of electricity which could otherwise have been generated using a more intensive GHG source. The overall effect significance considers all emissions released by the wind farms in their entirety and therefore the net contribution to climate change.

117. Likely significant effects identified within the assessment as major/moderate adverse or beneficial are deemed to be significant in EIA terms within this chapter. In cases where there is a net reduction in emissions, only one level of significance criteria is offered.

30.4.3.2 GHG Assessment - Cumulative Effect Assessment Methodology

118. The global atmosphere is the receptor for the GHG assessment. Emissions of GHGs to the atmosphere have the potential to contribute to climate change, and therefore the effects are global and cumulative in nature. This is considered in defining the receptor (i.e. the global atmosphere) as high sensitivity.

119. The IEMA guidance (IEMA 2022) states that effects of GHG emissions from specific cumulative projects should 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.

30.4.3.3 GHG Assessment - Transboundary Effect Assessment Methodology

120. As noted above for cumulative impacts, the receptor for the GHG assessment is the global atmosphere, and therefore emissions of GHGs have an indirect transboundary impact. As the GHG emissions are assessed in context of the UK carbon budgets and the aspirations to reduce GHG emissions in line with climate agreements, the transboundary impacts of GHGs emitted by the Projects are not considered to require a separate assessment.

30.4.3.4 CCRA Methodology

121. The methodology adopted for the CCRA is informed by IEMA guidance, Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation (IEMA 2020). The methodology varies from general EIA approach presented in **Volume 7**, **Chapter 6 EIA Methodology (application ref: 7.6)**.

122. The purpose of this assessment is to evaluate the resilience and vulnerability of the design and infrastructure to the projected effects of climate change over the construction, operational and maintenance, and decommissioning phases of the Projects. This assessment identifies the likelihood of climate hazards occurring within the study area, and the consequences of the impact will be highlighted.

123. The CCRA methodology is outlined in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)**, which was applied for the In Isolation and Sequential Scenarios.

30.4.3.5 CCRA - Cumulative Effect Assessment Methodology

124. The cumulative effect assessment (CEA) for a CCRA considers the potential for other projects or plans to act collectively to exacerbate a project's climate vulnerability and risk. Likewise, there is also potential for a project to influence the climate change resilience of other projects or plans.

125. The only climate hazard with a potential for cumulative effects in the CCRA is surface water flooding. As identified in **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)**, there are 16 schemes which were identified as having the potential to result in cumulative surface water flooding effects, due to their location compared to the Onshore Development Area. An assessment of the potential cumulative effects of these 16 schemes is considered in section 30.8.

30.4.3.6 CCRA - Transboundary Effect Assessment Methodology

126. It is not relevant to assess transboundary effects relating to climate change resilience, since the assessment focusses on the effects of climate change on the Projects. Therefore, a transboundary effect assessment is not undertaken for the CCRA.

30.4.4 Assumptions and Limitations

127. Several assumptions are made in the GHG assessment and the CCRA, as set out in **Table 30-14**. Further details of the methodology adopted to quantify GHG emissions from the Projects and the CCRA are presented in **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)** and **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** respectively.

Table 30-14 Assumptions and Limitations of the GHG Assessment and CCRA

ID	Assumption / Limitation	Discussion
1	Some quantities for materials to be used during construction are not currently available	Quantities of the main and most GHG intensive materials are included in the assessment. Furthermore, precautionary assumptions are adopted for quantities of known materials (i.e. using the maximum quantity).
2	Recycled content of construction materials is unknown	It has been assumed that all steel used on the Projects is virgin steel to provide a precautionary assessment. However, it is likely that steel used in construction would 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 are 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 is variation across different compositions of the same material, the 'General' option within the ICE database is chosen, if available, or the median value if not. This approach is appropriate in the absence of specific material information.

ID	Assumption / Limitation	Discussion
5	The origin port of some 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.	As most emissions would be released from vessels whilst at the site during installation, the changes to the transit time for marine vessels would have a limited effect in terms of the overall GHG footprint. However, the most likely origin ports known at the time of the assessment are used to derive GHG emissions during vessel transit.
6	Operation and maintenance emissions	Many sectors are anticipated to decarbonise over the next 35 years, and during operation and maintenance, it is likely that the emissions intensity of producing materials and the movement of marine vessels would be less than the present day. Therefore, emissions associated with the operation and maintenance phase of the Projects are likely to be a significant overestimation.

ID	Assumption / Limitation	Discussion
7	Where there are multiple options for possible project parameters, the worst case is selected including, material quantities, vessel movements, plant and equipment operational requirement.	This approach provides a conservative assessment as there may be unrealistic combinations of the Projects' parameters which are used in determining the worst case scenario. This approach is applied for the following: • Material quantities for the construction phase of the Projects. See section 30.1.1 of **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)** for details. • Movement of marine vessels on site during construction. See section 30.1.2 of **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)** for details. • Helicopter movements during the construction/commissioning, operation, and maintenance. See section 30.1.3 of **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)** for details. • Plant and equipment for onshore components. See section 30.4.3.1.5.5 and section 30.1.5 of **Volume 7**, **Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**.

ID	Assumption / Limitation	Discussion
8	Climate change projections	A key assumption of the climate change projection data from the UKC18 is that the model is strongly dependent on the 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 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 Projects. However, the UKCP18 guidance cautions that the scientific community cannot reliably place probabilities on which scenario of GHG emissions is most likely. Due to the intrinsic uncertainty within climate change projections, the UKCP data is based upon probabilistic projections, generating a normally distributed model per output. The model outputs values for the 10th, 50th and 90th percentiles, which represents the range of uncertainty, and is therefore presented as such in the chapter. In addition, UKCP data do not cover all climate variables which may be relevant to the study area. Where information gaps exist, these are supplemented with other available literature sources.
9	Spatial resolution of the climate baseline	Climate change projections are provided by grid cells. The size of the grid cell determines the spatial resolution of the projection data and how it corresponds to the study area. It is assumed that the climate baseline across the study area is adequately described by the selected grid cell. It is important to note that the majority of climate observation and projection data is for onshore areas, with less information available for marine areas.

ID	Assumption / Limitation	Discussion
10	Temporal resolution of the climate baseline	Moreover, climate change projections are provided as time series. For the purpose of the CCRA, the data is summarised and presented as climate averages for the selected time slices. It is assumed that these time slices are representative of current and future conditions within the study area and provide sufficient temporal coverage. The CCRA is based on historical observations, most recent climate change projections and existing climate change literature and research. Thus, information which has been made available after the time of assessment is not reflected within this chapter.

30.5 Existing Environment

30.5.1 GHG Assessment - Baseline 'Do Nothing' Scenario

128. To help determine the significance and contextualise the outcomes of the GHG assessment, consideration of a baseline or 'Do Nothing' scenario is required which assumes that no Project is constructed.

129. The UK electricity grid mix currently includes several different energy sources, including gas, nuclear, onshore, and offshore wind, coal, bioenergy, solar and hydroelectric. However, it is recognised that the growth of renewable energy is key to the UK's Energy Strategy and net zero targets, coupled with a transition away from electricity generated from fossil fuels.

130. Therefore, to evaluate the impacts of the In Isolation and Sequential Scenarios in line with the worst case scenario detailed in section 30.3.3.2.1, the 'Do Nothing' scenario considers the emissions from fossil fuel electricity generation sources that are not displaced by the provision of renewable energy to the grid supplied by the Projects in the scenario the Projects are not constructed. This was considered for the In Isolation and Sequential Scenarios over the 30 year temporal scope of the assessment. Noting that whilst each project in a Sequential Scenario is operational for 30 years, the temporal scope of the Sequential Scenario is 32 years due to the (up to) 2 year lag between the construction of each Project.

30.5.1.1 Energy Produced by the Projects

131. The approximate quantity of energy produced by the Projects both annually and over the lifetime of the Project for both the In Isolation and Sequential Scenarios is quantified from the approach advocated by RenewableUK (2022). In this method, the installed capacity (assumed to be a maximum of 1,500 MW) is multiplied by the hours in the year (8,760) and by the appropriate average load or capacity factor for the Projects. For new build offshore wind farms, BEIS advises that the load factor is 63.1% (BEIS, 2021).

132. The anticipated energy produced by the Projects is provided in **Table 30-15**.

Table 30-15 Energy Produced by the Projects

Scenario	Energy per Year (MWh)	Energy over the lifetime of the Projects (MWh)
In isolation (30 years)	8,291,340	248,470,200

Scenario	Energy per Year (MWh)	Energy over the lifetime of the Projects (MWh)
Sequential (30 years per project over an overall 32 year time frame)	16,582,680	497,480,400

30.5.1.2 GHG Emissions from the 'Do Nothing' Scenario

133. In the 'Do Nothing' Scenario, where the Projects are not constructed, it has been assumed that the energy produced by the Projects would be produced using gas instead, as this is the most common form of new plant in terms of fossil fuel combustion (DESNZ, 2023d).

134. The quantity of GHG emissions produced from the generation of electricity by gas, that the Projects would otherwise provide in the 'Do Nothing' scenario is presented in **Table 30-16** for the In Isolation and Sequential Scenarios**.**

135. This has been quantified by multiplying the anticipated energy generated by the Projects by the estimated CO_2 emissions from gas supplied electricity (371 tCO_2 per GWh) (DESNZ, 2023d). It is noted that the electricity supplied by gas emission factor is in units of CO_2 rather than CO_2e, however CO_2 is likely to form the main contribution to generation of electricity from gas and the factor is likely higher, if other GHGs are to be included.

Table 30-16 Do Nothing Scenario Baseline GHG Emissions

Timeframe	Anticipated energy produced by the Projects (GWh)	GHG emissions from electricity generated from gas (tonnes CO_2)
In Isolation Scenario		
Per year	8,291	3,074,329
Duration of the Project (30 years)	248,740	92,229,856
Sequential Scenario		
Per year	16,583	6,148,657

Timeframe	Anticipated energy produced by the Projects (GWh)	GHG emissions from electricity generated from gas (tonnes CO_2)
Duration of the Project (30 years)	497,480	184,459,713

30.5.2 CCRA

30.5.2.1 Existing Climate

136. Annual average temperatures over the most recent decade (2009 to 2018) have been on average 0.2°C warmer than the 1981-2000 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 1981-2000 and 5% wetter than 1961-1990 for the UK overall (Met Office 2022a).

137. The Projects' offshore Array Areas are in the southern North Sea. DBS West is located 100km from the closest point on the shore, near Skipsea, and DBS East is located 122km closest point to the shore. The Onshore Development Area is in the county of East Riding of Yorkshire. Existing climate data for the period 1991 to 2020 has been obtained from the Leconfield Sar (East Riding of Yorkshire) meteorological recording station, which is the closest station to the Onshore Development Area. The Met Office UK Climate Averages (2022b) are only publicly available for onshore meteorological sites. Climate data for Leconfield Sar, England and the UK are provided in **Table 30-17.**

Table 30-17 Existing Local, Regional and National Climate for the 1991 to 2020 Period (Met Office 2022b)

Climate variable	Units	Annual average			
		Leconfield Sar	North of England	England	UK
Maximum temperature (average over 12 months)	°C	13.85	12.79	13.82	12.79

Climate variable	Units	Annual average			
		Leconfield Sar	North of England	England	UK
Minimum temperature (average over 12 months)	°C	6.19	5.55	6.12	5.53
Days of air frost	Days	40.06	51.29	45.14	53.36
Rainfall	mm	661	986	870	1,163
Days of rainfall ≥ 1 mm	Days	124.0	147.4	135.2	159.1
Mean wind speed at 10 m	Knots	8.20	8.88	8.33	9.27

138. **Table 30-17** displays the influence of the maritime setting of the Onshore Development Area. Annual average maximum and minimum temperatures are both higher than the England North, England and UK averages, and there are fewer days of air frost. As the Onshore Development Area is located on the east coast of England, it experiences less average rainfall than the rest of England and the UK. This is due to the predominant weather patterns in the UK whereby wetter conditions are typically experienced in the west due to the influence of south-west prevailing winds from the Atlantic Ocean. The mean wind speed (at 10 m) at the Leconfield is less than the regional, England, and UK averages.

30.5.2.2 Projected Climate Change

139. Climate change projects were used to identify the future change to climate variables within the Study Area. It is anticipated that the In Isolation and Sequential Scenarios would have an operational lifespan of at least 30 years. As such, climate forecasts and impacts to the baseline conditions arising from the operation of the In Isolation and Sequential Scenarios are based on a 35 and 37-year lifespan respectively (assuming a construction period of approximately 5 and 7 years respectively).

140. The UKCP database uses RCPs which align with the emissions scenarios used in the Intergovernmental Panel on Climate Change (IPCC) 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. The RCP scenarios are defined in **Table 30-18**. For each of these RCPs, where relevant and available, three probabilities will be considered, 10% (unlikely), 50% (central estimate of projections) and 90% (projections unlikely to be less than).

Table 30-18 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 emission 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 emissions scenario	4.3 (3.2 -5.4)	Increasing global GHG emissions throughout the 21st century

141. Future climate projects are modelled projections and are strongly dependent on future global GHG emissions, and uncertainties associated with these are detailed in **Table 30-14**. Where possible, climate changes over construction, and the 30-year operational and maintenance phases of In Isolation and Sequential Scenarios are detailed.

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

142. 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 an RCP 8.5 scenario, where global GHG emissions continue to increase throughout the 21st 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).

143. 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 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).

144. 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).

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

146. 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).

147. The majority of UKCP probabilistic projections are land-based and therefore only provide direct coverage for the Onshore Development for the Projects.

148. Data from the RCP emission scenarios presented within **Table 30-18** were obtained from two 25km land-based grid cells which cover the Onshore Development Area (512500, 437500 and 512500, 462500 grid cells)

149. The UKCP18 data provides 20-year time slices relative to the 1981 to 2000 baseline. The climate projections have been obtained for the 2030s (2020-2039), 2050s (2040 – 2059) and 2060s (2050-2069), these periods cover the construction, operation and decommissioning phase of the Projects and represent the short-, medium- and long-term climate change impacts.

150. Changes in annual average temperature and precipitation rate anomalies are compared to a baseline period 1981 to 2000 and are displayed in **Table 30-19** and **Table 30-20** for the RCP2.6 (stringent emission scenario) and RCP8.5 (very high emission) scenarios respectively (Met Office 2018a). The RCP2.6 and RCP8.5 scenarios are considered in order to provide a balanced representation of climate projections and enable a comparison of the best and worst case climate conditions as a result of future GHG emissions.

Table 30-19 Temperature and Precipitation Projection Data Under RCP2.6 within the Study Area in 2030s, 2050s and 2060s (from a 1981-2000 Baseline), at the 10th, 50th and 90th Percentile

Season	**Variable**	**Time period**	**UKCP18 land-based grid cell - 512500, 437500**			**UKCP18 land-based grid cell - 512500, 462500**		
			Project change at					
			10th percentile	**50th percentile**	**90th percentile**	**10th percentile**	**50th percentile**	**90th percentile**
Annual	Mean Temperature (°C)	2030s (construction phase)	0.42	0.97	1.55	0.42	0.97	1.55
		2050s (operation and maintenance phase)	0.53	1.22	1.97	0.53	1.22	1.97
		2060s (Decommissioning phase)	0.45	1.18	1.95	0.45	1.17	1.94
	Mean Precipitation (%)	2030s	-5.16	2.02	10.02	-4.86	2.26	10.12
		2050s	-9.15	-1.62	6.28	-8.58	-1.45	6.02
		2060s	-9.61	-0.71	8.21	-9.38	-0.73	8.09
Winter	Mean Temperature (°C)	2030s	0.03	0.81	1.63	0.03	0.82	1.63
		2050s	-0.02	1.01	2.06	-0.02	1.01	2.06
		2060s	-0.04	1.04	2.10	-0.05	1.04	2.10
	Mean Precipitation (%)	2030s	-5.62	4.41	15.09	-5.12	4.85	15.52
		2050s	-4.31	5.65	17.00	-3.72	6.34	17.92
		2060s	-4.66	5.66	17.61	-4.67	5.46	17.36
Summer	Mean Temperature (°C)	2030s	0.37	1.15	1.94	0.37	1.14	1.92
		2050s	0.70	1.56	2.49	0.70	1.55	2.47

Season	Variable	Time period	UKCP18 land-based grid cell - 512500, 437500			UKCP18 land-based grid cell - 512500, 462500		
			Project change at					
			10th percentile	50th percentile	90th percentile	10th percentile	50th percentile	90th percentile
		2060s	0.52	1.43	2.38	0.52	1.42	2.36
	Mean Precipitation (%)	2030s	-23.60	-3.02	16.53	-23.90	-5.76	13.38
		2050s	-32.51	-13.64	5.06	-32.26	-14.14	3.84
		2060s	-32.38	-10.76	11.36	-31.79	-11.04	10.72

Table 30-20 Temperature and Precipitation Projection Data Under RCP8.5 within the Study Area in 2050s (2040-2059, from 1981-2000 Baseline)

Season	Variable	Time period	UKCP18 512500, 437500 25km land-based grid cell			UKCP18 512500, 462500 25km land-based grid cell		
			Project change at					
			10th percentile	50th percentile	90th percentile	10th percentile	50th percentile	90th percentile
Annual	Mean Temperature (°C)	2030s (construction phase)	0.44	0.99	1.58	0.44	0.99	1.57
		2050s (operation and maintenance phase)	0.89	1.72	2.60	0.88	1.72	2.59
		2060s (Decommissioning phase)	1.13	2.13	3.20	1.12	2.12	3.18
	Mean Precipitation (%)	2030s	-5.03	2.83	10.76	-9.38	-0.73	8.09
		2050s	-10.53	-1.46	7.69	-9.94	-1.34	7.52
		2060s	-11.71	-1.54	9.16	-11.43	-1.57	9.01
Winter		2030s	0.14	0.90	1.72	0.14	0.90	1.72

Season	Variable	Time period	UKCP18 512500, 437500 25km land-based grid cell			UKCP18 512500, 462500 25km land-based grid cell		
			Project change at					
			10th percentile	50th percentile	90th percentile	10th percentile	50th percentile	90th percentile
	Mean Temperature (°C)	2050s	0.46	1.54	2.70	0.46	1.54	2.70
		2060s	0.61	1.92	3.32	0.61	1.92	3.31
	Mean Precipitation (%)	2030s	-5.58	4.86	15.69	-5.06	5.30	16.13
		2050s	-3.95	7.84	21.04	-3.29	8.61	22.12
		2060s	-4.49	8.77	24.91	-4.59	8.72	24.82
Summer	Mean Temperature (°C)	2030s	0.36	1.15	1.94	0.36	1.14	1.93
		2050s	0.93	2.08	0.93	0.92	2.06	0.92
		2060s	1.16	2.55	3.98	1.15	2.53	3.95
	Mean Precipitation (%)	2030s	-22.04	-3.02	16.53	-22.31	-3.45	16.33
		2050s	-37.03	-14.00	9.37	-36.81	-14.46	8.06
		2060s	-41.39	-15.21	12.43	-40.81	-15.22	11.78

151. **Table 30-19** and **Table 30-20** highlights that under both RCP2.6 and RCP8.5, annual, summer and winter temperatures in the Onshore Development Area are likely to increase in the Projects' construction (2030s), operational (2050s) and decommissioning (2060s) phases. For the operational phase of the Projects, under RCP8.5, as shown in **Table 30-20**, the probabilistic annual mean temperature projections in the 2050s are predicted to increase by 0.8 and 2.6°C (10th and 90th percentile respectively) for the 512500, 437500 and 512500, 462500 grid areas (Met Office 2018a). The worst case projected annual temperature increase under the RCP8.5 scenario (90th percentile), 512500, 462500 grid area) for the decommissioning phase of the Projects is 3.2°C and 3.1°C (for the 512500, 437500 and 512500, 462500 grid areas).

152. Under the RCP8.5 scenario detailed in **Table 30-20**, the annual mean precipitation rate appears more variable, with the construction phase (2030s) figures ranging from -5.03 to 10.6% and -9.38 to 80.9% change (10th and 90th percentile) for the respective 512500, 437500 and 512500, 462500 grid areas (Met Office 2018a). In addition, for the operational phase (2050s), the annual mean precipitation rate appears more variable and ranges from -10.53 to 7.69%, and -9.94 to 7.52% change (10th and 90th percentile) for the respective 512500, 437500 and 512500, 462500 grid areas (Met Office 2018a).

30.5.2.2.2 Sea Temperature

153. Alteration of climate is also likely to affect sea surface temperatures and near-bottom temperatures, which in addition to melting ice sheets and glaciers, contribute to global sea level rise due to thermal expansion of seawater (Fox-Kemper *et al.* 2021). Over the last 40 years, average sea surface temperature around the UK has shown a significant warming trend of around 0.3°C per decade, with marked local and regional variations, as shown in **Plate 30-3**.

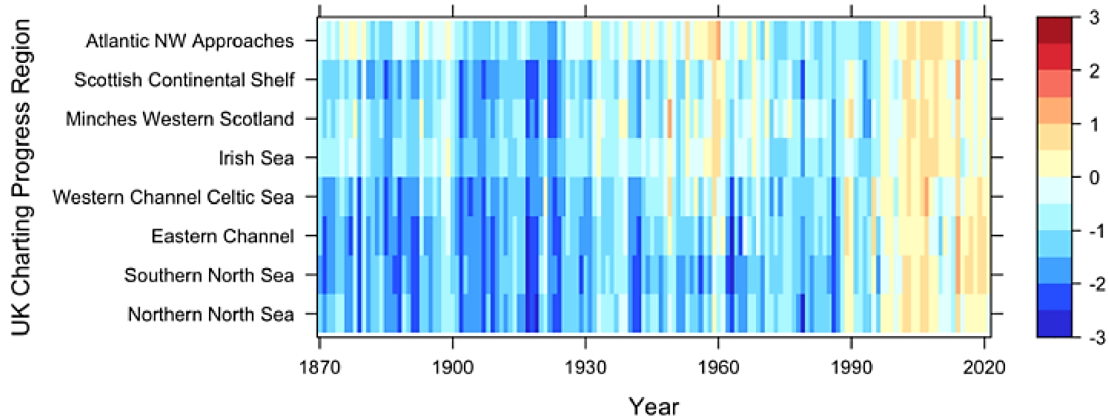

Plate 30-3 Observed changes in sea temperatures around the UK (sourced from Tinker et al. 2023)

30.5.2.2.3 Marine Projection – Sea Level Rise, Storm Surge and Coastal Erosion

154. 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).

155. The UKCP climate marine projection data are most applicable to onshore and coastal areas. Average sea level rise data from the nearest coastal grid square covering where the export cable corridor reaches landfall (53.94, -0.08), were obtained from 2007 to 2100 for RCP2.6 and RCP8.5 scenarios as displayed in plot graphs in **Plate 30-4**.

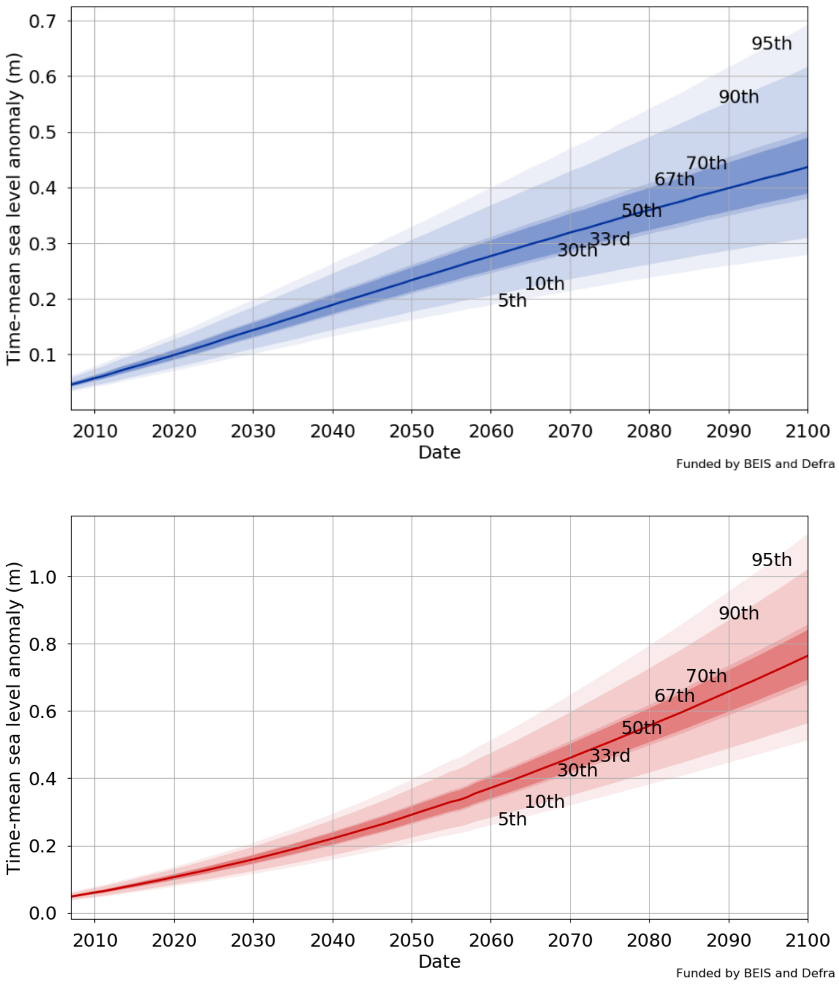

Plate 30-4 Time mean sea level anomaly (m) years 2007 up to and including 2100, for the Projects coastal grid square (53.94, -0.08), using baseline 1981-2000, and scenarios RCP2.6 (blue)), RCP8.5 (red), showing the 5th to 95th percentiles (Met Office 2018a)

156. As shown in **Plate 30-4**, it is projected that the average sea level in the coastal area of the Projects would increase over the different phases of the Projects for both RCP2.6 and RCP8.5.

157. Under RCP2.6, the average sea level rise of the Projects' coast area by 2030 (construction phase) is predicted to be between 0.11 and 0.20m (5^{th} and 95^{th} percentile respectively), by 2050 (operational phase) the average sea level rise is predicted to be between 0.16 and 0.33m (5^{th} and 95^{th} percentile respectively) and by 2060 (decommissioning phase) the average sea level rise is predicted to be between 0.19 and 0.40m (5^{th} and 95^{th} percentile respectively) (Met Office 2018b).

158. Under RCP8.5, this projection increases to a sea level rise of between 0.11 and 0.20m by 2030 (construction phase) (5th and 95th percentile respectively), between 0.20 and 0.39m by 2050 (operational phase) (5th and 95th percentile respectively) and between 0.26 and 0.51m by 2060 (decommissioning phase) (Met Office 2018b).

159. It is predicted that future extreme sea levels will be as a result of changes in mean sea level, and not from the storm surge component or changes to tides. It is estimated that current regional rates of sea level rise around the UK are between 1mm to 2mm per annum, and rates in the south of the UK are higher than some parts of Scotland when vertical land movement (glacial isostatic adjustment since the last ice age) is also taken into consideration (Horsburgh *et al*. 2020).

160. Horsburgh *et al.* (2020) concluded that there is no observational evidence for long-term trends in either storminess across the UK or resultant storm surges, and simulations for storm surges over the 21st century suggest that there are likely to be no significant changes to storm surges in the UK. The Wolf *et al.* (2020) summary on future projections on storms and waves concluded that future projections in waters surrounding the UK are sensitive to climate model projections for the North Atlantic storm track, which contains considerable uncertainty. In the near future, natural variability dominates any climate-related trends in storms and waves, and towards the end of the 21st century, there is some consensus that mean significant wave height is decreasing while most extreme wave height is increasing.

161. Sea level rise, in addition to other factors such as storms, anthropogenic disturbance and reduced sediment supply, will also result in more erosion of the coast. Approximately 17% of the UK coastline is undergoing erosion and approximately 28% of the 3,700km England and Wales coastline is experiencing erosion greater than 10 cm per year (Masselink *et al.* 2020). The future baseline for coastal erosion for the Projects is discussed in **Volume 7**, **Chapter 8 Marine Physical Environment (application ref: 7.8)**.

30.6 Assessment of Significance

30.6.1 Impact 1 - GHG Assessment

162. This section presents the GHG emissions associated with the construction, operation, and maintenance, and decommissioning of the Projects. The carbon benefits of the Projects are then listed, including the quantity of GHG emissions saved (or avoided), the GHG intensity of the electricity produced by the Projects and the GHG payback period.

163. One of the principal purposes of the Projects is to make a contribution to mitigating climate change by generating renewable electricity, therefore helping decarbonise the UK's grid.

30.6.1.1 Potential Effects During Construction

30.6.1.1.1 In Isolation Scenario

164. For the In Isolation Scenario, described in section 30.3.3, the emissions sources that were considered include embodied carbon in materials used during construction, marine vessels, road vehicles, helicopters and the use of onshore plant and equipment. GHG emissions were quantified in accordance with the methodology outlined in section 30.4.3.1 and **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**. Construction emissions for the In Isolation Scenario are shown in **Table 30-21** by source group.

Table 30-21 In Isolation Scenario Construction GHG Emissions

Source group	GHG emissions (tonnes CO_2e)	Percentage of construction emissions
Embodied carbon	2,425,343	71.0%
Marine vessels	943,946	27.6%
Helicopters	7,605	0.2%
Construction Plant and Equipment	35,314	1.0%
Construction Traffic	6,077	0.2%
Total (over entire construction phase)	**3,418,284**	

165. Total emissions during construction for the In Isolation Scenario were estimated at 3,418,284 tonnes CO_2e. Embodied carbon in construction materials is expected to be the largest contributor to construction phase emissions, representing 71% of the total during this phase. Most of the embodied carbon is associated with the use of steel, which has a high embodied carbon content and large quantities are required for the Projects. As noted in section 30.4.4, conservative assumptions were used in the assessment, such as the use of virgin steel, which is likely to result in an overestimation of emissions.

30.6.1.1.1.1 Comparison to UK Carbon Budgets

166. The construction phase of the In Isolation Scenario is due to commence in 2026, and last for a duration of five years. It would therefore fall within the 4th carbon budget period (2023 to 2027) and 5th carbon budget period (2028 to 2032). Estimated emissions during construction would constitute around 0.08% of the 4th carbon budget and 0.12% of the 5th carbon budget, which forms a relatively small proportion, and GHG emissions during construction would occur over a short duration as a single occurrence.

167. Given the international nature of supply chains, it should be noted that a portion of embodied carbon emissions are likely to occur outside the territorial boundary of the UK, and hence outside the scope of the UK's national carbon budget, policy, and governance. However, considering that GHG emissions affect the climate system wherever they occur and the need to avoid 'carbon leakage' overseas when reducing UK emissions, embodied carbon emissions have been included in the assessment.

30.6.1.1.1.2 Significance of Effect - In Isolation Scenario

168. As GHG emissions resulting from the construction of the In Isolation Scenario would have a **negligible** contribution to the 4th and 5th carbon budget, construction of the Projects is unlikely to adversely affect the UK's ability to meet its future carbon targets. At each stage of the design process, the climate change impact of the In Isolation Scenario has been considered by the Applicants. This has resulted in the implementation of mitigation measures to optimise the design including minimising steel mass in the offshore foundation structures, and the use of the latest technology where possible. In addition, a number of conservative assumptions were adopted for the assessment, including the use of virgin materials for all components of the Projects.

169. Therefore, construction emissions in the In Isolation Scenario are considered to have a **minor adverse** effect on climate change and are considered non-significant in EIA terms. Emissions during construction are required to enable the implementation of the Projects to enable the provision of renewable energy in support of the UK's decarbonisation goals as detailed in section 30.6.1.2.1.1.

30.6.1.1.1.3 Mitigation and Residual Significance of Effect – In Isolation Scenario

170. Emissions from construction of the In Isolation Scenario were predicted to be not significant. However, the Applicants are committed to reducing emissions during the construction phase where practicable.

171. As stated in section 30.4.1.3.4.3, the PAS 2080 guidance document provides requirements to demonstrate leadership and establish effective governance mechanisms for reducing whole life carbon in built environment projects. The following management measures are recommended for further consideration as the Projects develop, but are not required as additional mitigation:

- Optimise the efficiency of construction activities to reduce fuel and material consumption and promote resource efficiency, inclusion of delivery and transport coordination requirements in a Vessel Management Plan, adoption of waste hierarchy in construction management plans.
- Explore opportunities to reduce embodied carbon and other construction emissions by developing carbon-focused procurement criteria and incentive mechanisms for material suppliers and project partners, such as low carbon and recycled materials, circular construction methods and performance benchmarking.
- Review and include PAS 2080's key principles and requirements with respect to carbon management in the relevant project documents which may include:
    - Establish and communicate carbon management goals, roles and responsibilities, requirements and procedures to parties involved in the delivery of the DBS East or DBS West In Isolation.
    - Practice the GHG mitigation hierarchy over the Projects' lifetime.
    - Set carbon reduction targets for the Project against a clear baseline which is aligned to the UK's net zero targets and develop the associated Key Performance Indicators and monitoring and reporting arrangements to keep track of the carbon performance of the Projects.

- Promote collaboration and information sharing across the value chain to encourage whole life carbon reductions and continual improvement.
- Provide training and raise awareness among the project team and partners on key carbon emission sources and low carbon solutions.

30.6.1.1.2 Sequential Scenario

172. For the Sequential Scenario, described in section 30.3.3, the emissions sources that were considered include embodied carbon in materials used during construction, marine vessels, road vehicles, helicopters and the use of onshore plant and equipment. Construction emissions for the Sequential Scenario are shown in **Table 30-22** by source group.

Table 30-22 Sequential Scenario Construction GHG Emissions

Source group	GHG emissions (tonnes CO_2e)	Percentage of construction emissions
Embodied carbon	4,259,303	69.4%
Marine vessels	1,793,658	29.2%
Helicopters	21,295	0.3%
Construction Plant and Equipment	52,243	0.9%
Construction Traffic	11,274	0.2%
Total (over entire construction phase)	6,137,772	

173. Emissions from construction of the Sequential Scenario were estimated to be 6,137,772tonnes CO_2e. Embodied carbon in construction materials is the largest source group, representing 69.4% of the total footprint. As noted in section 30.4.4, conservative assumptions were used in the assessment, such as the use of virgin steel for the Projects, which is likely to result in an overestimation of emissions.

30.6.1.1.2.1 Comparison to UK Carbon Budgets

174. The construction phase of the Sequential Scenario is due to commence in 2026, and last for up to seven years. It would therefore fall within the 4th carbon budget period (2023 to 2027) and 5th carbon budget period (2028 to 2032). Estimated emissions during construction would constitute approximately 0.1% of the 4th carbon budget and 0.25% of the 5th carbon budget, which forms a relatively small proportion, and GHG emissions during construction would occur over a short duration as a single occurrence.

30.6.1.1.2.2 Significance of Effect

175. As GHG emissions resulting from the construction of the Sequential Scenario have a **negligible** contribution to the 4th and 5th carbon budget, construction of the Projects is unlikely to affect the UK's ability to meet its future carbon targets. At each stage of the design process, the climate change impact of the Sequential Scenario has been considered by the Applicants. This has resulted in the implementation of mitigation measures to optimise the design including minimising steel mass of the offshore foundation structures and the use of the latest technology where possible. In addition, a number of conservative assumptions were adopted for the assessment, including the use of virgin materials for all components of the Projects.

176. The construction emissions associated with the Sequential Scenario are considered to have a **minor adverse** effect on climate change and are considered to be non-significant in EIA terms. Emissions during construction are required to enable the implementation of the Projects; which in turn will enable the provision of renewable energy in support of the UK's decarbonisation goals as detailed in section 30.6.1.2.1.1.

177. As detailed in section 30.3.3.2.1, the outcomes of the Sequential Scenario are considered to be representative of the Concurrent Scenario.

30.6.1.1.2.3 Mitigation and Residual Significance of Effect – Sequential Scenario

178. Emissions from construction in the Sequential Scenario were predicted to be not significant. However, the Applicants are committed to reducing emissions during the construction phase where practicable, including potential use of mitigation measures such as those listed in section 30.6.1.1.1.3.

30.6.1.2 Potential Effects During Operation

30.6.1.2.1 In Isolation Scenario

179. For the In Isolation Scenario, the emission sources that were considered include marine vessels, helicopters, road vehicles and embodied carbon in spare parts. Emissions were calculated using the methodology outlined in section 30.4.3.1 and **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**. Emissions during the operation and maintenance phase are shown in **Table 30-23**.

Table 30-23 In Isolation Scenario Operation and Maintenance GHG Emissions

Source group	GHG emissions (tonnes CO_2e)	Percentage of operation and maintenance emissions
Marine vessels	255,593	64.4%
Helicopters	300	0.1%
Road Traffic	83	0.02%
Spare parts	141,165	35.5%*
Total (over 30-year operational lifetime)	**397,141**	
Annual (average per year)	13,238	
*Spare parts are 3.7% of the total construction, operation and maintenance emissions.		

180. Total operation and maintenance emissions for the In Isolation Scenario was estimated to be 397,141 tonnes CO_2e over the 30-year operational lifetime, and on average 13,238 tonnes CO_2e per year. Most of the emissions are due to embodied carbon in spare parts, and marine vessel activity, accounting for 35.5 and 64.4% of the total operation and maintenance emissions respectively.

30.6.1.2.1.1 Operational GHG Intensity and Emission Savings

181. Electricity generated by the In-Isolation Scenario is less GHG intensive than other forms of generation such as gas or alternative energy sources considered in the future UK grid mix, leading to avoided GHG emissions and thus savings over its operational lifetime. This is discussed further in section 30.6.1.4 when the whole life cycle emissions of the Projects are considered. **Table 30-24** presents the quantity of emissions which would have been produced under the 'Do Nothing' scenario for the In Isolation Scenario. In addition, emissions saved from the Project's supply of renewable energy to the grid are presented, accounting for operation and maintenance emissions which are released by the Project.

Table 30-24 GHG Emission Saved by the In Isolation Scenario

Baseline scenario	Operation and maintenance GHG emissions (tonnes CO_2e)	GHG emissions from 'Do Nothing' scenario (tonnes CO_2e)	GHG emissions saved (tonnes CO_2e)
In Isolation Scenario	397,141	92,229,856	91,832,715

182. Assuming the electricity generated by the Project displaces electricity generated from natural gas, approximately 91.8 million tonnes CO_2 would be saved under the In Isolation Scenario. Although the emission factor used for natural gas generation is in units of CO_2 rather than CO_2e, this figure is still considered to be representative, as the majority of GHG emissions from fossil fuel combustion is from CO_2.

30.6.1.2.1.2 Comparison to UK Carbon Budgets

183. The operation and maintenance phase is expected to commence in 2029 in the In Isolation Scenario, and therefore is within both the 5^{th} carbon budget period (2028 to 2032) and 6^{th} carbon budget period (2033 to 2037). Operation and maintenance emissions over this period would account for 0.002% of the 5^{th} carbon budget and 0.01% of the 6^{th} carbon budget. Although the operation and maintenance of the In Isolation Scenario would occur continually over its lifetime, the magnitude of emissions would be negligible in comparison to the carbon budget.

184. In addition, when considering the emissions saved by the Project from the provision of renewable energy to the grid, the Project would result in avoided emissions when compared to the Do Nothing Scenario detailed in **Table 30-16**.

30.6.1.2.1.3 Significance of Effect

185. The Project would contribute to the UK meeting the projected increase in electricity demand over the years due to population and economic growth (BEIS, 2022), as well as the supply of renewable energy to decarbonise the power sector and support emission reductions in other economic sectors. Given the emission savings associated with the Project's operations under the In Isolation Scenario, the effect significance during the operation and maintenance phase is considered **beneficial,** which is significant in EIA terms. Any operation and maintenance emissions released by the Project over its lifetime would be **negligible** and offset by the avoided emissions it enables.

30.6.1.2.2 Sequential Scenario

186. For the Sequential Scenario, the emission sources that were considered include marine vessels, helicopters, road vehicles and embodied carbon in spare parts. Emissions were calculated using the methodology outline in section 30.4.3.1 and **Volume 7, Appendix 30-2 Greenhouse Gas Assessment Methodology (application ref: 7.30.30.2)**. Emissions during the operation and maintenance phase for the Sequential Scenario are shown in **Table 30-25**.

Table 30-25 Sequential Scenario Operation and Maintenance GHG Emissions

Source group	GHG emissions (tonnes CO_2e)	Percentage of operation and maintenance emissions
Marine vessels	733,386	73.5%
Helicopters	600	0.1%
Road Traffic	165	0.02%
Spare parts	264,019	26.5% *
Total (over 30-year operational lifetime)	**998,171**	

Source group	GHG emissions (tonnes CO_2e)	Percentage of operation and maintenance emissions
Annual (average per year)	33,272	
*Spare parts are 3.7% of the total construction, operation, and maintenance emissions.		

187. Total operation and maintenance emissions for the Sequential Scenario was estimated to be 998,171 tonnes CO_2e over the 30-year operational lifetime, and an average of 33,272 tonnes CO_2e per year. Most of the emissions are due to marine vessels and embodied carbon in spare parts, accounting for 73.5 and 26.5% of the total operation and maintenance emissions respectively.

30.6.1.2.2.1 Operation GHG Intensity and Emission Savings

188. Electricity generated by the Projects is less GHG intensive than other forms of generation such as natural gas or alternative energy sources considered in the future UK grid mix, leading to avoided GHG emissions and thus savings over its operational lifetime. **Table 30-26** presents quantity of emissions which would have been produced under the 'Do Nothing' scenario for the Sequential Scenario. In addition, emissions saved from the Projects' supply of renewable energy to the grid, accounting for operation and maintenance emissions which are released by the Projects are presented.

Table 30-26 GHG Emission Saved by the Sequential Scenario

Baseline scenario	Operation and maintenance GHG emissions (tonnes CO_2e)	GHG emissions from 'Do Nothing' scenario (tonnes CO_2)	GHG emissions saved (tonnes CO_2e)
Sequential Scenario	998,171	184,459,713	183,461,542

189. Assuming electricity from the Projects displaces electricity generated from natural gas, approximately 183.5million tonnes CO_2 would be saved under the Sequential Scenario. Although the emission factor used for natural gas generation is in units of CO_2 rather than CO_2e, this figure is still considered to be representative, as the majority of GHG emissions from fossil fuel combustion is from CO_2.

190. The Projects would supply renewable energy to the UK grid, therefore there would be emissions savings from the avoided emissions by replacing electricity that would have been generated from natural gas.

30.6.1.2.2.2 Comparison to UK Carbon Budgets

191. The first years of operation and maintenance of the Sequential Scenario fall under the 6th carbon budget period (2033 to 2037). Operation and maintenance over this budget period result in around 0.02% of the 6th carbon budget. Although greater than the contribution of the In Isolation Scenario, the emissions resulting from the Sequential Scenario are assessed to be negligible in comparison to the carbon budget.

192. In addition, when considering the emissions saved by the Projects from the provision of renewable energy to the grid, the Projects would result in avoided emissions when compared to the Do Nothing Scenario detailed in **Table 30-16**.

30.6.1.2.2.3 Significance of Effect

193. The Projects would contribute to the UK meeting the projected increase in electricity demand over the years due to population and economic growth (BEIS, 2022), as well as the supply of renewable energy to decarbonise the power sector and support in other economic sectors. It should be noted that operational and maintenance emissions released in the Sequential Scenario would be the same as the Concurrent Scenario. Given the emission savings associated with Concurrent and Sequential Scenarios, the effect significance during the operation and maintenance phase is considered **beneficial**, which is significant in EIA terms. Any operation and maintenance emissions released by the Projects over their lifetime would be **negligible** and offset by the avoided emissions they enable.

30.6.1.3 Potential Effects During Decommissioning

30.6.1.3.1 In Isolation Scenario

194. **Volume 7, Chapter 5 Project Description (application ref: 7.5)** outlines the general decommissioning approach for the Projects where applicable, however a Decommissioning Programme for the offshore elements would be developed prior to construction. An onshore Decommissioning Plan would be submitted and approved following cessation of commercial operation prior to decommissioning commencing. As the Decommissioning Plan and Programme are not available at this stage, the quantification of project-specific decommissioning emission sources was not undertaken. However, emission sources during decommissioning are likely to include marine vessel emissions from the disassembly of offshore infrastructure and transport to its end-of-life destination and emissions from waste processing, recycling, and disposal. Using an industry benchmark obtained from the literature (Thomson and Harrison, 2015), the emissions from decommissioning for the In Isolation Scenario were estimated to be 46,357tonnes CO_2e.

195. It is anticipated that a considerable amount of wind farm components would be recycled, repurposed, or incinerated for energy recovery at the end-of-life stage, as opposed to being sent to landfill, with current estimates for wind turbine recyclability ranging from 85 to 90% (Schmid *et al.*, 2020). There are also alternatives to decommissioning of offshore wind farms with potentially lower GHG footprint which could be explored as part of determining the preferred decommissioning plan. Therefore, emissions for the In Isolation Scenario are likely to be an overestimation, as they do not account for high levels of decarbonisation which will be achieved in the future, with 2050 being the UK's target net zero year, and new end-of-life strategies which may become commercially available.

30.6.1.3.1.1 Significance of Effect

196. Given that decommissioning would result in a single occurrence of GHG emission and is an inherent process in the lifecycle of offshore wind projects, the decommissioning emissions in the In Isolation Scenario are considered to have **minor adverse** effect on climate change, which is considered non-significant in EIA terms. Similarly, to the construction phase, decommissioning activities are expected to comply with applicable policy requirements and good practice design standards for offshore wind farms at the time of occurrence as detailed in **Volume 7**, **Chapter 5 Project Description (application ref: 7.5)**. Carbon management measures as specified in PAS 2080 discussed in section 30.6.1.1.1.2 are also applicable to decommissioning activities.

30.6.1.3.2 Sequential Scenario

197. As detailed for the In Isolation Scenario in section 30.6.1.2.2, the decommissioning plan is not available at this stage. However, emission sources during decommissioning are likely to include marine vessel emissions from the disassembly of offshore infrastructure and transport to its end-of-life destination and emissions from waste processing, recycling, and disposal. Using an industry benchmark obtained from the literature (Thomson and Harrison, 2015, the emissions from decommissioning in the Sequential Scenario were estimated to be 86,702 tonnes CO_2e.

198. It is anticipated that a considerable amount of wind farm components would be recycled, repurposed, or incinerated for energy recovery at the end-of-life stage, as opposed to being sent to landfill, with current estimates for wind turbine recyclability ranging from 85 to 90% (Schmid *et al*., 2020). As stated in section 30.6.1.2.2, due to the expected future decarbonisation, with 2050 being the UK's target net zero year, there may be new end-of-life strategies and alternative approaches to decommissioning wind farms that would result in lower end-of-life GHG footprints. Therefore, emissions during decommissioning for the Sequential Scenario are likely to be an overestimate.

30.6.1.3.2.1 Significance of Effect

199. Given that decommissioning would result in a single occurrence of GHG emission and is an inherent process in the lifecycle of offshore wind projects, emissions during decommissioning for the Sequential Scenario are considered to have a **minor adverse** effect on climate change, which is considered non-significant in EIA terms. Similarly, to the construction phase, decommissioning activities are expected to comply with applicable policy requirements and good practice design standards for offshore wind farms at the time of occurrence as detailed in **Volume 7**, **Chapter 5 Project Description (application ref: 7.5)**. Carbon management measures as specified in PAS 2080 discussed in section 30.6.1.1.2.2 are also applicable to decommissioning activities.

200. As detailed in section 30.3.3.2.1, the outcomes of the Sequential Scenario are considered representative of the Concurrent Scenario.

30.6.1.4 Whole Lifecycle and In-combination GHG Emissions

30.6.1.4.1 In Isolation Scenario

201. GHG emissions associated for the Projects over their whole lifecycle under the In Isolation Scenario is presented in **Table 30-27**.

Table 30-27 Whole Lifecycle GHG Emissions from the In Isolation Scenario

Phase	GHG emissions (tonnes CO_2e)	Percentage of whole lifecycle emissions
Construction	3,418,284	88.5%
Operation and maintenance	397,141	10.3%
Decommissioning	46,357	1.2%
Total	3,861,783	

202. The total GHG emissions resulting from the construction, operation and maintenance and decommissioning of the In Isolation Scenario were estimated to be 3,861,783 tonnes CO_2e. Construction emissions contributed to the largest proportion of lifecycle emissions, accounting for 88.5% of the total.

30.6.1.4.1.1 Overall GHG Intensity and Payback Period

203. An overall GHG intensity and payback period of the In Isolation Scenario in its entirety were calculated using whole lifecycle GHG emissions, the anticipated electricity generated by the wind farm and the avoided emissions from the displacement of electricity which would have otherwise been generated using natural gas, as discussed in section 30.5.1.

204. The overall GHG intensity of the Projects under the In Isolation Scenario was estimated to be 16 g CO_2e per kWh, and the GHG payback period is 1.3 years from the time when the Projects become fully operational.

205. As the GHG payback period scenario is 1.3 years, whole lifecycle emissions of the Projects under the In Isolation Scenario would be fully offset within the Projects operational lifetime. In addition, the overall GHG intensity of the Projects under the In Isolation Scenario compares favourably with other forms of fossil fuel electricity generation based on their predicted GHG intensities (CCC, 2013), as listed below:

- Unabated Combined Cycle Gas Turbine: 380 to 500 g CO_2e per kWh.
- Gas with Carbon Capture Storage: 90 to 245 g CO_2e per kWh.
- Coal with Carbon Capture Storage: 80 to 310 g CO_2e per kWh.

30.6.1.4.1.2 Overall Significance of Effect

206. As the Projects under the In Isolation Scenario would enable the provision of renewable energy to the UK electricity grid and contribute positively to the UK's progress in meeting its net zero targets, the overall significance of effect is considered **beneficial**, which is significant in EIA terms.

30.6.1.4.2 Sequential Scenario

207. GHG emissions associated for the Projects over their whole lifecycle under the in-Sequential Scenario are presented in **Table 30-28**.

Table 30-28 Whole Lifecycle GHG Emissions from the Sequential Development Scenario

Phase	GHG emissions (tonnes CO_2e)	Percentage of whole lifecycle emissions
Construction	6,137,772	85.0%
Operation and maintenance	998,171	13.8%
Decommissioning	86,702	1.2%
Total	7,222,645	

208. The total GHG emissions resulting from the construction, operation and maintenance and decommissioning of the Sequential Scenario were estimated to be 7,222,645 tonnes CO_2e. Construction emissions contributed the largest proportion of lifecycle emissions, accounting for 85% of the total.

30.6.1.4.2.1 Overall GHG Intensity and Payback Period

209. An overall GHG intensity and payback period of the Sequential Scenario in its entirety were calculated using whole lifecycle GHG emissions, the anticipated electricity generated by the wind farm and the avoided emissions from the displacement of electricity which would have otherwise been generated using natural gas, as discussed in section 30.5.1.

210. The overall GHG intensity of the Projects under the Sequential Scenario was estimated at 14.5g CO_2e per kWh, and the GHG payback period is 1.2 years from the time when the Projects become fully operational.

211. As the GHG payback period is 1.2 years, whole lifecycle emissions of the Projects under the Sequential Scenario would be fully offset within the Projects operational lifetimes. In addition, the overall GHG intensity of the Sequential Scenario compares favourably with other forms of fossil fuel electricity generation based on their predicted GHG intensities presented in section 30.6.1.4.1.1.

30.6.1.4.2.2 Overall Significance of Effect

212. As the Projects under the Sequential Scenario would enable the provision of renewable energy to the UK electricity grid and contribute positively to the UK's progress in meeting its net zero targets, the overall significance of effect is considered **beneficial**, which is significant in EIA terms.

213. As detailed in section 30.3.3.2.1, the outcomes of the Sequential Scenario are considered representative of the Concurrent Scenario.

30.6.2 Impact 2 - CCRA

214. The potential effects of climate change to the Projects during the construction, operation and maintenance and decommissioning phases has been assessed. This section provides a summary of identified climate change variables and the associated hazards anticipated to interact with the Projects. As detailed in section 30.3.3.2.2, the Sequential Scenario was considered worst case for the CCRA, but the outcomes of the assessment are considered representative of the In Isolation and Concurrent Scenarios. Therefore, the CCRA presented for the Projects in this section is based on the worst case Sequential Scenario parameters detailed in **Table 30-1**.

30.6.2.1 Step 1: Identifying Receptors, Climate Variables and Hazards

215. As identified in section 30.5.2, the main climate variables which could be affected by climate change in the Study Area are temperature, precipitation, wind speeds, extreme weather events, sea level rise and coastal erosion.

216. The Projects 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). Exposure to climate hazards may lead to impacts to the Projects such as physical damage to infrastructure components or adverse working conditions during construction, operation and maintenance and decommissioning activities.

217. The receptors identified in the assessment that may be vulnerable to the projected effect of climate change during the construction, operation and maintenance and decommissioning phases are detailed in **Table 30-29**.

Table 30-29 Projects' Climate Change Resilience Receptors

Projects' Phase	Onshore Receptors	Offshore Receptors
Construction	• Construction site workers • Onshore temporary construction facilities • Trenchless crossing techniques i.e. HDD • Onshore Export Cables • Onshore Converter Stations	• Construction site workers • Landfall • Array cables • Inter-platform cables • Offshore Export Cables • Offshore platforms • Wind turbines
Operation and maintenance	• Onshore Export Cables • Onshore Converter Stations	• Landfall • Array cables • Inter-platform cables • Offshore Export Cables • Offshore platforms • Wind turbines
Decommissioning*	• Decommissioning site workers • Onshore temporary decommissioning facilities • Onshore Export Cables • Onshore Converter Stations	• Decommissioning site workers • Landfall • Array cables • Inter-platform cables • Offshore Export Cables • Offshore platforms • Wind turbines
The decommissioning policy for the Projects' onshore and offshore infrastructure has not yet been made. However, decommissioning is considered in this CCRA based on the assumption that the receptors would be the same as the construction phase.		

218. The Projects' receptors, climate variables and hazards taken forward into Step 2 of the CCRA are detailed in **Table 30-30**.

Table 30-30 Projects' Receptor, Climate Variable and Climate Hazard

Climate Variable	Potential Climate Hazards			Receptors Affected
	Construction Phase	Operation and Maintenance Phase	Decommissioning Phase	
Temperature	**Heatwave** – For the construction phase, the RCP8.5 climate projection data in **Table 30-20** shows that annual temperatures in the Study Area are predicted to rise, particularly during summer months, with an increase of between 0.36 to 1.94°C (10th to 90th percentile). This may result in more periods of heatwaves or high temperatures.	**Heatwave** – For the operation and maintenance phase, the RCP8.5 climate projection data in **Table 30-20** shows that annual temperatures in the Study Area are predicted to rise, particularly during summer months, with an increase of between 0.70 to 2.47°C (10th to 90th percentile). This may result in more periods of heatwaves or high temperatures.	**Heatwave** – For the decommissioning phase, the RCP8.5 climate projection data in **Table 30-20** shows that annual temperatures in the Study Area are predicted to rise, particularly during summer months, with an increase of between 1.15 to 3.95°C (10th to 90th percentile). This may result in more periods of heatwaves or high temperatures.	• Construction site workers • Onshore temporary construction facilities • Trenchless crossing technique i.e. HDD • Onshore export cables • Onshore converter stations
	Snow and Ice - the RCP8.5 climate projection data in **Table 30-20** shows that for the construction phase, the average temperatures in the Study Area are predicted to increase in winter months within the range of 0.14 to 1.72°C (10th to 90th percentile), meaning potential impacts associated with snow and ice conditions are likely to decrease.	**Snow and Ice** - the RCP8.5 climate projection data in **Table 30-20** shows that for the operation and maintenance phase, the average temperatures in the Study Area are predicted to increase in winter months within the range of 0.46 to 2.70°C (10th to 90th percentile), meaning potential impacts associated with snow and ice conditions are likely to decrease.	**Snow and Ice** - the RCP8.5 climate projection data in **Table 30-20** shows that for the construction phase, the average temperatures in the Study Area are predicted to increase in winter months within the range of 0.61 to 3.31°C (10th to 90th percentile), 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 Projects are not considered to be likely.
Precipitation	**Surface Water Flooding** – the RCP8.5 climate projection data in **Table 30-20** show that annual precipitation levels for the construction phase in the Study Area are variable and likely to be similar to the present climate. However, there is projected to be an increase in precipitation during winter months with a maximum projected increase of 16.13% (90th percentile), which could lead to more frequent surface water flooding events during this season.	**Surface Water Flooding** – the RCP8.5 climate projection data in **Table 30-20** show that annual precipitation levels in the Study Area for the operation and maintenance phase are variable and likely to be similar to the present climate. However, there is projected to be an increase in precipitation during winter months with a maximum projected increase of 22.12% (90th percentile), which could lead to more frequent surface water flooding events during this season.	**Surface Water Flooding** – the RCP8.5 climate projection data in **Table 30-20** show that annual precipitation levels in the Study Area for the decommissioning phase are variable and likely to be similar to the present climate. However, there is projected to be an increase in precipitation during winter months with a maximum projected increase of 24.91% (90th percentile), which could lead to more frequent surface water flooding events during this season.	• Construction site workers • Onshore temporary construction facilities • Trenchless crossing technique i.e. HDD • Landfall • Onshore Export Cables • Onshore Converter Stations

Climate Variable	Potential Climate Hazards			Receptors Affected
	Construction Phase	Operation and Maintenance Phase	Decommissioning Phase	
	Drought – the RCP8.5 climate projection data in **Table 30-20** show that annual precipitation levels in the Study Area for the construction phase are variable and likely to be similar to the present climate. However, there is projected to be less precipitation during summer months, with a maximum of -22.31°C (10th percentile) and **-**3.45°C (90th percentile) which could lead to drought events during summer.	**Drought** – the RCP8.5 climate projection data in **Table 30-20** show that annual precipitation levels in the Study Area for the operation and maintenance phase are variable and likely to be similar to the present climate. However, there is projected to be less precipitation during summer months, with a maximum of -37.03°C (10th percentile) and -14.06°C (90th percentile) which could lead to drought events during summer.	**Drought** – the RCP8.5 climate projection data in **Table 30-20** show that annual precipitation levels in the Study Area for the decommissioning phase are variable and likely to be similar to the present climate. However, there is projected to be less precipitation during summer months, with a maximum of -41.39°C (10th percentile) and -15.22°C (90th percentile) which could lead to drought events during summer.	The Project' onshore aspects are not considered to be vulnerable to drought events.
Sea level rise	**Sea level rise -** sea levels are likely to rise in the construction phase by between 0.11 and 0.20m (5th and 95th percentile respectively) as detailed in section 30.5.2.2.3 because of increased global temperatures, which may affect receptors in coastal areas such as the landfall.	**Sea level rise -** sea levels are likely to rise in the operation and maintenance phase by between 0.16 and 0.33m (5th and 95th percentile respectively) as detailed in section 30.5.2.2.3 because of increased global temperatures, which may affect receptors in coastal areas such as the landfall.	**Sea level rise -** sea levels are likely to rise in the decommissioning phase (by between 0.19 and 0.40m (5th and 95th percentile respectively) as detailed in section 30.5.2.2.3 because of increased global temperatures, which may affect receptors in coastal areas such as the landfall.	• Landfall
Wind Speeds	**Average wind speeds** – There is uncertainty as to whether climate change would result in a difference to annual average winds speeds. Potential impacts from higher wind speeds in extreme weather events are considered in the row below.			None identified.

Climate Variable	Potential Climate Hazards			Receptors Affected
	Construction Phase	**Operation and Maintenance Phase**	**Decommissioning Phase**	
Extreme Weather Events	**Storm events (high winds and flooding)** - although there is uncertainty as to the degree that climate change would 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 construction and decommissioning and the above ground infrastructure such as the Onshore Converter Stations during the operation and maintenance phase. For the marine climate, storm events include turbulent waves, strong undercurrents and storm surges or ocean swelling cause by high wind pushing the sea towards the coast and lower atmospheric pressure during storms (Palmer *et al.* 2018).			• Construction site workers • Onshore temporary construction facilities • Trenchless crossing technique i.e. HDD • Onshore Export Cables • Onshore Converter Stations • Landfall • Array cables • Inter-platform cables • Offshore export cables • Offshore platforms • Wind turbine
Extreme Weather Events	**Storm surges** – extreme weather events may result in storm surges which may affect receptors in coastal areas such as the landfall. The Flood Risk Assessment (FRA) (**Volume 7, Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)**) notes the Landfall Zone during construction is at risk of coastal flooding, which could be caused by storm surges. The Onshore Converter Stations would be located approximately 25km from the nearest coastline and is deemed to be a very low risk to flooding from the sea in the FRA (**Volume 7, Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)**). However, the risk of flooding from all potential sources of flood risk are likely to be amplified as a result of the predicted changes associated with climate change.			• Landfall • Construction site workers
	Tidal flooding - extreme weather events may result in a greater risk to tidal flooding, which may affect receptors in coastal areas such as the Landfall Zone. The FRA (**Volume 7**, **Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)**) notes that the Onshore Converter Stations would be located approximately 25km from the nearest coastline and is deemed to be a very low risk to flooding. However, the risk of flooding from all potential sources of flood risk are likely to be amplified as a result of the predicted changes associated with climate change.			• Landfall • Construction site workers

219. The climate hazards with potential to affect receptors associated with the Projects are identified as:

- Surface Water Flooding
- Tidal Flooding
- Sea Level Rise
- Heatwaves
- Storm events (high winds and storm surges)

220. The vulnerability and by extension the resilience of the Projects' receptors to these climate parameters are considered in Step 2 of the CCRA.

30.6.2.2 Step 2: Climate Vulnerability Assessment

221. The vulnerability of the identified receptors to each of the climate hazards presented in **Table 30-30** are assessed below.

30.6.2.2.1 Construction Phase

30.6.2.2.1.1 Surface Water and Tidal Flooding, Sea Level Rise

222. Flooding events associated during the construction phase of the Projects could be associated with sea level rise, tidal flooding, storm events and rain intensity.

223. **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)** presents a detailed evaluation of the risk of surface water, tidal flooding, and sea level parameters during the construction phase of the Projects. The Onshore Development Area lies within the catchment area for three operational rivers and crosses several water bodies which are detailed in section 20.5.1 of **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)**.

224. The FRA presented in **Volume 7**, **Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)**, considers the impact of climate change on the Projects in the future. It is acknowledged that the risk of flooding from all potential sources is likely to be amplified in future by climate change.

225. The surface water flood risk for the Onshore Development Area is high in several places including the area occupied by the Onshore Converter Stations as detailed in section 20.5.5.2 of **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)**. In addition, **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)** also states that the Onshore Development Area is not subject to groundwater flooding.

226. Section 20.4.6 of the **Volume 7**, **Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)**, states that Onshore Converter Stations are in proximity to Ordinary Watercourses which may increase the risk of fluvial flooding due to climate change effects. However, the assessment concludes that the risk of flooding from surface water flooding is considered to be low for the Onshore Substation Zones.

227. As detailed in **Table 30-20**, the projected Projects' worst case mean precipitation for the construction phase shows an increase of 16.13% (90th percentile) in winter for the RCP8.5 compared with the 1981- 2010 baseline. Based on the worst case projected rainfall, the future climate change within the construction phase is expected to potentially cause increased rain intensity in the Onshore Development Area.

228. As detailed in **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)**, embedded mitigation measures will be implemented including the use of trenchless crossing technology (i.e. horizontal directional drilling (HDD)) to avoid direct interaction with watercourse, the use of temporary access across watercourses, and the undertaking of a ground investigation and a hydrological risk assessment at each trenchless crossing location i.e. HDD, and the implementation of best practice mitigation measures at the trenched crossing of Ordinary Watercourse.

229. As detailed in **Volume 7**, **Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)**, the majority of the temporary construction compounds are in Flood Zone 1, with some areas in Flood Zone 2 and 3. However, the temporary compounds are considered to have a low risk of surface water flooding.

230. As detailed in section 30.3.4, embedded mitigation to reduce the impacts of climate change events including flooding will be implemented during the construction phase through the appropriate best practice design and techniques, including as part of an Outline PEMP and OCoCP. In addition, these plans will list monitoring requirements during the construction phase, including measures for construction site works to adopt and implement when working in high-risk flood zone to minimise risk during periods of extreme weather.

231. The receptors outlined in **Table 30-29** for the construction phase of the Projects are considered to have medium exposure to flooding and a low sensitivity to climatic change. Based on the criteria identified in Table 30-3-1 in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)**, the receptors are considered to have **low vulnerability** to flooding.

232. Given the vulnerability rating of low for the flooding climate hazard for the construction phase of the Projects, an assessment of the predicted effects and associated risks of flooding (Step 3 of the CCRA methodology detailed in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** was not carried out.

30.6.2.2.1.2 Heatwave

233. As noted in section 30.5.2.2, the UK is projected to be warmer across all seasons. In the construction phase of the Projects, for the RCP8.5 (very high emission scenario), the probabilistic annual mean temperature projections detailed in **Table 30-20** are predicted to increase by 0.44 and 1.59°C (10^{th} and 90^{th} percentile respectively) for the Onshore Development Area compared to the 1981-2000 baseline. Due to the projected future increases in temperature, there is a potential for heatwave or increased temperature to cause harm to construction site workers and damage to the onshore components, specifically the Onshore Export Cables and Onshore Converter Stations.

234. The application of an Outline PEMP and OCoCP during the construction phase will prioritise workers' safety by considering the impact of extreme weather events. These plans will include mitigation measures such as monitoring on-site weather conditions, incorporating a severe weather protocol, and scheduling activities based on information from weather forecasts. Construction site workers are required to include provisions specific to prevailing weather conditions, such as additional rest breaks during heatwaves. By implementing these measures, construction sites can minimise the risks associated with heatwaves to the construction workers and impact on construction activities.

235. Due to the short duration of the construction phase of the Projects and the application of best practice measures, receptors detailed in **Table 30-29** that could be sensitive to heatwaves are considered to have low exposure during the construction phase and a low sensitivity to such climate change during the construction phase. Based on the criteria identified in Table 30-3-1 in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)**, the heatwave receptors are considered to have **low vulnerability** to heatwave.

236. Given the vulnerability rating of low for the heatwave climate hazard for the construction phase of Projects, an assessment of the predicted effects and associated risks of heatwave (Step 3 of the CCRA methodology detailed in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** was not carried out.

30.6.2.2.1.3 Storm Events (high winds and storm surges)

237. As highlighted in section 30.5.2.2.3, there is no observational evidence for a long-term trend in storminess across the UK or resultant storm surges which could cause disruption, flooding and damage during the construction phase of the Projects.

238. The construction of the Projects will be aligned with the Outline PEMP and OCoCP, which considers the impact of extreme weather events like high winds and storms. The PEMP and OCoCP will outline the protocols for severe weather situations, the monitoring of on-site weather conditions and scheduling construction activities based on accurate weather forecasts. Therefore, construction activities will not take place during periods of heavy weather. By implementing these measures, the risks associated with high winds and storms mitigated can be mitigated.

239. The extreme weather receptors for the construction phase of the Projects are detailed in **Table 30-29**, and are considered to have medium exposure to extreme weather events and a low sensitivity to such storm events due to climate change in the construction phase. Based on the criteria identified in Table 30-3-1 in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)**, the receptors are considered to have **low vulnerability** to storm events.

240. Given the vulnerability rating of 'low' for storm event hazards for the construction phase of the Projects, an assessment of the predicted effect and associated risks of storm events (Step 3 of the CCRA methodology detailed in **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)**) was not carried out.

30.6.2.2.2 Operation and Maintenance Phase

30.6.2.2.2.1 Surface Water and Tidal Flooding, Sea Level Rise

241. As detailed in **Table 30-20**, the projected worst case precipitation change is an increase of 22.1% in winter for the RCP8.5 scenario for the 90th percentile in the UKCP land grid option 512500, 437500 compared with the 1981-2000. Based on the worst case projected rainfall, future climate change is expected to potentially cause increased rain intensity within the Study Area.

242. **Volume 7, Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)** identifies two main aspects of climate change which are likely to impact the Projects in terms of flood risk. These include an increase in peak river flows and an increase in the duration and intensity of rainfall events, which may increase the risk of surface water flooding.

243. Consideration is given to the climate change allowances for peak river flow and fluvial flooding which is only applicable to the onshore components of the Projects such as the Onshore Converter Stations. The Onshore Export Cables are not considered to be a receptor of fluvial flooding as they would be located below ground.

244. The effect of increased rainfall intensity due to climate change on the Projects are considered in section 23.3.11.3 of **Volume 7**, **Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)**. The appropriate climate change allowances applicable for the design life of the Projects within the Hull and East Riding Management Catchment area have been accounted for in the surface water drainage design.

245. **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)** states that the operational drainage at the Onshore Converter Stations will adhere to the principles of the sustainable drainage system (SuDS) discharge hierarchy. The SuDS basin will be designed to accommodate the 1:100 year storm +40% climate change allowance.

246. The receptors presented in **Table 30-29**, are considered to have medium exposure to flooding and a low sensitivity to such climatic change for the Projects. Based on the criteria identified in Table 30-3-1 in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)**, the receptors are considered to have **low vulnerability** to flooding.

247. Given the vulnerability rating of low for the flooding climate hazard for the operation and maintenance phase of the Projects, an assessment of the predicted effects and associated risks of flooding (Step 3 of the CCRA methodology detailed in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** was not carried out.

30.6.2.2.2.2 Heatwave

248. As noted in section 30.5.2.2, the UK is projected to be warmer across all seasons. In the operation and maintenance phase of the Projects, for the RCP8.5 (very high emission scenario), the probabilistic annual mean temperature projections detailed in **Table 30-20** are predicted to increase by 0.89 and 2.6°C (10th and 90th percentile respectively) for the Onshore Development Area. Due to the projected future increases in temperature, there is a potential for heatwave or increased temperature to cause damage to the onshore components, specifically the Onshore Export Cables and Onshore Converter Stations. The Onshore Export Cables will be designed to accommodate a range of future climatic conditions including increased temperature.

249. The receptors with longer lifetimes such as concrete structures, will be resilient to the shorter-duration maximum temperatures due to the material and structural qualities. The below ground components of the Projects including the Onshore Export Cable, will be afforded thermal insulation by the ground and are therefore not considered to be sensitive to damage due to high temperatures during the operational phase of the Projects. The Projects' receptors will be constructed using building materials and techniques as per industry standards that provide sufficient thermal protection to mitigate the risk of increased high temperatures.

250. The climate hazard receptors considered to be sensitive to heatwaves are considered to have low exposure and a low sensitivity to such climate change during the operation and maintenance phase, due to the embedded mitigation included as part of the design. Based on the criteria identified in Table 30-3-1 in the **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)**, the heatwave receptors are considered to have **low vulnerability** to heatwave.

251. Given the vulnerability rating of low for the heatwave climate hazard for the operation and maintenance phase of the Projects, an assessment of the predicted effects and associated risks of heatwave (Step 3 of the CCRA methodology detailed in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** was not carried out.

30.6.2.2.2.3 Storm Events (high winds and storm surges)

252. As detailed in section 30.5.2.2.3, there is no observational evidence for long-term trends in storminess across the UK or resultant storm surges which could cause operational disruption and damage flooding to the Projects. In addition, future climate projection related to wind conditions and storminess are uncertain. The Projects have been designed to have an inherent level of resilience to mitigate the risk of storm events to affect receptors associated with the Projects.

253. It was identified that the landfall was in an area sensitive to coastal erosion, mitigation against the risk of coast erosion was considered in the design and the location of the landfall has been set back from the coast to account for coastal retreat.

254. The extreme weather receptors for the operation and maintenance phase of the Projects are detailed in **Table 30-29**, and are considered to have medium exposure to extreme weather events and a low sensitivity to such storm events due to climate change in the operation and maintenance phase. Based on the criteria identified in Table 30-3-1 in **Volume 7, Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)**, the receptors are considered to have **low vulnerability** to storm events.

255. Given the vulnerability rating of low for storm events hazard for the operation and maintenance phase of the Projects, and assessment of the predicted effect and associated risks of storm events (Step 3 of the CCRA methodology detailed in **Volume 7, Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** was not carried out.

30.6.2.2.3 Decommissioning Phase

256. The decommissioning policy for the Projects is not yet known and thus a detailed assessment cannot be performed at this stage. Decommissioning scenarios are described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**. Decommissioning arrangements for the offshore components would be submitted in a Decommissioning Programme prior to construction and for the onshore elements through the approval of a Decommissioning Plan following cessation of commercial operation, however for the purpose of this assessment it is assumed that decommissioning of the Projects could be conducted separately, or at the same time.

257. A high-level assessment for the Projects is presented based on the high-level decommissioning aims outlined in **Volume 7**, **Chapter 5 Project Description (application ref: 7.5),** and assumption that the decommissioning receptors will be equivalent to the construction receptors outlined in **Table 30-29**. In addition, it was assumed that the decommissioning phase for the Projects would be of a similar duration to the construction phase. However, this is likely an overestimation as future development of regulation and methodologies may result in alternative approaches being implemented.

258. It is expected that a detailed CCRA for decommissioning will be performed as part of the Decommissioning Plan, and suitable mitigation measures will be adopted to minimise the risk to the Projects.

30.6.2.2.3.1 Surface Water and Tidal flooding, Sea Level Rise

259. Flooding events associated with the climate change for Projects during the decommissioning phase could be associated with sea level rise, tidal flooding, storm events and rain intensity.

260. As detailed in **Table 30-20**, the projected Projects' worst case mean precipitation for the decommissioning phase shows an increase of 24.91% (90^{th} percentile) in winter for the RCP8.5 compared with the 1981- 2010 baseline. Based on the worst case projected rainfall, the future climate change within the construction phase is expected to potentially cause increased rain intensity in the Onshore Development Area.

261. **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)**, assumes that residual effect during decommissioning would be no worse and potentially less than for construction. In addition, the decommissioning mitigation measures are not known at this stage. However, it is assumed that best practice measures will be implemented.

262. Therefore, the decommissioning phase of the Projects is considered to have the medium exposure to flooding compared to the comparable worst case mean precipitation for the operation and maintenance phase. The sensitivity is assumed to be low if suitable mitigation measures are implemented. As a result, based on the criteria identified in Table 30-3-1 in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)**, the receptors are considered to have **low vulnerability** to flooding for the Projects.

263. Given the vulnerability rating of low for the flooding climate hazard for the decommissioning phase of the Projects and the lack of detailed decommissioning information, an assessment of the predicted effects and associated risks of flooding (Step 3 of the CCRA methodology detailed in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** was not carried out.

30.6.2.2.3.2 Heatwave

264. As noted in section 30.5.2.2, the UK is projected to be warmer across all seasons. In the decommissioning of the Projects, for the RCP8.5 (very high emission scenario), the probabilistic annual mean temperature projections detailed in **Table 30-20** are predicted to increase by 1.13 and 3.2°C (10th and 90th percentile respectively) for the Onshore Development Area. Due to the projected future increases in temperature, there is a potential for heatwave or increased temperature to cause harm to construction site workers and damage to the onshore components, specifically the Onshore Export Cables and Onshore Converter Stations.

265. As there is no current Decommissioning Plan, detailed mitigation measures are not available. However, it is assumed that the Decommissioning Plan will include the requirement to utilise the best practice measures at the time of decommissioning. It is assumed that implementing these measures, will minimise the risks associated with heatwaves to the site workers and impact on decommissioning activities.

266. In addition, the duration of the decommissioning activities is assumed to be equivalent to the construction duration. Therefore, due to the anticipated short duration of decommissioning activities, the Projects are assumed to have a low exposure to and a low sensitivity during the decommissioning phase. The sensitivity is assumed as low if suitable mitigation measures are implemented. As a result, based on the criteria identified in Table 30-3-1 in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** the receptors are considered to have **low vulnerability** to heatwave for the Projects.

267. Given the vulnerability rating of low for the heatwave climate hazard for the decommissioning phase of the Projects and the lack of detailed decommissioning information, an assessment of the predicted effects and associated risks of heatwave (Step 3 of the CCRA methodology detailed in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** was not carried out.

30.6.2.2.3.3 Storm Events (high winds and storm surges)

268. As noted in section 30.5.2.2.3, there is no observational evidence for long-term trends in storminess across the UK or resultant storm surges which cause disruption, flooding and damage during the decommissioning phase of the Projects.

269. As there is no current Decommissioning Plan, detailed mitigation measures are not available. However, it is assumed that the Decommissioning Plan will include the requirement to utilise the best practice measures at the time of decommissioning. It is assumed that implementing these measures, will minimise the risks associated with storm events to the site workers and impact on decommissioning activities.

270. Therefore, the decommissioning phase of the Projects are considered to have medium exposure to storm events and low sensitivity to storm events during the decommissioning phase. The sensitivity is assumed as low if suitable mitigation measures are implemented. As a result, based on the criteria identified in Table 30-3-1 in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** the receptors are considered to have **low vulnerability** to storm events for the Projects.

271. Given the vulnerability rating of low for storm events for the decommissioning phase of the Projects and the lack of detailed decommissioning information, an assessment of the predicted effects and associated risks of heatwave (Step 3 of the CCRA methodology detailed in **Volume 7**, **Appendix 30-3 Climate Change Resilience Assessment Methodology (application ref: 7.30.30.3)** was not carried out.

30.6.2.3 Significance of effect

272. The CCRA identified the vulnerability of the Projects to key climate hazards that are likely to occur within the Study Area over the operation and maintenance phase. This was based on the Sequential Scenario, which was deemed to be worst case, however the outcomes were considered representative of all the Development Scenarios. The assessment determined that, accounting for the Projects' embedded mitigation, the vulnerability rating of the hazards identified would be low. Therefore, there is a **low** likelihood of climate change impacts to adversely affect the Projects during the construction and, operation and maintenance phase and any effects of climate change on the Projects are considered likely to be not significant.

273. A high-level assessment of the decommissioning phase was undertaken. However, due to the lack of detailed decommissioning information, a detailed CCRA for decommissioning of the Projects is required at a later stage. Based on the high-level assessment, which considered the same receptors as the construction phase, the vulnerability rating of the hazards was deemed to be low. Therefore, it is assumed there is a **low** likelihood that climate change impacts would adversely affect the Projects during the decommissioning phase and the impacts are assumed to be not significant**.**

274. It is recommended that a more detailed assessment of this phase is undertaken prior to decommissioning, where more up to date climate projection data would be available and more information on the decommissioning policy would be known. This assessment would be undertaken prior to the finalisation of the Decommissioning Plan.

30.7 Potential Monitoring Requirements

275. Monitoring requirements will be described in the In-Principal Monitoring Plan (IPMP) submitted alongside the DCO application and further developed and agreed with stakeholders prior to construction taking account of the final detailed design of the Projects.

276. The Projects are not anticipated to require any specific monitoring requirements with respect to GHG emissions and climate change resilience.

30.8 Cumulative Effect Assessment

277. Cumulative effects are defined as incremental effects on that same receptor from other proposed and reasonably foreseeable schemes and developments in combination with the Projects. This includes all schemes that result in a comparative effect that is not intrinsically considered as part of the existing environment and is not limited to offshore wind projects.

278. The overarching method followed in identifying and assessing potential cumulative effects is set out in **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** and **Volume 7, Appendix 6-1 Onshore Cumulative Assessment (application ref: 7.6)**. The approach is based upon the Planning Inspectorate Advice Note Seventeen: Cumulative Effects Assessment (PINS 2017). The approach to the CEA is intended to be specific to the Projects and takes account of the available knowledge, the environment and other activities around the Onshore Development Area.

30.8.1 GHG Assessment

279. As noted in section 30.4.3.2, the global atmosphere is the only receptor for the GHG assessment, and IEMA guidance (2022) states that the effects of 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 impacts considered by the GHG assessment are inherently cumulative, as all developments which emit, avoid, or sequester GHG emissions affect global atmospheric concentrations irrespective of their location. Thus, no specific cumulative assessment with other schemes was undertaken for the GHG assessment.

30.8.2 CCRA

280. The only climate variable identified in section 30.4.3.5 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 Development Area.

281. **Table 20-26** in **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)**, presents the projects considered in the cumulative effect assessment in relation to hydrology and flood risk. Section 20.9 of **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)** concluded that none of the identified schemes would result in significant cumulative effects of flooding. Therefore, the CCRA has not identified any schemes where significant cumulative effects could arise.

30.9 Transboundary Effects

282. Transboundary effects are not considered to require specific consideration for the GHG assessment and CCRA.

283. The receptor for the GHG assessment is the global atmosphere, and therefore GHG emissions have an indirect transboundary effect on climate change. Emissions released and avoided by the Projects have been assessed in the context of the UK carbon budgets, which have been set in accordance with international climate agreements.

30.10 Interactions

284. The effects identified and assessed in this chapter have the potential to interact with each other. The areas of potential interaction between effects are presented in **Table 30-31**. This provides a screening tool for which effects have the potential to interact. **Table 30-32** provides an assessment for each receptor (or receptor group) as related to these impacts.

285. Within **Table 30-32** the effects are assessed relative to each development phase to see if multiple effects could increase the significance of the effect upon a receptor. Following this a lifetime assessment is undertaken which considers the potential for effect to affect receptors across all development phases.

Table 30-31 Interactions Between Impacts - Screening

Potential Interactions between Impacts		
Construction		
	Impact 1 GHG emissions	Impact 2 Climate Hazards on receptors
Impact 1 GHG emissions		No
Impact 2 Climate Hazards on receptors	No	
Operation		
	Impact 1 GHG emissions	Impact 2 Climate Hazards on receptors
Impact 1 GHG emissions		No
Impact 2 Climate Hazards on receptors	No	
Decommissioning		
	Impact 1 GHG emissions	Impact 2 Climate Hazards on receptors

Potential Interactions between Impacts		
Impact 1 GHG emissions		No
Impact 2 Climate Hazards on receptors	No	

Table 30-32 Interaction Between Impacts - Phase and Lifetime Assessment

Receptor	Highest Significance Level				
	Construction	**Operation**	**Decommissioning**	**Phase Assessment**	**Lifetime Assessment**
Global Atmosphere	Minor adverse	Beneficial	Minor adverse	**No greater than individually assessed impact.** The receptor for the GHG assessment is the global atmosphere. Each GHG released to the atmosphere has the potential to contribute to climate change. The GHGs released, or saved in each phase of the development are distinct from one another, therefore it is considered that there would either be no interactions between impacts during each of the phases.	A whole lifecycle GHG assessment was undertaken in section 30.6.1.4, which highlights that the overall significance of the Projects with respect to GHG emissions would be beneficial, from the provision of renewable electricity to the grid.

Receptor	Highest Significance Level				
	Construction	Operation	Decommissioning	Phase Assessment	Lifetime Assessment
Receptors identified in CCRA	Not significant	Not significant	Not significant	**No greater than individually assessed impact.** The CCRA assessment considers the potential effects of climate change, through climate hazards, to receptors associated with the Projects. It is considered there would be no pathway for interaction to exacerbate the potential impacts associated with climate hazards during or between any of the project phases.	**No greater than individually assessed impact.** The CCRA predicted that the Projects would have a low vulnerability to climate change in each project phase. It is considered that over the project lifetime, these impacts would not combine to increase the significance level of any impacts identified in this assessment.

30.11 Inter-relationships

286. The receptor for the GHG assessment is the global atmosphere. There are no other topics which have direct effects on this receptor, and therefore there are no inter-relationships with this topic.

287. Similarly, the CCRA focusses on the effects of climate change on the Projects themselves, while other topics of the EIA assess the effects of the Projects on other receptors. There are not considered to be any inter-relationships with other environmental effects related to the Projects with respect to climate change resilience.

30.12 Summary

288. A summary of the impacts for all Development Scenarios on climate change identified in the assessment are provided in **Table 30-33**. The GHG assessment calculated the potential for the avoided emissions by replacing electricity that would have been generated from natural gas. Avoided emissions were estimated to be approximately 91.8 million and 183.4 million tonnes for the In Isolation and Sequential Scenarios respectively, resulting in a beneficial effect, which is considered to be significant in EIA terms.

289. A summary of the Projects' vulnerability and resilience to climate change is provided in **Table 30-33**. The assessment determined that, accounting for embedded mitigation, the vulnerability rating of the Projects to identified climate hazards would be low. Therefore, there is a low likelihood that climate change impacts would adversely affect the Projects during the construction and, operation and maintenance phase, and any effect of climate change on the Projects would be not significant.

290. A high-level assessment of vulnerability and resilience of the Projects during the decommissioning phase was undertaken, where the same receptors and similar assumptions with respect to the implementation of appropriate measures during construction were considered. The assessment predicted a low likelihood of climate change impacts adversely affecting the Projects in the decommissioning phase. However, it is recommended that a more detailed assessment of this phase should be undertaken prior to decommissioning, where more up to date climate projection data would be available and more information on the decommissioning policy would be known.

Table 30-33 Summary of Potential Likely Significant Effects on Climate Change

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
GHG assessment						
Construction- GHG emissions (all Development Scenarios)	Global atmosphere	High	N/A	Minor adverse	N/A	**Minor adverse**
Operation and maintenance GHG emissions and avoided GHG emissions from the provision of renewable energy (all Development Scenarios)	Global atmosphere	High	N/A	Beneficial	N/A	**Beneficial**
Decommissioning GHG emissions (all Development Scenarios)	Global atmosphere	High	N/A	Minor adverse	N/A	**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Whole life cycle emissions and net effect on climate change (all Development Scenarios)	Global atmosphere	High	N/A	Beneficial	N/A	**Beneficial**
CCRA						
Climate change resilience (all Development Scenarios)	Decommissioning site workers Onshore temporary decommissioning facilities Onshore infrastructure Offshore infrastructure	Low	N/A	Not significant	N/A	Not significant

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