Chapter 17: Climatic Effects

Array EIA Report

2024

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17. CLIMATE CHANGE

17.1. INTRODUCTION

1. This chapter of the Array Environmental Impact Assessment (EIA) Report presents the assessment of the likely significant effects (LSE[1]) (as per the "EIA Regulations") on and from climate change as a result of the Ossian Array which is the subject of this application (hereafter referred to as "the Array"). Specifically, this chapter considers the potential impacts of the Array on and from climate change during the construction, operation and maintenance, and decommissioning phases.

2. Climate change in the context of EIA can be considered broadly in two parts:

   - the effect of greenhouse gas (GHG) emissions caused directly or indirectly by the Array, which may have the potential to contribute to climate change; and
   - the potential effect of climate change on the Array, which could affect the Array directly or could modify its other environmental impacts. Consideration of inter-related effects (IRE) is outlined within section 17.15 of this chapter and an In-Combination Climate Impact (ICCI) assessment is presented in volume 3, appendix 17.3.

3. The following technical chapters also inform the assessment presented in this chapter:

   - volume 3, appendix 17.1: GHG Technical Report;
   - volume 3, appendix 17.2: Climate Change Risk Assessment Technical Report; and
   - volume 3, appendix 8.1: Benthic Subtidal Ecology Technical Report.

17.2. PURPOSE OF THE CHAPTER

4. The Array EIA Report provides the Scottish Ministers, statutory and non-statutory stakeholders with adequate information to determine the LSE[1] of the Array on the receiving environment. This is further outlined in volume 1, chapter 1.

5. The purpose of this climatic effects Array EIA Report chapter is to:

   - present the existing environmental baseline established from desk studies, and consultation with stakeholders;
   - identify any assumptions and limitations encountered in compiling the environmental information;
   - present the environmental impacts on climate change (GHG emissions) arising from the Array, and from climate change (risk and resilience) on the Array, and reach a conclusion on the LSE[1] on and from climate change, based on the information gathered and the analysis and assessments undertaken; and
   - highlight any necessary monitoring and/or mitigation measures which are recommended to prevent, reduce or offset the likely significant adverse environmental effects of the Array on and from climate change.

17.3. STUDY AREA

6. Figure 17.1 illustrates the climatic effects study area for the Array which encompasses the Array (i.e. the area in which the wind turbines and associated infrastructure will be located), in the context of the domestic and international scope as developed on the basis of established Institute of Environmental Management and Assessment (IEMA) guidance (IEMA, 2022) utilised throughout this chapter. Domestic scope considers the local and national policy and targets concerning GHG and climate resilience.

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

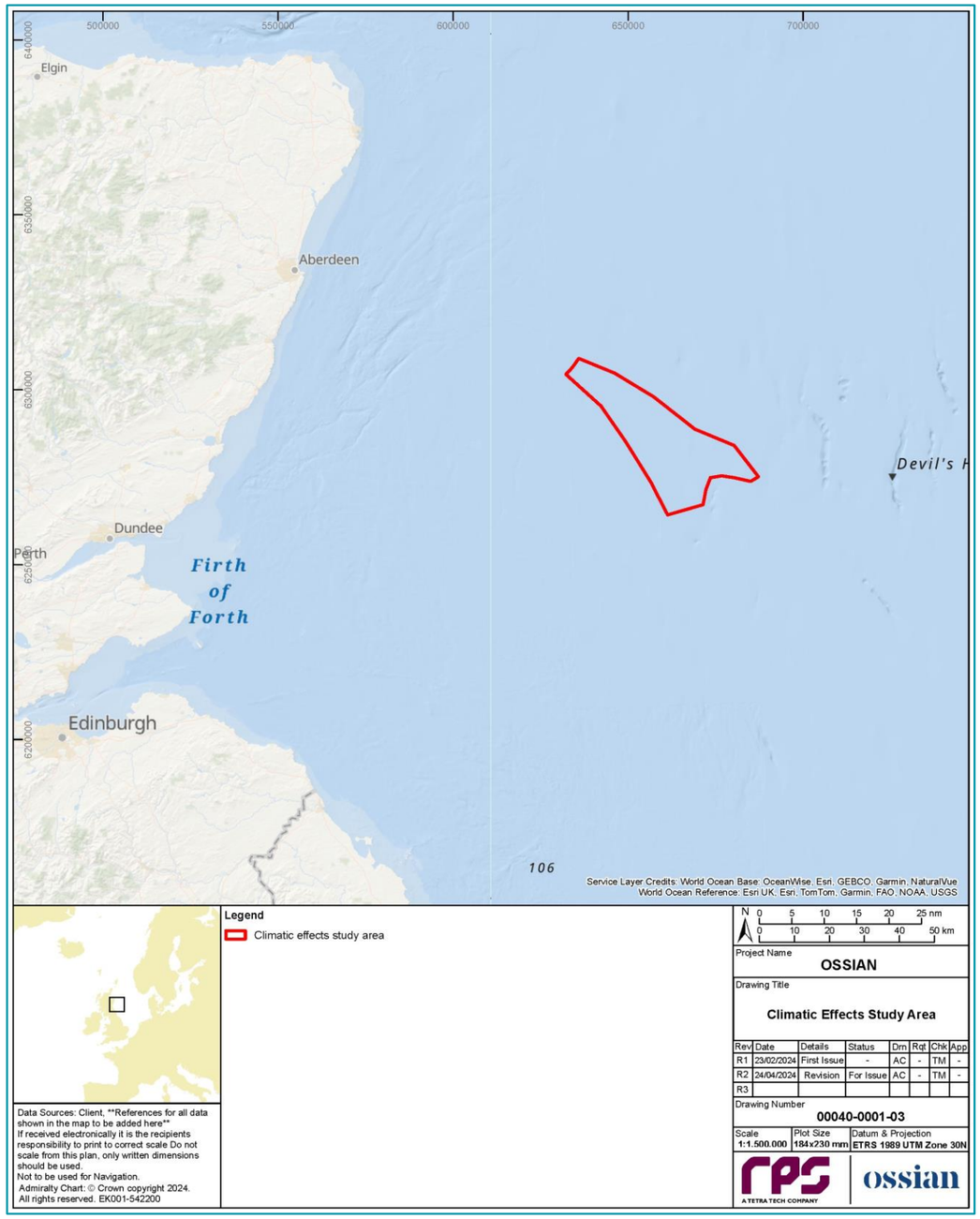

Figure 17.1: Climatic Effects Study Area

17.4. POLICY AND LEGISLATIVE CONTEXT

8. Volume 1, chapter 2 of the Array EIA Report presents the policy and legislation of relevance to renewable energy infrastructure. Policy specifically in relation to climate change is contained in the Scottish National Marine Plan (NMP) (Scottish Government, 2015) and the United Kingdom (UK) Marine Policy Statement (MPS) (Department for Environment, Food and Rural Affairs (Defra), 2011). Table 17.1 presents a summary of UK and Scottish legislation relevant to climatic effects, with other relevant policy provisions set out in Table 17.2, Table 17.3 and Table 17.4.

9. There are no relevant polices specific to climatic effects in the Sectoral Marine Plan (SMP) for Offshore Wind Energy (Scottish Government, 2020a). As such, this Plan has not been considered further.

10. Further detail is presented in volume 1, chapter 2.

Table 17.1: Summary of Climate Change Legislation Relevant to Climatic Effects

Summary of Relevant Legislation	How and Where Considered in the Array EIA Report
Climate Change Act 2008, as amended by the Climate Change Act 2008 (2050 Target Amendment) Order 2019	
The Climate Change Act 2008, as amended, creates a framework for setting a series of interim national carbon budgets and plans for national adaptation to climate risks. The Act requires the UK government to set carbon budgets (a carbon budget places a restriction on the total amount of greenhouse gases the UK can emit over a 5-year period if the budget for the period is to be met) for the whole of the UK. At present, the Third, Fourth, Fifth and Sixth Carbon Budgets, set through The Carbon Budget Orders 2009, 2011, 2016 and 2021 are 2,544 mega tonnes carbon dioxide equivalent ($MtCO_2e$) for 2018 to 2022, 1,950 $MtCO_2e$ for 2023 to 2027, 1,725 $MtCO_2e$ for 2028 to 2032 and 965 $MtCO_2e$ for 2033 to 2037 respectively. The Sixth Carbon Budget is the first Carbon Budget that is consistent with the UK's net zero target, requiring a 78% reduction in GHG emissions by 2035 from 1990 levels.	Section 17.11.1 provides an assessment of GHG emissions of the Array. A detailed assessment is provided with volume 3, appendix 17.1. The assessment considers whether the emissions associated with the Array are in line with the UK's net zero target. The GHG emissions impact of the Array is contextualised against the UK Carbon Budgets in sections 17.11.1 and 17.11.3. Section 17.11.2 provides an assessment of climate risk and resilience for the relevant elements the Array. A detailed assessment is provided with volume 3, appendix 17.2.
Climate Change (Scotland) Act 2009, as amended by the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019	
The Climate Change (Scotland) Act 2009, as amended (2019) sets out Scotland's GHG emissions reduction targets in line with its net zero emissions target date of 2045. Interim targets are also set by the Act, with a requirement to achieve a 75% reduction in GHG emissions by 2030 and 90% reduction in GHG emissions by 2040, relative to a 1990 baseline emissions year. Statutory annual GHG emissions targets are also set out for every year until 2045, in line with the interim targets in 2030 and 2040. The total of such emissions targets from 2031 to 2040 total 142.6 $MtCO_2e$, and emissions targets from 2041 to 2045 total 17.0 $MtCO_2e$.	Section 17.11.1 provides an assessment of GHG emissions of the Array. A detailed assessment is provided with volume 3, appendix 17.1.
UK's Nationally Determined Contribution (Department for Business, Energy and Industrial Strategy (BEIS), 2022a)	
The UK's nationally determined contribution (BEIS, 2022a) under the Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC) (United Nations, 2015), submitted in September 2022, commits the UK to reducing economy wide GHG emissions by at least 68% by 2030, compared to 1990 levels.	The assessment of GHG effects (sections 17.11.1 and 17.11.3) considers whether the Array's emissions are in line with relevant national policy and legislation, as discussed in section 17.9.2.

Table 17.2: Summary of the Scottish NMP Relevant to Climatic Effects (Scottish Government, 2015)

Summary of Relevant Policy	How and Where Considered in the Array EIA Report
GEN5 Climate Change	
"Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change." The NMP considers climate change in two distinct ways; in terms of how actions under this Plan might help mitigate the degree of anthropogenic induced climate change and facilitate a transition to a low carbon economy; and how actions under this Plan need to be adapted to take into account the effects of climate change, and where appropriate provide effective adaptation to its predicted effects. It is stated that developers should seek to address climate change through both of these aspects of climate change.	Section 17.11.1 provides an assessment of GHG emissions associated with the Array. A detailed assessment is provided with volume 3, appendix 17.1. Section 17.11.2 provides an assessment of climate risk and resilience for the relevant elements the Array. A detailed assessment is provided with volume 3, appendix 17.2.
Chapter 11: Offshore Wind and Marine Renewable Energy Policies	
The following key objectives and policies are included within chapter 11 relevant to climate change: • Objective 5: *"Contribute to achieving the renewables target to generate electricity equivalent to 100% of Scotland's gross annual electricity consumption from renewable sources by 2020."* • Objective 6: *"Contribute to achieving the decarbonisation target of 50gCO2/kWh by 2030 (to cut carbon emissions from electricity generation by more than four-fifths)."* • Renewables 7: "*Marine planners and decision makers should ensure infrastructure is fit for purpose now and in future. Consideration should be given to the potential for climate change impacts on coasts vulnerable to erosion."* The following text is also relevant in providing context to the above objectives and policies: *"Offshore wind and marine renewable energy is a key part of the mitigation measures and new technologies which will put Scotland at the forefront of building a sustainable low carbon economy. Offshore and marine renewables will contribute to Scotland's climate change target for renewable sources to generate the equivalent of 100% of Scotland's gross annual electricity consumption by 2020 and the decarbonisation target to achieve 50 gCO_2e/kWh of electricity generation in Scotland by 2030. Whilst the technologies themselves will involve the use of energy for construction, transportation and maintenance, they will contribute to the decarbonisation of electricity generation through their long-term operation."* *"A changing climate may result in changes in extreme weather events which could create difficult operating conditions for offshore installations. Offshore and onshore infrastructure supporting renewable energy developments should account for the potential impact of climate change."*	Volume 1, chapter 2 provides a summary of the policy and legislative background for the Array, including the need for new renewable energy capacity and offshore wind generation as identified in UK and Scottish policy. The assessment of significance of net GHG effects of the Array (section 17.11), has considered emissions associated with the Array and associated generated electricity. Section 17.11.2 provides an assessment of climate risk and resilience for the relevant elements the Array. A detailed assessment is provided with volume 3, appendix 17.2.

Table 17.3: Summary of UK MPS Relevant to Climatic Effects (Defra, 2011)

Summary of Relevant Policy	How and Where Considered in the Array EIA Report
Section 2.6.7 Climate Change Adaptation and Mitigation & Section 3.3 Energy Production and Infrastructure Development	
Understanding the impacts and effects of climate change is key to maintaining a healthy environment. This will influence how we use and value our coasts and seas both now and in the future. Adaptation, including in the marine environment, is necessary to deal with the potential impacts of these changes which are already in train. Sea level rises, increased flooding and coastal erosion will lead to increased vulnerability for development and significant change along parts of the UK coast (paragraph 2.6.7.3). In marine planning and decision making consideration will need to be given to how the marine environment can adapt to the impacts of climate change When developing Marine Plans, marine plan authorities should make an assessment of likely and potential impacts from climate change and their implications for the location or timing of development and activities over the plan period and beyond. (paragraph 2.6.7.7). The assessment should be made in consultation with the relevant statutory agencies. If any adaptation measures give rise to consequential or additional impacts, such as on coastal change, as a result of protecting a development against flood risk or coastal change for example, the marine plan authority should consider their impacts in relation to the Marine Plan as a whole (paragraph 2.6.7.9). Increasing the generation of energy from low carbon sources will mitigate against climate change, lessen the UK's dependence on fossil fuels and improve energy security by increasing the diversity of electricity supply (paragraph 3.3.16).	Volume 1, chapter 2 provides a summary of the policy and legislative background for the Array, including the need for new renewable energy capacity and offshore wind generation as identified in UK and Scottish policy. Section 17.11.2 provides an assessment of climate risk and resilience for the relevant elements the Array. A detailed assessment is provided with volume 3, appendix 17.2.

11. National climate change policy in relation to renewable energy infrastructure provides overarching guidance for the contribution of the Array towards government targets. These policies are set out in Table 17.4.

Table 17.4: Summary of National Climate Change Policy Relevant to Climatic Effects

Summary of Relevant Policy	How and Where Considered in the Array EIA Report
National Planning Framework 4 (NPF4) (Scottish Government, 2023)	
Policy 1: Tackling the climate and nature crises *"When considering all development proposals significant weight will be given to the global climate and nature crises".* Policy 2: Climate mitigation and adaptation	The assessment of significance of GHG effects of the Array (sections 17.11.1 and 17.11.3), has considered the Array's contribution to national climate change policy, including renewable energy capacity targets. Section 17.11.1 provides an assessment of GHG emissions of the Array. A detailed assessment is provided with volume 3, appendix 17.1.
This policy sets out that developments should consider climate change in the following ways: • *"Development proposals will be sited and designed to minimise lifecycle greenhouse gas emissions as far as possible.* • *Development proposals will be sited and designed to adapt to current and future risks from climate change".*	Section 17.11.1 provides an assessment of GHG emissions of the Array. A detailed assessment is provided with volume 3, appendix 17.1. Section 17.11.2 provides an assessment of climate risk and resilience for the relevant elements the Array. A detailed assessment is provided with volume 3, appendix 17.2.
Net Zero Strategy: Build Back Greener (BEIS, 2021)	
This strategy (BEIS, 2021a) sets out the UK's long-term plans to meet net zero emissions by 2050 and gives the vision for a decarbonised economy in 2050. This strategy sets out the ambition to fully decarbonise the UK's power system by 2035, with electricity sourced predominantly from offshore wind generation. It also highlights the role that electrification will play in decarbonisation of transport, heat and industry, with electricity demand anticipated to double by 2050. Further, the strategy outlines aims to support the decarbonisation of the construction and building sector. Reporting on embodied carbon in buildings and infrastructure is sought to be improved, alongside reductions in embodied carbon by way of material substitution, where appropriate, and resource efficiency.	Volume 1, chapter 2 provides a summary of the policy and legislative background for the Array, including the need for new renewable energy capacity and offshore wind generation as identified in UK and Scottish policy. Section 17.11.1 provides an assessment of GHG emissions of the Array. A detailed assessment is provided with volume 3, appendix 17.1. Within section 17.11.1, the assessment includes emissions resulting from construction of the Array, in particular emissions resulting from the manufacturing of materials required for the Array. The assessment of significance of GHG effects of the Array (sections 17.11.1 and 17.11.3), has considered the Array's contribution to national climate change policy, including renewable energy capacity targets.
Addressing Carbon Leakage Risk to Support Decarbonisation (HM Treasury and Department for Energy Security and Net Zero (DESNZ), 2023)	
This consultation response (HM Treasury and DESNZ, 2023) sets out the measures that the UK Government is exploring or committed to in order to address carbon leakage, whereby production of emissions-intensive products is transferred to another country, resulting in increased emissions abroad and reduced production in the UK. A UK Carbon Border Adjustment Mechanism (CBAM) will be implemented by 2027. The CBAM will apply a tariff (or "carbon price") on imported emission-intensive products, including the iron and steel, aluminium and cement industries. A CBAM sets out additional tariffs that would reflect both the carbon emitted in their production together with any gap between the carbon price applied in the country of origin and the carbon price that is incurred by UK-based production.	Section 17.11.1 provides an assessment of GHG emissions of the Array. A detailed assessment is provided with volume 3, appendix 17.1. Within section 17.11.1, emissions associated with the construction phase have been presented within the assessment and quantification of GHG emissions, as part of the Array, whether these emissions occur within or outside the territorial boundaries of the UK.
Powering Up Britain: The Net Zero Growth Plan (DESNZ, 2023c)	
Due to a successful legal challenge on the 2021 Net Zero Strategy (BEIS, 2021), the UK Government published an updated strategy in March 2023, titled "the Net Zero Growth Plan" (DESNZ, 2023c). This plan largely restated existing policy contained within previous policy papers above. The plan confirmed the UK's commitment to having a decarbonised power system by 2035, with the majority of power generated from renewable sources such as wind and solar. An increase to 50 GW of offshore wind capacity by 2030 is targeted. However, the policy also sets out how 'transition fuels' such as natural gas, will continue to play a role in the power sector,	Volume 1, chapter 2 provides a summary of the policy and legislative background for the array, including the need for new renewable energy capacity and offshore wind generation as identified in UK and Scottish policy. Section 17.11.1 provides an assessment of GHG emissions of the Array. A detailed assessment is provided with volume 3, appendix 17.1. Within section 17.11.1, the assessment includes emissions avoided as a result of the displacement of alternative generation sources by the renewable energy generated by the Array. In

Summary of Relevant Policy	How and Where Considered in the Array EIA Report
accompanied by carbon capture, usage and storage (CCUS) abating emissions from these transition fuel sources.	recognition of the role that transition fuels may play, a range of alternative generation sources are presented for assessment.
Draft Energy and Just Transition Plan (Scottish Government, 2023)	
The draft Energy and Just Transition Plan (Scottish Government, 2023), an update to the Scottish Energy Strategy (Scottish Government, 2017) outlines how Scotland can transition towards cleaner energy. Key policies include: • More than 20 GW of onshore and offshore renewable electricity by 2030. • Accelerated decarbonisation of domestic industry, transport and heat. • Generation of surplus electricity, enabling export of electricity to support decarbonisation UK- and Europe-wide.	Volume 1, chapter 2 provides a summary of the policy and legislative background for the array, including the need for new renewable energy capacity and offshore wind generation as identified in UK and Scottish policy. Section 17.11.1 provides an assessment of GHG emissions of the Array. A detailed assessment is provided with volume 3, appendix 17.1. The assessment of significance of GHG effects of the Array (sections 17.11.1 and 17.11.3), has considered the Array's contribution to national climate change policy.

17.5. CONSULTATION

12. Table 17.5 presents a summary of the key issues raised during consultation activities undertaken to date specific to climatic effects for the Array and in the Ossian Array Scoping Opinion (Marine-Directorate – Licensing Operations Team (MD-LOT), 2023) along with how these have these have been considered in the development of this climatic effects Array EIA Report chapter. Further detail is presented within volume 1, chapter 5.

Table 17.5: Summary of Issues Raised During Consultation and Scoping Opinion Representations Relevant to Climatic Effects

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
Scoping Opinion			
June 2023	MD-LOT	MD-LOT highlight that *"the GHG assessment should include the pre-construction, construction, operation and decommissioning phases, including consideration of the supply chain as well as benefits beyond the life cycle of the Proposed Development."* *"In addition to the GHG assessment, the Scottish Ministers, direct the Developer to the NatureScot representation in relation to blue carbon assessment. The Scottish Ministers advise that consideration should be given to impacts on blue carbon as a result of the Proposed Development, any proposed wet storage areas as well as an expanded assessment for benthic ecology focusing on potential impacts on marine sediments."*	The GHG assessment takes a whole-life approach to the assessment of GHG effects, including emissions from the supply chain and avoided emissions from the displacement of fossil fuels. The assessment has considered the widest scope of emission sources as is feasible across the whole life cycle of the Array, where emissions sources are likely to be significant. The assessment of net GHG effects can be found in section 17.11.3. The impact of disturbance from the Array on blue carbon is considered in section 17.11.1.
June 2023	NatureScot Scoping Representation (May 2023)	NatureScot highlight that *"the impact of climate change effects should be considered, both in futureproofing the project design and how certain climate stressors may work in combination with potential effects from the proposed wind farm. The EIA Report should also consider the carbon cost of the wind farm (including supply chain) and to what extent this is offset through the production of green energy."* *"In addition to the climate change assessments mentioned in the EIA Scoping Report, we recommend that consideration is given to impacts on blue carbon and whether or not an assessment can be undertaken. Not just in in respect of the windfarm, but also in terms of any wet storage areas. This should expand on the information and assessment conducted for benthic ecology to focus on the potential impacts of the proposed development on marine sediments."*	The impact of climate change on the Array is considered in the climate change risk assessment (CCRA), volume 3 appendix 17.2. The GHG assessment takes a whole-life approach to the assessment of GHG effects to calculate the 'carbon cost' of the Array, including emissions from the supply chain and avoided emissions from the displacement of fossil fuels. The net GHG effects of the Array are considered in section 17.11.3. The impact of disturbance from the Array on blue carbon is considered in section 17.11.1.
June 2023	East Lothian Council Scoping Representation (March 2023)	"*We would also suggest consideration of what happens to the parts after decommissioning (for example if they are recycled) which is not specifically mentioned in Table 5.12 but will have an impact on emissions overall."* *"We agree that the potential for carbon displacement due to the provision of renewable energy should be included. We expect that this may change over the life of the project and some estimate of the change over time should be included."* *"The Climatic section does not include any information on whether local changes to weather or climate are expected, either of the project alone or cumulatively. If this could happen, especially if rainfall on land could increase or decrease, this should be included."*	The end-of-life impacts of materials used for the Array are considered in the assessment of decommissioning GHG effects in section 17.11.1. The avoided emissions as a result of displacing fossil fuel generating sources are presented in section 17.11.1, which includes a range of avoided emissions based on different future baseline scenarios and modelled over the lifetime of the Array. A detailed assessment, including projected avoided emissions, is provided with volume 3, appendix 17.1. The impact of climate change on the Array is considered in the CCRA, volume 3 appendix 17.2, and section 17.11.2 of this chapter. The CCRA considers future climate change projections, including precipitation changes.
June 2023	Scottish Fishermen's Federation (SFF) Scoping Representation (April 2023)	The SFF would expect *"to see scoped in a genuine auditable range of positive and negative values of emissions engendered by the project from day one to decommissioning, recognising that at that point most of the structures become waste."*	In section 17.11.1 of this chapter, the GHG assessment takes a whole-life approach to the assessment of GHG effects, including emissions from decommissioning of the Array.

17.6. METHODOLOGY TO INFORM BASELINE

13. Information from desktop studies, including climatic data and GHG emissions data, has been reviewed and analysed to inform this climatic effects baseline.

17.6.1. RELEVANT GUIDANCE

14. The main guidance used for the assessment of GHG emissions in EIA is the IEMA guide to 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (IEMA, 2022).

15. The main guidance document with regard to climate risk and resilience assessment (including IRE assessment) within the context of EIA is the Environmental Impact Assessment Guidance on: Climate Change Resilience and Adaptation (IEMA, 2020).

16. Additional guidance used for the quantification of GHG emissions includes:

- the Greenhouse Gas Protocol suite of documents (World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), 2004);
- PAS 2080:2023 - Carbon Management in Infrastructure (BSI, 2023); and
- UK Government GHG Conversion Factors for Company Reporting (DESNZ and Department for Environment, Food and Rural Affairs (Defra), 2023).

17.6.2. DESKTOP STUDY

17. Information on climate change within the climatic effects study area was collected through a detailed desktop review of existing studies and datasets which are summarised in Table 17.6.

18. Both the literature review of the reports and subsequent analysis using the datasets were used to characterise the baseline. Full details of the analysis undertaken to develop the climatic effects baseline for the GHG emissions assessment and climate change risk are detailed in volume 3, appendix 17.1 and appendix 17.2 respectively.

Table 17.6: Summary of Key Desktop Reports

Title	Source	Extent	Year	Author
Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book	DESNZ	2010-2100	2023	DESNZ
UK Government GHG Conversion Factors for Company Reporting	DESNZ and Defra	2023	2023	DESNZ and Defra
Scottish Blue Carbon – a literature review of the current evidence for Scotland's blue carbon habitats	NatureScot Research Report 1326	Unknown	2023	Cunningham and Hunt
UK Offshore Energy Strategic Environmental Assessment: Appendix 1F: Climate and Meteorology	Department for Business, Energy and Industrial Strategy (BEIS)	1981-2020	2022	BEIS
Inventory of Carbon and Energy (ICE) database	Jones and Hammond	2019	2019	Jones and Hammond
Climate Change 2021: The Physical Science Basis	Intergovernmental Panel on Climate Change (IPCC)	1850-2100	2021	IPCC
UK Climate Projections 2018 (UKCP18) Marine Report	UKCP18 Database	1981-2100	2018	Palmer *et al.*

17.6.3. SITE-SPECIFIC SURVEYS

19. No site-specific surveys have been undertaken to inform the EIA for climatic effects. This is because the calculation of GHG emissions to inform the GHG assessment is solely a desk-based exercise, informed by the maximum design scenario as described in Table 17.7. Additionally, the CCRA and future climatic baseline have been informed by climate projections, sourced from relevant literature and guidance. As such, no site-specific surveys specific to climatic effects are required. However, information gathered as part of the benthic survey (volume 3, appendix 8.1, annex A) and geoenvironmental survey (volume 3, appendix 7.1, annex A) has been used to inform the climatic effects baseline, where appropriate.

17.7. BASELINE ENVIRONMENT

17.7.1. OVERVIEW OF BASELINE ENVIRONMENT

20. The following sections provide a summary of the climatic effects baseline environment. The GHG technical report (volume 3, appendix 17.1) and CCRA technical report (volume 3, appendix 17.2), includes full details of the analysis undertaken to develop the climate change risk and GHG emissions baseline.

GHG Emissions Assessment Baseline Environment

21. To determine the GHG emissions assessment baseline environment, information has been sourced and cross referenced from the benthic subtidal ecology technical report (volume 3, appendix 8.1).

22. The baseline consists of various subtidal habitats which have been classed according to sediment type using the Folk (1954) classification, as set out in volume 2, chapter 8. The predominant sediment types are muddy sand, sand and slightly gravelly sand. These sediments are likely to contain stores of 'blue carbon', which is organic carbon that has been captured and stored through biological processes in the coastal and marine environment (Cunningham and Hunt, 2023). Though subtidal sediments are a large carbon store within Scottish Exclusive Economic Zone (EEZ) waters, with an estimated 357 mega tonnes (Mt) of organic carbon stored within coastal and marine sediments (Smeaton *et al.*, 2020), such subtidal habitats are likely to present carbon stores of low relative importance, given their low organic carbon storage density compared to other habitats, including saltmarsh and seagrass habitats. Section 17.11.1 presents the standing blue carbon stock in the subtidal sediments present within the Array.

23. The Array will likely contribute to the abatement of the amount of fossil fuel generation within the UK Grid (i.e. UK Grid carbon intensity). As such, the current baseline with regard to UK Grid-average emission factor for electricity generation, without the Array, is 252.97 $kgCO_2e/MWh$ (including well-to-tank but as-generated, i.e. excluding transmission and distribution losses) (DESNZ and Defra, 2023).

24. Further information is presented in the GHG technical report (volume 3, appendix 17.1).

CCRA Baseline Environment

25. Baseline offshore climatic conditions for the climatic effects study area have been sourced from observational data collated within the UK Offshore Energy Strategic Environmental Assessment (BEIS, 2022c), IPCC Sixth Assessment Reporting of the physical science (IPCC, 2021) and relevant information included in the physical processes technical report (volume 3, appendix 7.1).

26. Mean air temperatures in the central North Sea (where the Array is located) range from lows of 1°C in January to 16°C in July, with surface air temperatures exceeding sea surface temperatures during the spring and summer months and falling below sea surface temperatures during the autumn and winter months (BEIS, 2022c). Global air temperatures rose by 0.85°C between 1880 and 2012, and continue to rise (IPCC, 2021).

27. Precipitation rates within the central North Sea follow a seasonal trend with April to June tending to be the driest months, and October to January being wetter. Thunderstorms are infrequent, and snow showers vary from approximately 10 to 12 days per year in the central North Sea (BEIS, 2022c).

28. Within the climatic effects study area, wind speeds have been recorded up to 31.5 m/s during the 1979 to 2023 period, with winds predominantly from the south-west. Annual mean significant wave height ranges from 1.87 m to 2.05 m, with wave direction predominantly from the north and north-north-east. An easterly storm event occurred within the climatic effects study area during November 2022, with maximum significant wave height of 8.96 m (volume 3, appendix 7.1).

29. Mean sea level (MSL) is a crucial element of climate change related risks for offshore wind farms, as increased MSL has the potential to both increase water damage and corrosion of components above the water line at time of construction, and/or increase mooring line tension. MSL rise also has the potential to cause increased damage from storm surge. Global MSL rose by 0.2 m between 1901 and 2018, and continues to rise (IPCC, 2021).

30. Further information is presented in the CCRA technical report (volume 3, appendix 17.2).

17.7.2. FUTURE BASELINE SCENARIO

31. The EIA Regulations require that "a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project, as far as natural changes from the baseline scenario can be assessed with reasonable effort, on the basis of the availability of environmental information and scientific knowledge" is included within the Array EIA Report.

32. If the Array does not come forward, an assessment of the 'without development' future baseline conditions has also been carried out and is described within this section.

GHG Emissions Assessment Future Baseline

33. The future baseline GHG emissions for existing land use (seabed) without the Array are expected to remain similar to that listed in paragraph 22. Some areas of the North Sea experience almost no sediment accumulation and associated carbon sequestration through organic carbon deposits (Cunningham and Hunt, 2023). As such, no material change to the blue carbon stored within the Array area is anticipated in the future baseline.

34. The future baseline for electricity generation that would be displaced by the Array depends broadly on future energy and climate policy in the UK, and more specifically (with regard to day-to-day emissions) on the demand for operation of the Array compared to other generation sources available, influenced by commercial factors and National Grid's needs.

35. Several future baseline scenarios have therefore been considered using DESNZ projections of the carbon intensity of long-run marginal electricity generation during the Array's operating lifetime (DESNZ, 2023a) and assumptions about specific generation sources that could be displaced. These are detailed in the GHG technical report (volume 3, appendix 17.1).

36. The carbon intensity of baseline UK Grid electricity generation (see paragraph 23) is projected to reduce over time and so too would the intensity of the marginal generation source, displaced at a given time.

CCRA Future Baseline

37. In the near future (the next decade to two decades), variations in average temperature and precipitation will likely be the most visible year-to-year changes in climate. In subsequent decades, within the operating lifetime of the Array, anthropogenic climatic changes are expected to become more apparent.

38. It is expected that sea surface temperatures will continue to increase in the 21st century, with global mean sea surface temperatures predicted to increase by approximately 2.9°C by 2100 under Representative Concentration Pathway (RCP) 8.5[1]. Sea temperatures in Northern Europe (including the North Sea) are predicted to rise at a greater rate than the global average, with temperatures predicted to increase by approximately 3.4°C under RCP8.5 in the same time period. Ocean acidification is anticipated to increase, with a fall in surface pH by 0.4 units by 2100 under RCP8.5 (IPCC, 2021).

39. Average sea level rise around the UK is expected to increase by 1 m by 2100, though a lesser rise is anticipated in the north of the UK. The east coast of Scotland can expect to see an average sea level rise of approximately 0.5 m to 0.6 m by 2100 (Palmer *et al*, 2018). The average wave height is predicted to decrease around much of the UK at a factor of about 10% to 20% over the 21st century, with average wave heights in the central North Sea predicted to reduce by 0.5 m. However, owing to variation between different models, confidence in projected sea wave height changes is low (Jaroszweski *et al*., 2021).

40. Further information has been presented within the CCRA technical report (volume 3, appendix 17.2).

17.7.3. DATA LIMITATIONS AND ASSUMPTIONS

41. There is uncertainty about future climate and energy policy and market responses, which affect the likely future carbon intensity of energy supplies, and thereby the future carbon intensity of the electricity generation being displaced by the Array. UK Government projections consistent with national carbon budget commitments have been used in the assessment ('long-run marginal' projections). It should be noted that latest UK Government projections include an increase in renewable energy generation, in particular from increased offshore wind capacity (DESNZ, 2023a), consistent with the UK Government's current policy of a low-carbon electricity grid by 2035 with no unabated fossil fuel generation (BEIS, 2021). Thereby, for the Array's operational lifetime, the long-run marginal projections presented are reliant on offshore wind projects such as the Array being brought online. As such, the long-run marginal does not represent a true 'without development' future baseline. Additionally, there is inherent uncertainty in such projections as the UK grid electricity factor changes from year to year as the fuel mix consumed in UK power stations changes, and as the proportion of net imported electricity also changes. Annual fluctuations can be large as they depend on the relative prices of coal and natural gas, alongside fluctuations in peak demand and renewable provision (DESNZ, 2023). Therefore, multiple scenarios have been considered to present a likely range of avoided emissions, including displacement of non-renewable fuels as an upper estimate for the likely avoided emissions, and comparison to the long-run marginal projections as a lower estimate.

42. Construction phase GHG emissions associated with the manufacturing of infrastructure associated with the Array may occur outside the territorial boundary of the UK and hence outside the scope of the UK's national carbon budget, policy and governance. However, in recognition of the climate change effect of GHG emissions (globally occurring), and to avoid 'carbon leakage' overseas when reducing UK emissions, emissions associated with the construction phase have been presented within the assessment and quantification of GHG emissions, as part of a life cycle GHG emission assessment of the Array (see paragraph 62).

43. The specific design for the components of the Array (floating wind turbines, mooring and anchoring systems, OSPs, inter-array and interconnector cabling), alongside the specifications of vehicles and vessels that would be used by the Array have not yet been specified. Thus, there is a degree of uncertainty

[1] The RCP scenarios describe different climatic futures, all of which are considered possible depending on the volume of GHGs emitted. These provide the basis for future assessments of climate change and possible response strategies, thereby giving a low to high range in potential global GHG reduction initiatives and resulting rate of climatic effects over a given period. Refer to volume 3, appendix 17.2 for more information on RCP scenarios.

regarding GHG emissions resulting from the manufacturing and construction of wind turbines and infrastructure, vessel movements and operation and maintenance activities associated with the Array. This assessment seeks to limit the impact this might have by using maximum design scenario (MDS), which includes material quantities and material types (i.e. those with the greatest carbon impact), in the calculation of construction phase emissions and emissions resulting from operation and maintenance activities. This assessment has also used MDS vessel movements, as stated in Table 17.7, and does not account for future decarbonisation of these vessel movements. It is unlikely that the full extent of these MDS material quantities will be used in the final design of the Array, owing to improvements in wind turbine and associated infrastructure design, refinements to design assumptions and continued decarbonisation of the manufacturing and transport sectors. As such, calculated emissions represent a conservative (reasonable adverse case) scenario.

44. Detailed information is not yet available for the decommissioning phase. However, it is anticipated that this phase will involve similar types and numbers of vessels and equipment to that of the construction phase. As such, emissions from the decommissioning phase have been estimated based on MDS vessel movements for the construction phase.

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

46. An assumed operational lifetime of 35 years (2038 to 2072) has been applied to the assessment of avoided GHG emissions associated with the operation and maintenance phase of the Array and consideration of maintenance activities.

47. When assessing climate risks, uncertainty arises from both modelling uncertainty and natural variability in the potential magnitude of future changes in climate. A high magnitude of change scenario and the high end of probabilistic projections have therefore been used, to provide a precautionary reasonable adverse approach. This is further discussed in the CCRA technical report (volume 3, appendix 17.2).

48. The above uncertainties are integral to the assessment of climatic effects, but a precautionary approach has been taken as far as practicable to provide a reasonable worst-case assessment. On the basis of the above, it is considered that limitations to the assessment have been reduced and that the results provide a robust estimate of the effects of the Array.

49. It is important to note that the Array would not operate in isolation, as transmission infrastructure is required to connect the Array to the grid in order to realise the potential avoided emissions associated with the production of wind energy. However, the proposed offshore export cable corridor(s) and proposed onshore transmission infrastructure are subject to separate applications. As such, it is necessary to consider the embodied emissions of the transmission infrastructure within the cumulative assessment, so as to understand the whole-life effects of Ossian.

50. The design parameters of the associated proposed offshore export cable corridor(s) and proposed onshore transmission infrastructure are not yet available. As such, calculations for the assessment of cumulative effects, in order to quantify whole-life GHG emissions for Ossian, have been based on high-level indicative parameters provided by the Applicant. These parameters will be refined in subsequent applications for the transmission infrastructure, alongside the associated calculations as more information becomes available. The cumulative assessment presented in section 17.12 is therefore carried out using a precautionary approach and is a maximum design scenario.

51. It is worth noting that a high level of conservatism has been used to derive the GHG calculations, as detailed in volume 3, appendix 17.1, as these are based on the current understanding of required materials for the Array, which are likely to be further refined during final stage design. In addition, the assessment included in this EIA chapter applies another layer of conservatism, as it is based on the most adverse scenario, leading to a precautionary assessment.

17.8. KEY PARAMETERS FOR ASSESSMENT

17.8.1. MAXIMUM DESIGN SCENARIO

52. The maximum design scenarios identified in Table 17.7 are those expected to have the potential to result in the greatest impact on an identified receptor or receptor group. These scenarios have been selected from the details provided in volume 1, chapter 3 of the Array EIA Report. Effects of greater adverse significance are not predicted to arise should any other development scenario within the Project Description (volume 1, chapter 3) and assessed here, be taken forward in the final design.

Table 17.7: Maximum Design Scenario Considered for Each Potential Impact as Part of the Assessment of LSE[1] on and from Climate Change

Potential Impact	Phase[2]			Maximum Design Scenario	Justification
	C	O	D		
GHG emissions arising from disturbance to blue carbon stocks during the construction, operation and maintenance and decommissioning of the Array	✓	✓	✓	**Construction, Operation and Maintenance and Decommissioning Phases** Maximum seabed footprint of the Array, including scour protection, is 32.25 km^2, consisting of: • a total footprint area of 1,503,613 m^2 due to wind turbine anchors (including scour protection); • mooring line footprint per floating foundation of 4,860 m^2; • a total footprint area of 89,386 m^2 due to OSP foundations (including scour protection); • a total footprint area of 24,448,000 m^2 due to inter-array cables (also accounting for area disturbed by cable protection); • a total footprint area of 4,720,000 m^2 due to interconnector cables (also accounting for area disturbed by cable protection); and • a total footprint area of 201,552 m^2 due to junction boxes (also accounting for area disturbed by seabed preparation). **Construction Phase** Maximum additional disturbance to the seabed associated with mooring lines during construction (3,240 m^2 per floating foundation). **Operation and Maintenance Phase** Maximum additional disturbance to the seabed associated with mooring lines during operation and maintenance (3,067 m^2 per floating foundation during storms).	The greatest footprint of the Array and greatest additional disturbance during construction and operation and maintenance phases will result in the greatest overall disturbance to the seabed, representing the greatest potential for GHG emissions from affecting blue carbon stores.

[2] C = Construction, O = Operation and maintenance, D = Decommissioning

Potential Impact	Phase[2] C	O	D	Maximum Design Scenario	Justification
GHG emissions arising from the manufacturing and installation of the Array	✓	✗	✗	**Construction Phase** The greatest number of wind turbines and floating foundations (265 no.). The maximum total length of mooring lines per wind turbine foundations (750 m) and maximum number of lines per platform (6 no.). The maximum number of anchors per platform (6 no.) and maximum total anchor scour protection volume (948,295 m^3). Offshore Substation Platforms (OSPs) (6 no large OSPs), maximum topside weight (33,000 tonnes per OSP) and maximum OSP scour protection volume (134,078 m^3). Export capacity of up to 3.6 GW. The maximum total length of interconnector cables (236 km), maximum cable protection volume (2,832,000 m^3) and maximum length of cable requiring protection (47,200 m). The maximum total length of inter-array cables (1,261 km), maximum cable protection volume (14,668,800 m^3) and maximum length of cable requiring protection (244,480 m). The maximum total volume of cable crossing protection (48,000 m^3 for the interconnector cables and 48,000 m^3 for the inter-array cables). The maximum number of junction boxes (228 no.) and maximum volume of scour protection per junction box (1,326 m^3). Maximum number of vessel movements (return trips) for site preparation and construction activities (7,902 no.). Maximum number of helicopter movements (return trips) for construction activities (3,942 no.).	The greatest number of wind turbines, floating platforms, junction boxes and vessel movements, maximum length of the inter-array and interconnector cables and maximum volume of cable and scour protection represent the greatest potential for GHG emissions from the construction and installation of the Array. 6 no. large OSPs represent the greatest potential for GHG emissions from the construction and installation of the Array.
GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the Array and estimated abatement of UK Grid emissions	✗	✓	✗	**Operation and Maintenance Phase** 35 year operating lifetime. Export capacity of up to 3.6 GW. Maximum number of vessel movements (return trips) per year (508 no.). Maximum number of helicopter movements (return trips) per year (216 no.). Maximum amount of material replacement: • Replacement of all scour protection twice over lifetime of the Array. • Two major component replacements per OSP every 10 years. • One campaign of component replacements for wind turbines every year. • 5% of the inter-array cables to be repaired or replaced annually.	The greatest number of vessel movements, and maximum amount of maintenance activities will result in the greatest consumption of fuel and materials representing the greatest potential for GHG emissions. The Array will have an export capacity of up to 3.6 GW.

Potential Impact	Phase[2] C	O	D	Maximum Design Scenario	Justification
GHG emissions arising from decommissioning works of the Array	×	×	✓	**Decommissioning Phase** At the end of the operational lifetime of the Array, it is anticipated that all floating structures, mooring lines, OSP topsides and foundations to the seabed level will be completely removed. Associated infrastructure, such as cables, scour protection and anchors and piles below the seabed may either be left *in situ* or removed, in accordance with the decommissioning plan. It may be decided, closer to the time of decommissioning, that removal will result in greater environmental impacts than leaving components *in situ*. The decommissioning sequence will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment.	The greatest number of vessel movements and the greatest number and size of structures will result in the greatest consumption of fuel and materials representing the greatest potential for GHG emissions from the decommissioning works.
Effects of climate change on the Array	×	✓	×	**Operation and Maintenance Phase** Use of most adverse future climate change projections available for the climatic effects study area (RCP8.5, see paragraph 38), subject to data availability. Under this projection, consistently heightened temperatures, changes to rainfall patterns, increased wind speeds and increased frequency of extreme events such as storms could lead to efficiency losses due to overheating, the failure of electrical equipment or damage to infrastructure which would result in an increase in operations and maintenance activities.	The use of the most adverse future climate change projection (RCP8.5, a high emissions scenario) will result in the greatest magnitude and severity of climate change risks to the Array.
Net GHG impacts of the Array	✓	✓	✓	**Construction Phase** MDS as per impacts above. • GHG emissions arising from disturbance to blue carbon stocks during the construction of the Array. • GHG emissions arising from the manufacturing and installation of the Array. **Operation and Maintenance Phase** MDS as per impacts above. • GHG emissions arising from disturbance to blue carbon stocks during the operation and maintenance of the Array. • GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the Array and estimated abatement of UK Grid emissions. **Decommissioning Phase** MDS as per impacts above. • GHG emissions arising from disturbance to blue carbon stocks during the decommissioning of the Array. • GHG emissions arising from decommissioning works of the Array.	See impacts above.

17.8.2. IMPACTS SCOPED OUT OF THE ASSESSMENT

53. On the basis of the baseline environment and the Project Description outlined in volume 1, chapter 3 of the Array EIA Report, one impact is proposed to be scoped out of the assessment for climatic effects.

54. This impact is outlined, together with a justification for scoping it out, in Table 17.8.

Table 17.8: Impact Scoped Out of the Assessment for Climatic Effects (Tick Confirms the Impact is Scoped Out)

Potential Impact	Phase[3]			Justification
	C	O	D	
The impact of the effects of climate change on the Array during construction and decommissioning phases	✓	✗	✓	Due to the length of the programme for construction and decommissioning phases (8 years for each of construction and decommissioning), variations in climatic parameters would be minimal compared to the present-day baseline. Construction work practices are adapted to existing climate conditions and weather in the UK. Additionally, it is assumed that construction and decommissioning work practices would likely evolve with time with climatic variations. As such, it is considered that there is not the potential for LSE[1] from the impact of the effects of climate change on the Array during the construction and decommissioning phases. The effects of climate change on construction and decommissioning activities are therefore not considered further. Such impacts are assessed within the operations and maintenance phase only.

17.9. METHODOLOGY FOR ASSESSMENT OF EFFECTS

17.9.1. OVERVIEW

55. The climate change assessment of effects has followed the methodology set out in volume 1, chapter 6 of the Array EIA Report. Specific to the climatic effects EIA, the following guidance documents have also been considered:

- IEMA guidance on Climate Change Adaption and Resilience (IEMA, 2020); and
- IEMA guidance on 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (IEMA, 2022).

56. In addition to the overarching policy and legislation as described in volume 1, chapter 2 of this Array EIA Report, national climate change policy and legislation relevant to the climatic effects impact assessment is set out in section 17.4. In order to undertake a climatic effects impact assessment, information gathered in the GHG assessment technical report (volume 3, appendix 17.1) and the CCRA technical report (volume 3, appendix 17.2) have been utilised. This information is sourced from primary calculations and secondary sources to calculate the effect of the Array on and from climate change.

[3] C = Construction, O = Operation and maintenance, D = Decommissioning

GHG Emissions Assessment Methodology

57. GHG emissions have been estimated by applying published emissions factors to activities in the baseline and to those required for the Array. The emissions factors relate to a given level of activity, or amount of fuel, energy or materials used to the mass of GHGs released as a consequence. The GHGs considered in this assessment are those in the 'Kyoto basket' of global warming gases[4] expressed as their CO_2-equivalent (CO_2e) global warming potential (GWP). This is denoted by CO_2e units in emissions factors and calculation results. GWPs used are typically the 100-year factors in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC, 2013) or as otherwise defined for national reporting under the UNFCCC.

58. Additional guidance used for the quantification of GHG emissions includes:

- DESNZ (2023a) Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book;
- UK Government GHG Conversion Factors for Company Reporting (DESNZ and Defra, 2023); and
- the Greenhouse Gas Protocol suite of documents WRI and World Business Council for Sustainable Development (WBCSD) (2004).

59. GHG emissions caused by an activity are often categorised into 'scope 1', 'scope 2' or 'scope 3' emissions, following the guidance of the WRI and the WBCSD Greenhouse Gas Protocol suite of guidance documents (WRI and WBSCD, 2004).

- Scope 1 emissions: direct GHG emissions from sources owned or controlled by the company, e.g. from combustion of fuel at an installation.
- Scope 2 emissions: caused indirectly by consumption of purchased energy, e.g. from generating electricity supplied through the national grid to an installation.
- Scope 3 emissions: all other indirect emissions occurring as a consequence of the activities of the company, e.g. in the upstream extraction, processing and transport of materials consumed or the use of sold products or services. Downstream use of products and services sold to customers would also be captured under Scope 3 emissions.

60. This assessment has sought to include emissions from all three scopes, where this is material and reasonably practicable from the information and emissions factors available, to capture the impacts attributable most completely to the Array. These emissions shall not be separated out by defined scopes (scopes 1, 2 or 3) in the assessment.

61. The assessment has considered:

- the GHG emissions arising from the Array (during construction, operation and maintenance, and decommissioning phases);
- any GHG emissions that it are avoided, compared to the current or future baseline; and
- the net impact on climate change due to these changes in GHG emissions overall.

62. As previously discussed in paragraph 42, construction phase GHG emissions associated with the manufacturing of components may occur outside the territorial boundary of the UK and hence outside the scope of the UK's national carbon budget. However, in recognition of the climate change effect of GHG emissions (wherever occurring) and to avoid 'carbon leakage' overseas when reducing UK emissions, the full life cycle GHG emissions of the Array, including emissions associated with the construction phase (wherever they derive, globally, where it is reasonably practicable to make assumptions for those emissions), have been evaluated where possible when determining the significance of effects.

63. The GHG technical report (volume 3, appendix 17.1), which provides further details of the GHG emissions assessment methodology, should be read alongside this chapter.

[4] The Kyoto Basket of global warming gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). The latter four are together termed "F-Gases".

CCRA Methodology

64. Baseline offshore climatic conditions have been sourced from observational data collated within the UK Offshore Energy Strategic Environmental Assessment (BEIS, 2022c), IPCC Sixth Assessment Reporting of the physical science (IPCC, 2021) and the physical processes technical report (volume 3, appendix 7.1). Information from the UKCP18 RCP8.5 has been drawn upon in addition to the UK CCRA3 to establish UK marine climate projections for the 21st century through to 2100.

65. The CCRA technical report (volume 3, appendix 17.2) should be read alongside this chapter, which provides further detail of the approach and data input.

66. A high level screening risk assessment has been undertaken, considering the hazard, potential severity of impact on the Array and workers, probability of that impact, and level of influence the Array design can have on the risk.

67. Where potentially significant impacts have been identified at the screening stage prior to any mitigation, further assessment has been undertaken with consideration of appropriate mitigation to determine whether significant residual risks are likely.

17.9.2. CRITERIA FOR ASSESSMENT OF EFFECTS

68. When determining the significance of effects, a two stage process is used which involves defining the magnitude of the potential impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The criteria for determining the significance of effects have been divided into two categories:

- assessment of the significance of the effect of the Array on climate change (GHG assessment); and
- assessment of the significance of the effect from climatic changes on the Array (CCRA).

69. The impact assessment criteria for each of these categories is set out below.

Impact Assessment Criteria: GHG Emissions

Magnitude of impact

70. In accordance with the IEMA Guidance (2022) where GHG emissions can be quantified directly and expressed based on their GWP as tonnes of CO_2e emitted, the magnitude of impact is reported numerically. Where a quantifiable figure is not possible, for example due to a lack of available data at early design stage, this is expressed qualitatively, based on professional judgement.

Sensitivity of receptor

71. GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in CO_2e, has therefore been treated as a single receptor of high sensitivity (given the importance of the global climate as a receptor).

Significance of effect

72. Assessment guidance for GHG emissions (IEMA, 2022) describes five levels of significance for emissions resulting from a development, each based on whether the GHG emission impact of the development will support or undermine a science-based 1.5°C compatible trajectory towards net zero, in line with the goals of the Paris Agreement (UN, 2015). To aid in considering whether climatic effects are significant, IEMA (2022) recommends that GHG emissions should be contextualised against pre-determined carbon budgets, or applicable existing and emerging policy and performance standards where a budget is not available. It is a matter of professional judgement to integrate these sources of evidence and evaluate them in the context of significance.

73. Taking the guidance into account, the following have been considered in contextualising the Array GHG emissions:

- the magnitude of net GHG emissions as a percentage of UK national carbon budgets (where feasible and where carbon budgets are available); and
- whether the Array contributes to, and is in line with, the UK's policy for GHG emissions reductions, where these are consistent with science-based commitments to limit global climate change to an internationally agreed level (as determined by the UK's nationally determined contribution (NDC) to the Paris Agreement (BEIS, 2022a)).

74. Effects from GHG emissions are described in this chapter as adverse (major, moderate or minor), negligible or beneficial based on the following definitions, which closely follow the examples in Box 3 of the IEMA guidance (IEMA, 2022) as detailed in Table 17.9.

Table 17.9: Guidance Definitions of Significance in Relation to GHG Emissions (IEMA, 2022)

Significance	Definition
Major adverse	The Array's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type.
Moderate adverse	The Array's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type.
Minor adverse	The Array's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type.
Negligible	The Array's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050.
Beneficial	The Array's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline.

75. Major and moderate adverse and beneficial effects are considered to be significant in EIA terms. Minor adverse and negligible effects are not considered to be significant in EIA terms.

76. GHG emissions associated with a proposed project are often reported as a whole life figure (net emissions) that takes account of all the Array's phases. The net whole life figure is the key element for determining the Array's whole life impact on climate change. However, it is noted in the IEMA guidance (2022) that due to the nature of GHG emissions, it is good practice to include a section that reports on the whole life GHG emissions associated with the Array, alongside the sections that assess construction, operation and maintenance and decommissioning effects in isolation.

Impact Assessment Criteria: CCRA

77. IEMA guidance (IEMA, 2020) defines climate change resilience as the *"ability to respond to changes in climate. If a receptor or project has good climate change resilience, it is able to respond to the changes in climate in a way that ensures it retains much of its original function and form. A receptor or project that has poor climate change resilience will lose much of its original function or form as the climate changes"*.

78. The methodology to assess impacts presented in the CCRA differs from many other EIA topics in that it considers how the resilience of a development is affected by an external factor (climate change) and not specifically how potential environmental receptors are affected by a development's impacts. Consequentially, the CCRA cannot be assigned significance with respect to the severity of impacts in the

same way as for the other topics. Instead, a risk-analysis based approach has been used for the assessment.

79. As is detailed in the CCRA technical report (volume 3, appendix 17.2), a risk assessment has been undertaken, considering the hazard, potential severity of impact on the Array and its users (including their sensitivity and vulnerability), probability of that impact, and level of influence the Array design can have on the risk. Each of these factors is assigned a score of between 1 and 3, as shown in Table 17.10 below. These individual scores are summed to give a final total score. A total score of five or more (the minimum score where more than one element of the risk assessment score is above 'one') has been defined as a risk that could lead to a significant adverse or beneficial effect in EIA terms. By considering designed in measures adopted as part of the Array, professional judgement is used in determining whether impacts are likely to result in significant adverse or beneficial, or non-significant negligible effects in EIA terms.

80. The criteria for defining the potential severity of a climate impact on the Array, probability of that impact, and influence factor of the design, used in this chapter to determine the significance of identified climate risks are outlined in Table 17.10 below.

Table 17.10: Severity, Probability, and Influence Factor Definitions

Factor	Score definition
Severity: the magnitude and likely consequences of the impact should it occur.	1 = unlikely or low impact: for example, low-cost and easily repaired property damage; small changes in occupiers' behaviour.
	2 = moderate impact with greater disruption and/or costs: for example, localised property damage; risk of injury.
	3 = severe impact, e.g. risk to individual life or public health, widespread property damage or disruption to business
Probability: reflects both the range of possibility of climatic parameter changes illustrated in CP18 projections and the probability that the possible changes would cause the impact being considered	1 = unlikely or low probability of impact; impact would occur only at the extremes of possible change illustrated in projections
	2 = moderate probability of impact, plausible in the central range of possible change illustrated in projections
	3 = high probability of impact, likely even with the smaller changes illustrated as possible in the projections
Influence: the degree to which design of the proposed development can affect the severity or probability of impacts	1 = no or minimal potential to influence, outside control of developer, e.g. reliance on national measures or individuals' attitudes/actions; or hypothetical measures would be impracticable
	2 = moderate potential to influence, e.g. a mixture of design and user behaviour or local and national factors; measures may have higher costs or practicability challenges
	3 = strong potential to influence through measures that are within the control of the developer and straightforward to implement

17.10. MEASURES ADOPTED AS PART OF THE ARRAY

81. As part of the Array design process, a number of designed in measures have been proposed to reduce the potential for impacts on and from climate change (see Table 17.11). They are considered inherently part of the design of the Array and, as there is a commitment to implementing these measures, these have been considered in the assessment presented in section 17.11 (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These designed in measures are considered standard industry practice for this type of development.

Table 17.11: Designed In Measures Adopted as Part of the Array

Designed In Measures Adopted as Part of the Array	Justification
Safety margin within the wind turbine design to be fitted with automatic shutdowns/lockdowns with regards to spinning too fast.	Enable the Array to be resilient to future climate change, in particular from the risk of increased frequency and intensity of extreme weather.
The OSP electrical plant will be located within an internal structure. Appropriate cooling plant will be designed to account for a range of temperature conditions.	Ensure appropriate, robust design and enable the OSPs to be resilient to the known environmental conditions and potential future changes.
Application of anti-corrosion protective coatings, accounting for sea level rise.	Enable the Array to be resilient to future climate change, in particular from the risk of increased sea temperatures, ocean acidification and sea level rise.
Development of, and adherence to, an OMP.	The OMP will detail a programme of routine inspections, of all project infrastructure to ensure safe and efficient operations.
Compliance with the Regulatory Expectations on Moorings for Floating Wind and Marine Devices (HSE and MCA, 2017).	Ensure that the final design is appropriately designed, constructed to an appropriate standard and structural integrity maintained during the operation and maintenance phase of the project.
Ossian Array infrastructure will be subject to third party verification, where applicable	Ensure that the final design is appropriately designed, constructed to an appropriate standard and structural integrity maintained during the operation and maintenance phase of the project.
Development of, and adherence to a Scour Protection Management Plan (SPMP).	There is the potential for scouring of seabed sediments to occur due to interactions between metocean regime (wave, sand and currents) and wind turbine anchors or OSP foundations or other seabed structures. This scouring can develop into depressions around the structure, therefore the use of scour protection around offshore structures and foundations will be employed, where required, as described in detail in volume 1, chapter 3.
Implementation of Net Zero Transition Action Plan (NZTAP), by the Applicant as appropriate.	This plan outlines the headline actions and sets short-, medium-, and long-term targets to achieve net zero by 2035 across its operations and by 2050 across its supply chain. These targets are intended to drive business activities which help support the decarbonisation of capital projects, thereby better enabling the wider net zero transition. The Applicant will apply the NZTAP to the Array to reduce carbon impacts during the lifecycle of the project (i.e. during construction, operation and maintenance, and decommissioning phases), where these can feasibly be achieved. Actions to be implemented by the Applicant, that are in line with the NZTAP, will be detailed within a Carbon Reduction Plan at detailed design stage.
Align the design of the Array with the principles of PAS 2080: Carbon Management in Infrastructure and Built Environment.	As the design of the Array progresses, this approach to carbon management in project design decision-making enables reductions of the Array's carbon impact over its life cycle (i.e. during construction, operation and maintenance, and decommissioning phases). Actions to be implemented by the Applicant, that are in line with the principles of PAS 2080, will be detailed within a Carbon Reduction Plan at detailed design stage. To support this work, SSE Renewables is a leading participant in the Sustainability Joint Industry Partnership. This partnership, led by the Carbon Trust and with major offshore wind developers among its members, is developing a standardised methodology and toolkit for how to measure and reduce carbon in the design of both fixed and floating offshore wind farms.
Sustainable procurement practices will be incorporated within the wider supplier and contractor procurement process: • the Applicant will take a sustainable approach to procurement and work with the supply chain to drive the uptake of low carbon solutions in the construction, and operation and maintenance of the Array where feasible; • focus areas for supply chain engagement during the construction phase of the Array will be on carbon hotspots, such as steel and marine shipping fuels; • sustainability criteria will be implemented within supplier selection processes, including tender questions on carbon management which are weighted and scored, and contractual clauses on sustainability performance for the contractors and suppliers delivering the Array; and • in the sourcing of Service Operation Vessels used for operation and maintenance phase activities, the Applicant will specify the use of more efficient vessels which are 'next-gen ready' where feasible.	Sustainable procurement practices incorporated by the Applicant within the wider supplier and contractor procurement process enable emissions reductions associated with the manufacture and installation of the Array during its construction, and operation and maintenance phases. Actions to be implemented by the Applicant will be detailed within a Carbon Reduction Plan at detailed design stage. Working with the supply chain to drive the uptake of low carbon solutions will enable construction, and operation and maintenance phase emissions associated with the manufacturing and installation of the Array to be reduced compared to a business-as-usual approach. Focus on carbon hotspots associated with the manufacturing and installation of the Array will prioritise those areas where the greatest emissions reductions could be achieved. The implementation of sustainability criteria by the Applicant during the tender process will promote emissions reduction measures to be implemented during the Array's construction phase, thereby reducing construction phase emissions associated with the manufacture and installation of the Array. The sourcing of efficient vessels which are 'next-gen ready' will enable emissions reductions during the Array's operation and maintenance phase. The supply of green hydrogen is expected to grow throughout the 2020s and 2030s as more electrolyser capacity comes online, which will help drive the use of hydrogen or hydrogen-derived fuels in maritime shipping and support the decarbonisation of construction, installation, and operational activities for offshore wind farms.

17.11. ASSESSMENT OF SIGNIFICANCE

82. Table 17.7 summarises the potential impacts arising from the construction, operation and maintenance and decommissioning phases of the Array, as well as setting out the maximum design scenario against which each impact has been assessed. An assessment of the likely significance of the effects of the Array on and from climate change is given below.

17.11.1. GHG EFFECTS

GHG EMISSIONS ARISING FROM DISTURBANCE TO BLUE CARBON STOCKS DURING THE CONSTRUCTION, OPERATION AND MAINTENANCE AND DECOMMISSIONING OF THE ARRAY

83. Throughout the lifetime of the Array, during the construction, operation and maintenance and decommissioning phases, it is anticipated that there will be disturbance to seabed habitats. For the construction phase this will arise from the installation of anchors and mooring cables, OSP foundations, interconnector and inter-array cables, cable protection and scour protection. For the operation and maintenance phase this may arise from mooring cable movement during rough weather and storms. For decommissioning, disturbance is likely to be similar to construction.

84. Where seabed habitats are disturbed, this affects the habitat's ability to store and sequester blue carbon. For example, when organic sediments are disturbed and enter the water column, stored blue carbon within these organic sediments can be converted to CO_2 through a process called remineralisation (Cunningham and Hunt, 2023). The emissions associated with the disturbance from the Array are detailed below. This impact entails an assessment of the largest total Array footprint over all phases, representing the greatest potential for GHG emissions from disturbance to blue carbon stores.

85. However, not all blue carbon stocks that are disturbed will be remineralised to CO_2 (Smeaton and Austin, 2022). As such, a range of emissions are presented, reflecting the likely range of remineralisation rates and resulting emissions (Smeaton and Austin, 2022; Cunningham and Hunt, 2023).

Construction phase

Magnitude of impact

86. Based on the MDS presented in Table 17.7, the total area disturbed during the construction phase is 32.25 km^2. As set out in volume 3, appendix 17.1, site-specific benthic surveys undertaken for the Array (volume 3, appendix 7.1, annex A) and published literature values (Smeaton *et al*, 2020) have been used to calculate the average blue carbon per hectare contained in habitats within the Array area. This figure has been calculated to be 5.00 tonnes of carbon per hectare, which corresponds to 18.35 tCO_2 per hectare when converted from carbon to CO_2. Literature values for rates of remineralisation in offshore sediments (Smeaton and Austin, 2022) were then used to calculate total emissions. Refer to volume 3, appendix 17.1 for more details.

87. The impact is predicted to be of international spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is calculated to be between 11,813 tCO_2 and 59,067 tCO_2.

Sensitivity of the receptor

88. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

89. Overall, the magnitude of impact is deemed to be between 11,813 tCO_2 and 59,067 tCO_2, and the sensitivity of the receptor is considered to be high. Consistent with paragraph 73, the magnitude of emissions comprise less than 0.002% of the Fifth and Sixth UK Carbon Budgets (set out in Table 17.1). Further, the magnitude of emissions arising from disturbance to blue carbon stocks during the construction phase comprises between 0.001% and 0.004% of Scotland's estimated blue carbon stocks (Smeaton *et al*., 2020; Cunningham *et al.*, 2023), with loss arising from habitats of low relative importance to carbon storage as outlined in paragraph 22. Therefore, the effect will be of **minor adverse** effect, which is not significant in EIA terms.

Secondary mitigation and residual effect

90. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

Operation and maintenance phase

Magnitude of impact

91. Based on the MDS presented in Table 17.7, the total area disturbed during the operation and maintenance phase is 1.22 km^2 Using the same methodology as summarised in paragraph 86, total operation and maintenance emissions associated with disturbance to blue carbon stocks have been calculated to be between 447 tCO_2 and 2,233 tCO_2.

92. As set out in volume 3, appendix 17.1, blue carbon sequestration rates in offshore sediments in the North Sea are deemed to be negligible, and as such there is negligible loss of sequestration potential for the disturbed sediments over the Array's 35 year operating lifetime.

93. The impact is predicted to be of international spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is calculated to be between 447 tCO_2 and 2,233 tCO_2.

Sensitivity of the receptor

94. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

95. Overall, the magnitude of impact is deemed to be between 447 tCO_2 and 2,233 tCO_2, and the sensitivity of the receptor is considered to be high. The magnitude of emissions is unable to be contextualised within the UK Carbon Budgets given the operation and maintenance phase falls outside of such budgets. The magnitude of emissions arising from disturbance to blue carbon stocks during the operation and maintenance phase comprises less than 0.001% of Scotland's estimated blue carbon stocks (Smeaton *et al*., 2020; Cunningham *et al.*, 2023), with loss arising from habitats of low relative importance to carbon storage as outlined in paragraph 22. Therefore the effect will be of **minor adverse** effect, which is not significant in EIA terms.

Secondary mitigation and residual effect

96. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

97. As stated in the Project Description (volume 1, chapter 3), the sequence of activities in the decommissioning phase will generally be the reverse of the construction sequence and will involve similar equipment. It is anticipated that all floating structures, mooring lines, OSP topsides and foundations to the seabed level will be completely removed. Associated infrastructure, such as cables, scour protection and anchors and piles below the seabed may either be left *in situ* or removed, in accordance with the decommissioning plan. It may be decided, closer to the time of decommissioning, that removal will result in greater environmental impacts than leaving components *in situ*.

98. Given the negligible rates of sediment accumulation and associated carbon sequestration in the Array area, there is not anticipated to be any material change to the blue carbon stocks over the Array's

operational lifetime. As such, any disturbance to the seabed and blue carbon habitats that may result from infrastructure removal at the decommissioning phase is not likely to result in the release of additional emissions not captured by the range of likely emissions presented in the assessment of construction effects.

99. As such, there will not be substantial additional disturbance of the seabed, meaning that further blue carbon stores will not be disturbed and released. The magnitude of impact is therefore negligible.

100. The impact is predicted to be of international spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is deemed to be negligible.

Sensitivity of the receptor

101. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

102. Overall, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Based on the definitions as set out in Table 17.9, the effect will be of **negligible** effect, which is not significant in EIA terms.

Secondary mitigation and residual effect

103. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

GHG EMISSIONS ARISING FROM THE MANUFACTURING AND INSTALLATION OF THE ARRAY

104. The below considers the embodied carbon emissions associated with materials and associated transportation emissions. This impact entails an assessment of the greatest number of wind turbines and floating foundations within the MDS in the Project Description (Table 17.7, volume 1, chapter 3), and maximum length of the inter-array and interconnector cables representing the greatest potential for GHG emissions from the construction and installation of the Array as a conservative estimate of impact.

Construction phase

105. This section considers the GHG emissions arising from the consumption of materials and activities required to construct the Array. Calculations to reach such emissions consider the maximum amount of materials required to construct the wind turbines and OSPs, maximum lengths of all cables, with associated scour protection and cable protection, representing the greatest potential for GHG emissions from the construction and installation of the Array as a conservative estimate of impact. Further, the designed in measures adopted as part of the Array (detailed in Table 17.11) have not been able to be quantitatively assessed given the early stage in the Array's design. As such, it can be expected that their implementation will result in a reduced magnitude of emissions than that presented within this assessment. Their impact on the significance of effect assessed has been considered qualitatively.

106. The following items are considered within this assessment:

- wind turbines (including floating foundations, mooring cables and anchors);
- OSP topside structures and foundations;
- interconnector and inter-array cables (including cable protection);
- inter-array cable junction boxes;
- scour protection; and
- vessel and helicopter movements.

107. Detailed and current Life Cycle Assessment (LCA) are not available for all items specific to the Array infrastructure due to the early stage of the Array design. As such, a combined approach has been taken to calculate embodied carbon, informed largely by conservative estimates of construction materials or fuels scaled by relevant emissions factors, and also in part by LCA data.

108. The potential impact of the wind turbines and foundations, mooring cables, anchors, OSP topsides and foundations, junction boxes, cabling (including inter-array and interconnector), cable protection and scour protection has been estimated using appropriate material emission intensities ICE database (Jones and Hammond, 2019), scaled by material estimates for each element. Material types and the emissions factors by which they have been scaled are listed within volume 3, appendix 17.1.

109. Construction phase emissions associated with the proposed electrical plant included on the OSPs has been captured using an intensity for the manufacturing GWP of 2,190 $kgCO_2e$ per MW (ABB, 2003). This was scaled by the Array output capacity of 3,600 MW to give an estimated embodied emission value of 7,884 tCO_2e.

110. Emissions associated with fuel combustion from vessel and helicopter movements have been calculated based on the maximum number of movements proposed during the construction phase, likely base port and fuel consumption rates per vessel type where available, in order to reach a conservative estimate. Anticipated fuel consumption for each movement was scaled by an appropriate emissions factor to give total estimated emissions of 385,615 tCO_2e during the construction phase.

111. Table 17.12 summarises the calculated construction phase emissions based on conservative estimates and a MDS (section 17.8.1) associated with the Array, which totals 9,479,984 tCO_2e. It is anticipated that the actual construction phase emissions would be lower than those detailed in Table 17.12 as this is a conservative maximum design scenario which will be further refined to reflect final detailed design for the Array.

Table 17.12: Construction Phase GHG Emissions

Item	Value (tCO_2e)
Turbines, floating platforms, anchors and mooring cables	7,472,974
OSP topsides, electrical equipment and foundations	500,421
Inter-array cables	273,844
Interconnector cables	51,251
Junction boxes	140,790
Cable protection	597,442
Scour protection	57,648
Transport	385,615
Total	**9,479,984**

Magnitude of impact

112. The impact is predicted to be of international spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be 9,479,984 tCO_2e for the construction phase.

113. As detailed within paragraph 105, the magnitude of emissions presented above does not account for the designed in measures adopted as part of the Array, which are not able to be quantified at this stage in the Array's design. It is likely that the magnitude of such emissions will be reduced when accounting for the impact of these measures.

Sensitivity of the receptor

114. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

115. Overall, the magnitude of the impact is deemed to be 9,479,984 tCO_2e and the sensitivity of the receptor is considered to be high. Consistent with paragraph 73, the magnitude of emissions comprise 0.3% of the Fifth and Sixth UK Carbon Budgets (set out in Table 17.1). Note that construction phase emissions have been calculated based on precautionary calculations of material quantities as set out in paragraph 43, which will be refined throughout the design stage. Further, as detailed within paragraph 105 and 113, the magnitude of such emissions do not account for designed in measures adopted to reduce emissions associated with the construction phase. As such, calculated emissions represent a conservative (reasonable adverse case) scenario.

116. Owing to the designed in measures adopted as part of the Array (comprising adherence to a NZTAP, alignment with the principles of PAS 2080, and incorporation of sustainable procurement practices), it can be concluded that the Array's impacts are consistent with good practice design aligned with a 1.5°C compatible trajectory towards net zero. Based on the definitions as set out in Table 17.9, the effect will be of **minor adverse** effect, which is not significant in EIA terms.

117. It is important to note that this assessment is based on a precautionary MDS and the magnitude of impact is likely to be lower after final design of the Array. In addition, the purpose of the Array is to provide a source of renewable energy, and as such, the effects due to GHG emissions from the manufacture and installation of the Array must be considered together with the effect of avoided GHG emissions arising from the operation of the Array (see paragraphs 119 to 131 below), so as to determine the net effects of GHG emissions resulting from the Array (see section 17.11.3 below), in line with IEMA (2022) guidance.

Secondary mitigation and residual effect

118. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

GHG EMISSIONS ARISING FROM THE CONSUMPTION OF MATERIALS AND ACTIVITIES REQUIRED TO FACILITATE THE OPERATION AND MAINTENANCE OF THE ARRAY AND ESTIMATED ABATEMENT OF UK GRID EMISSIONS

Operation and maintenance phase

119. The primary purpose of the operational phase of a wind farm is to generate electricity which avoids the need for fossil fuel generated electricity and reduces the UK Grid carbon intensity. The avoided emissions associated with the displacement of projected marginal generation of the UK Grid should be considered in combination with the impact of GHG emissions arising from the consumption of materials and activities required to facilitate the operations and maintenance of the Array.

120. The GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the Array are presented in Table 17.13, and further details are presented in volume 3, appendix 17.1. The majority of emissions result from the vessel and helicopter movements required to undertake maintenance activities over the Array's lifetime. Remaining emissions are associated with the replacement of cables, electrical equipment and scour protection, informed by conservative assumptions for material replacement rates. Emissions from the vessel and helicopter movements and cable, scour protection and electrical equipment replacement have been calculated following the methodology outlined in paragraphs 108 to 110 above, representing the greatest potential for GHG emissions from the operation and maintenance of the Array as a conservative estimate of impact. Further, the designed in measures adopted as part of the Array (detailed in Table 17.11) have not been able to be quantitatively assessed given the early stage in the Array's design. As such, it can be expected that their implementation will result in a reduced magnitude of emissions than that presented within this assessment. Their impact on the significance of effect assessed has been considered qualitatively.

Table 17.13: Operation and Maintenance Phase GHG Emissions

Item	Value (tCO_2e)
Transport	808,057
Materials	680,115
Total	**1,488,172**

121. It should be noted that when considering the Array's impact on climate change, the emissions as a result of operation and maintenance activities must be considered alongside the displacement of marginal alternative sources of electricity generation. This element is further considered in the assessment below.

122. Table 17.14 sets out the parameters for the Array and associated annual energy output.

Table 17.14: Energy Flows for the Array

Parameter	Value	Unit	Source
Input parameter – anticipated rated power	3,600	MW	Volume 1, chapter 3
Input parameter – capacity factor	39.7	%	DESNZ (2023b)
Input parameter – degradation factor	1.6	%	Staffel and Green (2014)
Input parameter – total annual operating hours	8,760	hrs	Total number of hours in year
Output parameter – annual energy output (year 1)	12,516,638	MWh	Calculated based on the input parameters
Output parameter – lifetime energy output (35 years)	337,457,750	MWh	Calculated based on the input parameters, accounting for the degradation factor.
Output parameter – operation and maintenance phase emissions intensity	4.4	gCO_2e/kWh	Calculated based on lifetime energy output and total operation and maintenance phase emissions (including emissions arising from Blue Carbon, see paragraph 93)

123. The input and output figures for the operation and maintenance phase of the Array have been scaled against the assumptions stated within the DESNZ long-run marginal (DESNZ, 2023a). This allows for a direct presentation of the cumulative GHG emissions avoided throughout the operation and maintenance lifetime of the Array and therefore, how the Array contributes towards reaching net zero targets.

124. The resulting estimated avoided emissions associated with the operation and maintenance phase of the Array would be 882,416 tCO_2e avoided emissions associated with the abatement of the UK Grid.

Sensitivity analysis

125. It should be noted that as the UK and Scotland move towards the 2050 and 2045 net zero carbon targets respectively, the marginal source of electricity generation will likely become a combination of renewables (predominately solar and wind) and energy storage. By the time the Array is anticipated to be fully operational, the UK and Scotland are expected to have made significant progress towards a low-carbon electricity grid, with the current UK Government policy target year of 2035 (BEIS, 2021). It is important to note therefore that from circa 2035 onwards, long-run marginal projections assume that there is no unabated fossil fuel generation, in line with UK Government policy.

126. However, the UK Government has highlighted that some 'transition' fossil fuels will continue to play a part in the UK's energy supply (DESNZ, 2023c). Further, the use of the long-run marginal projections may not present a true 'without development' future baseline and does not account for uncertainty in the UK grid carbon intensity as a result of annual fluctuation due to changes in the energy market (as detailed in paragraph 41). Therefore, it is likely that the true value of the avoided emissions displaced as a result of the Array's contribution to the UK electricity grid would be higher than that of avoided emissions detailed above.

127. As such, a sensitivity analysis has been carried out using the current UK electricity grid carbon intensity and current estimated intensity from electricity supplied for 'all non-renewable fuels', as detailed in volume 3, appendix 17.1. This is shown in Table 17.15.

Table 17.15: Array Avoided Emissions Sensitivity Test

Operating years	Output (MWh)	DESNZ Long-run Marginal Avoided Emissions (tCO_2e)	Current UK Grid Average Avoided Emissions (tCO_2e)	DESNZ 'Non-renewable Fuels' Avoided Emissions (Tco_2e)
35	337,457,750	882,416	69,878,823	143,082,086

128. Although the use of the current UK electricity Grid average and DESNZ 'non-renewable fuels' carbon intensities would conclude greater avoided emissions and an ultimate reduction in carbon payback period, these are static baselines and do not account for future UK electricity grid decarbonisation. Further, as the Array's generation output would be dictated by day-to-day demand alongside commercial factors and the National Grid's needs, the benefit of provision of additional low carbon electricity capacity cannot be used to quantify avoided emissions. As such, the long-run marginal provides a conservative quantification of avoided emissions for the purpose of this assessment. The true avoided emissions value for the Array is likely to lie between the upper and lower limits shown in Table 17.15 (i.e. between 882,416 tCO_2e and 143,082,086 tCO_2e) and has been used to provide additional context to the assessment of significance.

Magnitude of impact

129. The impact is predicted to be of international spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is considered to be an emissions impact of between 605,756 tCO_2e (long-run marginal) and -141,593,914 tCO_2e (DESNZ 'non-renewable fuels mix')[5], when considering the emissions associated with operations and maintenance (Table 17.13) alongside the avoided emissions of the Array (Table 17.15). This range reflects displacement of alternative energy generation sources from a range of future baseline scenarios (note that negative values represent avoided emissions, i.e. emissions that would have occurred without the Array), in order to provide additional context to the assessment.

Sensitivity of receptor

130. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

131. Overall, the magnitude of the impact is deemed to be between 605,756 tCO_2e and -141,593,914 tCO_2e and the sensitivity of the receptor is considered to be high. As discussed in paragraph 126, it is likely that the use of the long-run marginal projections represents an underestimate of the true value of avoided emissions from the Array. Additionally, emissions associated with operations and maintenance have been calculated based on precautionary calculations of material quantities and do not account for the designed in measures adopted as part of the Array, which are not able to be quantified at this stage in the Array's design, or for the continued decarbonisation of UK industry, as set out in paragraph 43. Both of which are anticipated to reduce emissions associated with the operation and maintenance phase. The magnitude of emissions is unable to be contextualised within the UK Carbon Budgets given the operation and maintenance phase falls outside of such budgets.

132. The Array will produce electricity at an emissions intensity of 4.4 gCO_2e/kWh (see Table 17.14). This is lower than the current grid average (207 gCO_2e/kWh), fossil fuel generation (424 gCO_2e/kWh) and the Climate Change Committee's electricity emissions intensity target for 2035 (10 gCO_2e/kWh) (Climate Change Committee, 2020).

133. Within the context of national policy, the purpose of the Array is to provide a source of renewable energy, thereby contributing towards UK and Scottish climate change policy goals and associated renewable energy targets. Based on the definitions set out in Table 17.9, the effect will be of **beneficial** effect, which is significant in EIA terms.

Secondary mitigation and residual effect

134. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is beneficial.

GHG EMISSIONS ARISING FROM DECOMMISSIONING WORKS OF THE ARRAY

Decommissioning phase

135. The majority of emissions during decommissioning of the Array relate to the use of plant/equipment for Array decommissioning, disassembly, transportation to a waste site, and ultimate disposal and/or recycling of the equipment and other site materials.

[5] These figures were calculated by subtracting the avoided emissions (882,416 tCO_2e for the long-run marginal, and 143,082,086 tCO_2e for the non-renewable fuels mix) from the operation and maintenance phase GHG emissions (1,488,172 tCO_2e) and emissions associated with disturbance of blue carbon stocks (up to 2,233 tCO_2e).

136. At this stage, the approach to decommissioning the Array is still to be determined. However, it is anticipated that all floating structures, mooring lines, OSP topsides and foundations to the seabed level will be completely removed. Associated infrastructure, such as cables, scour protection and anchors and piles below the seabed may either be left *in situ* or removed, in accordance with the decommissioning plan. It may be decided, closer to the time of decommissioning, that removal will result in greater environmental impacts than leaving components *in situ*.

137. The components of the wind turbines are considered to be highly recyclable. When disposing of wind turbines, recycling is the preferred solution. This not only prevents the materials from being sent to landfills, but also reduces the need for the extraction of primary materials. Material which cannot be recycled might be used for incineration or energy from waste. It is considered the same approach can be applied to all mooring lines, OSP topsides and foundations and cables retrieved during decommissioning.

138. Cables and other infrastructure, such as anchoring systems, may be left *in situ* during decommissioning or removed. If removed, this infrastructure would be recycled or reused where possible, or used for incineration or energy from waste as per paragraph 137. If left *in situ,* this will not result in additional emissions during this phase. As such, emissions associated with the disposal of materials at the end of their lifetime is considered to be immaterial and may even result in future avoided emissions. This impact is not assessed further.

139. In the absence of detailed information regarding offshore transport movements during the decommissioning phase, it has been assumed that such emissions equal those associated with the construction phase, totalling 385,615 tCO_2e. It is worth noting that this value is precautionary and likely to be reduced after final design of the Array. Given carbon emissions associated with use of plant and fuel is expected to have achieved good levels of decarbonisation at the decommissioning phase of the Array, this is likely to present a conservative maximum design scenario.

Magnitude of Impact

140. The impact is predicted to be of international spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is determined to be 385,615 tCO_2e.

Sensitivity of the receptor

141. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

142. Overall, the magnitude of the impact is deemed to be 385,615 tCO_2e and the sensitivity of the receptor is considered to be high. The magnitude of emissions is unable to be contextualised within the UK Carbon Budgets, as required by paragraph 73, given the decommissioning phase falls outside of such budgets when the UK will have achieved net zero. It is expected that the decommissioning activities will have achieved good levels of decarbonisation in line with applicable policy requirements at that time. The effect will, therefore, be of **minor adverse** effect, which is not significant in EIA terms.

Secondary mitigation and residual effect

143. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

17.11.2. CLIMATE CHANGE RISK

EFFECTS OF CLIMATE CHANGE ON THE ARRAY

Operation and maintenance phase

144. The CCRA (see volume 3, appendix 17.2), identifies the following risks:

- increases in average and extreme air temperatures, both in winter and summer;
- increases in sea surface temperatures and ocean acidification;
- changes to rainfall patterns, leading to increased annual precipitation;
- increased frequency and intensity of extreme weather i.e. storms;
- increased wind speeds and changes to wind patterns;
- increase in mean sea level;
- increased wave height; and
- changes in the tidal range.

145. These risks could lead to:

- efficiency losses and more frequent turbine shut-downs, reducing output of the Array;
- the failure of electrical equipment, increasing operation and maintenance activities;
- damage to infrastructure, increasing operation and maintenance activities; and
- reduced accessibility for maintenance and inspection.

146. The impact is predicted to be of local spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. Volume 3, appendix 17.2 summarises the potential climatic changes in the coming decades and considers the potential consequences for the Array in a risk assessment format, including scoring for each risk.

147. The risk assessment presented in volume 3, appendix 17.2 considers in its scoring the level of influence the design of the construction and operations and maintenance of the Array can have upon the remaining risks, in addition to its severity and probability. Those risks over which the Applicant has little or no influence are therefore typically not considered significant effects of the Array, save where the severity and/or probability are highest.

148. The assessment of effects has considered the measures adopted as part of the array (Table 17.11) in determining the combined risk score. As detailed in paragraph 80 a score of 5 or more is assessed as a significant effect which is presented in the 'significant effect' column. Should an effect be significant, secondary mitigation is presented where relevant to reduce the residual effect to negligible and not significant in EIA terms.

149. No risks to the Array due to climate change have been identified as significant before mitigation (see volume 3, appendix 17.2). As such, the effect on the Array has been determined to be **negligible** which is not significant in EIA terms.

17.11.3. NET EFFECTS

NET GHG IMPACTS OF THE ARRAY

150. As detailed in section 17.9, consideration of the Array's whole life impact is an important consideration when assessing the Array's impacts and subsequent effects on climate change. As such, the consideration of the Array's net emissions in the context of existing and emerging policy commitments and UK and Scottish carbon budgets is necessary.

151. Over its lifetime, the net impact of the Array would result in between 10,532,655 tCO_2e and -131,667,016 tCO_2e, based upon a precautionary range derived from the calculations in volume 3,

appendix 17.1 (as detailed in paragraphs 41, 125 and 126). This net impact considers the GHG emissions associated with disturbance to blue carbon habitats, materials and vessel movements during the construction, operation and maintenance and decommissioning phases, alongside the avoided emissions from the operation of the Array. Negative emissions represent net avoided emissions. The Array would have a carbon payback period of 2 years (at the earliest) when accounting for construction, operation and maintenance and decommissioning phase emissions (see Table 17.16 below). As discussed in paragraph 128, the true avoided emissions value is likely to lie between these values. Given the operation of the Array would avoid the need for fossil fuel generators through the provision of renewable electricity, the associated avoided emissions would likely be greater than those presented in the conservative case (i.e. when using the long-run marginal projections) resulting in a reduction to the conservative net effect scenario presented above.

Table 17.16: Summary of Array Net GHG Emissions

	DESNZ long-run marginal	Current UK Grid average	DESNZ 'non-renewable fuels'
Construction Emissions (tCO_2e)*	9,539,051		
Operation and Maintenance Emissions (tCO_2e)*	607,989	-68,388,418	-141,591,681
Decommissioning Emissions (tCO_2e)	385,615		
Net Emissions (tCO_2e)*	10,532,655	-58,463,753	-131,667,016
Payback Period (Years)	No payback	4 years	2 years

*Including emissions associated with blue carbon. The greatest magnitude of emissions released have been reported within this table, to provide a conservative estimate of net GHG emissions from the Array.

152. Consideration of the Array's net emissions performance can be considered with the following contextualisation:

- it provides additional low carbon electricity generation capacity; and
- it is in keeping with Scottish and UK energy and climate policy.

153. The Array's net emissions accounting for the construction phase up to the end of the UK Sixth Carbon Budget are detailed in Table 17.17 below. As the Array is anticipated to become fully operational by 2038, the avoided emissions resulting from the operation and maintenance phase of the Array and the final year of construction lie outside the scope of the currently quantified UK carbon budgets, which end in 2037 (HM Government, 2008). GHG emissions associated with the construction phase have been scaled annually, and applied to the relevant carbon budget periods. When accounting for the first seven years of the Array's construction phase GHG emissions (8,346,669 tCO_2e) to the end of the Sixth Carbon Budget (2037), this corresponds to approximately 0.31% of the UK Carbon Budget for the same period. Note that construction phase emissions have been calculated based on precautionary calculations of material quantities as set out in paragraph 43, which will be refined throughout the design stage, and do not account for the designed in measured adopted as part of the Array (detailed in Table 17.11). As such, calculated emissions represent a conservative (reasonable adverse case) scenario.

Table 17.17: GHG Impacts in the Context of the UK's Carbon Budgets

	2028-2032	2033-2037	Total
UK Carbon Budget (tCO_2e)	1,725,000,000	960,000,000	2,865,000,000
Array GHG Impacts (tCO_2e)	2,384,763	5,961,907	8,346,669
Array emissions as percentage of UK Carbon Budget (%)	0.14%	0.62%	0.31%

154. The Array's net emission intensity, when accounting for construction, operation and maintenance and decommissioning emissions alongside total generation output, is 33.8 gCO_2e/kWh. There are no established net emission intensity benchmarks available for the industry that the Array's net emission intensity can be compared against.

155. The Array is in line with the Scottish NMP's principle of supporting new offshore wind and marine renewable energy, in addition to their associated infrastructure, in order to contribute to reductions in GHG emissions. In addition, the up to 3.6 GW capacity from the Array, based on current understanding, would contribute towards the UK Government's ambitions to increase low carbon electricity generation, with an anticipated doubling in electricity demand by 2050.

156. Further, the Array is supported by national energy and climate change policy (including the National Infrastructure Strategy, Net Zero Strategy, Energy and Just Transition Plan and Scotland's Climate Change Plan) which highlight the need for an end to the use of unabated fossil fuel generation, whilst also significantly ramping up electricity generation capacity to meet the demands of increased electrification of transport, heat and industry. As such, UK and Scottish government policy dictates that large-scale deployment of renewable energy generators such as the Array are necessary in order to meet GHG reduction targets.

157. In addition, National Grid modelling anticipates an increase in annual electricity demand across the UK to between 570 TWh and 726 TWh per year by 2050, compared to 286 TWh per year in 2022 (National Grid ESO, 2023). By facilitating the expansion of renewable energy supply, the Array would assist the UK Government target of achieving a fully decarbonised power system by 2035, and the UK and Scottish Government's aim to become net zero by 2050 and 2045 respectively.

Magnitude of impact

158. The impact is predicted to be of international spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. Between 10,532,655 tCO_2e and -131,667,016 tCO_2e. This range reflects displacement of alternative energy generation sources from a range of future baseline scenarios, in order to provide additional context to the assessment.

Sensitivity of the receptor

159. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

160. Overall, the magnitude of the impact is deemed to be between 10,532,655 tCO_2e and -131,667,016 tCO_2e and the sensitivity of the receptor is considered to be high. As discussed in paragraph 126, it is likely that the use of the long-run marginal projections is likely to represent an underestimate of the true value of avoided emissions from the Array. Given the operation of the Array would avoid the need for fossil fuel generators through the provision of renewable electricity, the associated avoided emissions would likely

be greater than those presented in the conservative case (i.e. when using the long-run marginal projections) resulting in a reduction to the conservative net effect scenario presented above. Further, construction phase emissions have been calculated based on precautionary calculations of material quantities as set out in paragraph 43, which will be refined throughout the design stage. Additionally, such emissions calculations do not account for the designed in measures adopted as part of the Array (detailed in Table 17.11), which are expected to reduce emissions associated with the manufacture and installation of the Array. As such, calculated emissions represent a conservative (reasonable adverse case) scenario. Operation and maintenance and decommissioning emissions have also not taken into account the designed in measures adopted as part of the Array, or the future decarbonisation of UK industry, as set out in paragraph 43, both of which are expected to reduce such emissions.

161. Consistent with paragraph 73, the magnitude of emissions comprise 0.31% of the Fifth and Sixth UK Carbon Budgets (set out in Table 17.1). Within the context of national policy, the purpose of the Array is to provide a source of renewable energy, thereby contributing towards UK and Scottish climate change policy goals and associated renewable energy targets (in particular the respective net zero targets). In accordance with the definitions set out in Table 17.9 the effect will be of **beneficial** effect, which is significant in EIA terms.

Secondary mitigation and residual effect

162. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is beneficial.

17.12. CUMULATIVE EFFECTS ASSESSMENT

17.12.1. METHODOLOGY

163. The CEA assesses the impact associated with the Array together with other relevant plans, projects and activities. Cumulative effects are defined as the combined effect of the Array in combination with the effects from a number of different projects, on the same receptor or resource. Further details on CEA methodology are provided in volume 1, chapter 6.

164. With respect to the CEA assessment for climatic effects, all developments that emit, avoid or sequester GHGs have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a cumulative impact on climate change. Consequently, in line with IEMA guidance (2022), cumulative effects due to other specific local development projects are not individually considered but are taken into account when considering the impact of the Array by defining the atmospheric mass of GHGs as a high sensitivity receptor. The construction, operation and maintenance and decommissioning phase effects of the assessment of the Array takes account of cumulative changes in GHG emissions from other energy generation sources. As such, no specific study area beyond that of the Array area is relevant for the Cumulative Effects Assessment (CEA) for climate change. However, it is important to note that the Array cannot realise the avoided emissions and associated significant beneficial effect detailed in section 17.11.3 without transmission infrastructure to enable connection of the Array to the Grid. This transmission infrastructure has associated emissions for its construction, operation and maintenance and decommissioning phases that must be considered within the cumulative assessment for climate change.

165. Therefore, the CEA takes into account the impact associated with the Array together with the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure required to enable connection of the Array to the Grid. The Array, alongside the Proposed offshore export cable corridor(s) search area, is shown in Figure 17.2.

166. A tiered approach has been adopted which provides a framework for placing relative weight upon the potential for each project/plan to be included in the CEA to ultimately be realised, based upon the project/plan's current stage of maturity and certainty in the projects' parameters. The tiered approach employs the following tiers:

- tier 1 assessment – Array and Proposed offshore export cables corridor(s) and Proposed onshore transmission infrastructure and all plans/projects which became operational since baseline characterisation, those under construction, and those with consent and submitted but not yet determined;
- tier 2 assessment – All plans/projects assessed under Tier 1, plus those projects with a Scoping Report; and
- tier 3 assessment – All plans/projects assessed under Tier 2, which are reasonably foreseeable, plus those projects likely to come forward where an AfL has been granted.

167. It should be noted that in line with paragraphs 164 and 165, projects and plans other than the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure are not applicable to climate change consideration of CEA and as such are not considered further.

168. The specific projects scoped into the CEA for climatic effects are outlined in Table 17.18.

169. The range of potential cumulative impacts that are identified and included in Table 17.19, is a subset of those considered for the Array alone CEA assessment. This is because some of the potential impacts identified and assessed for the Array alone, are localised and temporary in nature. It is considered therefore, that these potential impacts have limited or no potential to interact with similar impacts associated with other plans or projects. These have therefore not been taken forward for detailed assessment.

170. In order to aid proportionate EIA, impacts have been combined – lifetime emissions resultant from the Array together with (enabled by) the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure. This assesses the cumulative GHG emissions associated with the Array and associated transmission infrastructure across all project phases.

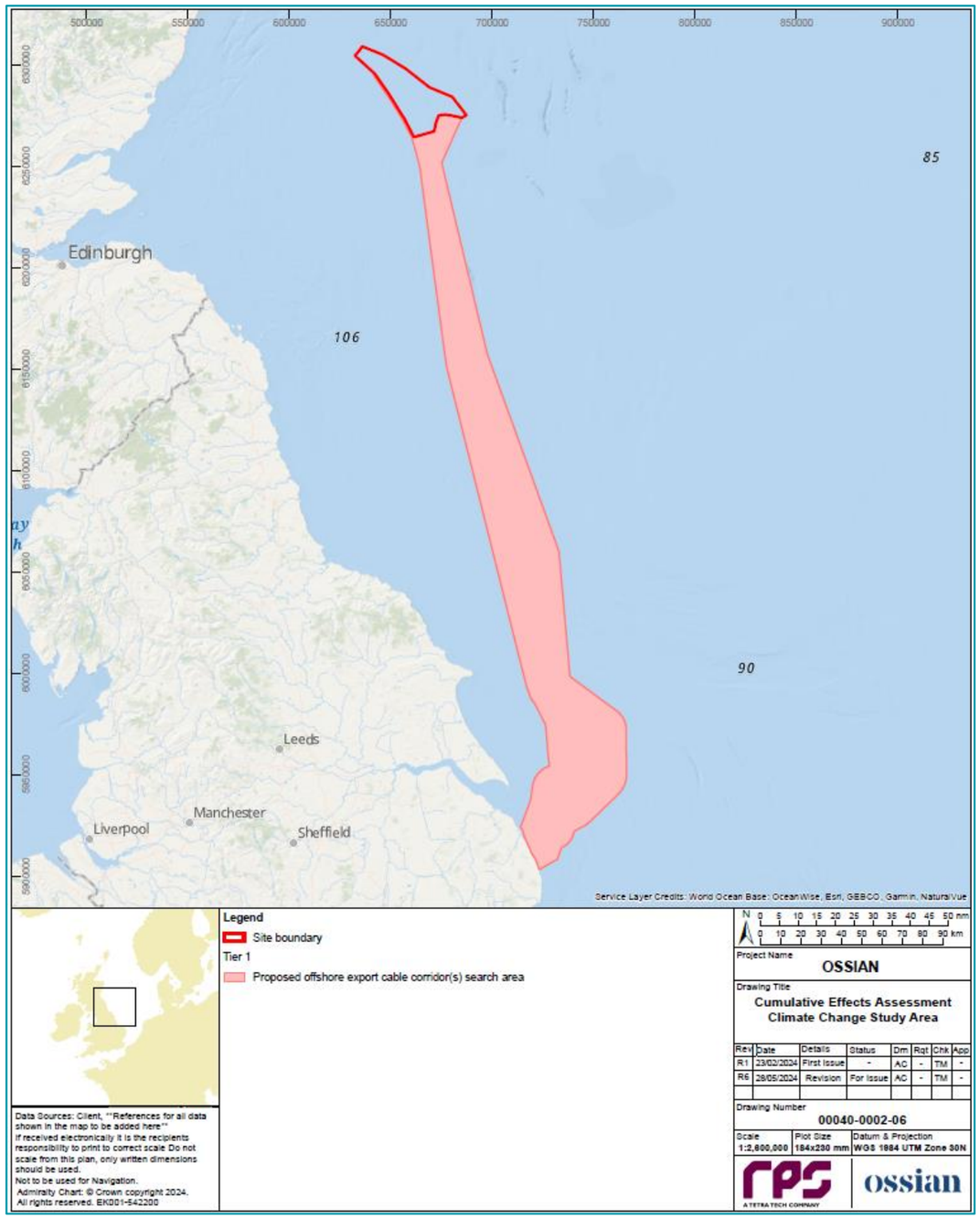

Figure 17.2: Other Projects/Plans Screened into the Cumulative Effects Assessment for Climatic Effects

Table 17.18: List of Other Projects and Plans Considered within the CEA for Climatic Effects

Project/Plan	Status [i.e. Application, Consented, Under Construction, Operational]	Distance from Array Area (km)	Description of Project/Plan	Dates of Construction (If Applicable)	Dates when Fully Operational	Overlap with the Array [e.g. Project Construction Phase Overlaps with Array Construction Phase]
Tier 1						
Proposed offshore export cable corridor(s)	Planned	0.00	Offshore transmission for the Array	2030 to 2037	2038 to 2072	All phases of the project and the Array overlap.
Proposed onshore transmission infrastructure	Planned	342.97	Onshore transmission for the Array	2030 to 2037	2038 to 2072	All phases of the project and the Array overlap.

17.12.2. MAXIMUM DESIGN SCENARIO

171. The maximum design scenarios identified in Table 17.19 have been selected as those having the potential to result in the greatest LSE[1] on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the details provided in volume 1, chapter 3 of the Array EIA Report as well as the information available on other projects and plans (see volume 3, appendix 6.4), to inform a 'maximum design scenario'. Effects of greater adverse significance are not predicted to arise should any other development scenario within the Project Description (volume 1, chapter 3), to that assessed here, be taken forward in the final design scheme.

Table 17.19: Maximum Design Scenario Considered for Each Impact as part of the Assessment of Likely Significant Cumulative Effects for Climatic Effects

Potential Cumulative Effect	Phase[6] C	Phase[6] O	Phase[6] D	Tier	Maximum Design Scenario
Emissions resultant from the Array together with (enabled by) the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure, resulting in lifetime emissions for Ossian	✓	✓	✓	1	**Construction Phase** <u>Array:</u> • maximum design scenario for construction of the Array as described in Table 17.7. <u>Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure:</u> • indicative maximum length of offshore export cable corridor approximately 400 km; • 4 no. offshore export cables and 4 no. onshore export cables; • 2 no. onshore export cable corridors, with indicative maximum length of approximately 60 km and 15 km; • indicative maximum length of grid connection cable corridor approximately 5 km; and • 4 no. converter stations may be required, with 4 no. grid connection cables required per converter station. **Operation and Maintenance Phase** <u>Array:</u> • maximum design scenario for operation and maintenance of the Array as described in Table 17.7. <u>Proposed offshore export corridor(s) and Proposed onshore transmission infrastructure:</u> • indicative maximum length of offshore export cable corridor approximately 400 km; • 4 no. offshore export cables, with an indicative maximum cable corridor length of approximately 400 km; • 4 no. onshore export cable over 2 no. onshore export cable corridors, with indicative maximum length of approximately 60 km and 15 km; • indicative maximum length of grid connection cable corridor approximately 5 km; and • 4 no. converter stations may be required, with 4 no. grid connection cables required per converter station. **Decommissioning Phase** <u>Array:</u> • maximum design scenario for decommissioning of the Array as described in Table 17.7.

[6] C = Construction, O = Operation and maintenance, D = Decommissioning

17.12.3. CUMULATIVE EFFECTS ASSESSMENT

172. An assessment of the likely significance of the cumulative effects of the Array on and from climate change is given below.

EMISSIONS RESULTANT FROM THE ARRAY TOGETHER WITH (ENABLED BY) THE PROPOSED OFFSHORE EXPORT CABLE CORRIDOR(S) AND PROPOSED ONSHORE TRANSMISSION INFRASTRUCTURE, RESULTING IN LIFETIME EMISSIONS FOR OSSIAN

Tier 1

173. This section presents an assessment of the GHG impacts during the construction, operation and maintenance and decommissioning phases from the Array, together with (enabled by) the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure.

174. However, detailed design parameters for the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure are not available at the time of writing. As such, the magnitude of impact presented below for the construction, operation and maintenance, and decommissioning phases represent a high level estimate of total emissions with a high degree of uncertainty. This is reflective in a precautionary and conservative MDS (see paragraphs 43 and 50). Such estimates have been informed by indicative maximum design scenarios based on the information currently available for the transmission infrastructure, as set out in Table 17.19, alongside assumptions based on the available Array design information. Furthermore, the MDS used to assess the GHG impacts associated with the Array are also precautionary and likely to be reduced following final Array design. These assumptions are set out in volume 3, appendix 17.1.

175. As the future transmission projects and applications are brought forward in relation to the transmission infrastructure, the assessment presented below will be enhanced and refined in the future consent applications for those elements of infrastructure.

176. Table 17.20 sets out a summary of the cumulative GHG impacts, which are assessed in the sections below This range reflects displacement of alternative energy generation sources from a range of future baseline scenarios, in order to provide additional context to the assessment. As mentioned in paragraph 151, although a range of net GHG effects is provided for the Array and Ossian as a whole, the operation of Ossian would avoid the need for fossil fuel generators through the provision of renewable electricity. As such the associated avoided emissions would likely be greater than those presented in the conservative case (i.e. when using the long-run marginal projections) resulting in a reduction to the conservative net effect scenario presented below.

Table 17.20: Summary of Cumulative GHG Impacts

Project	Construction (tCO_2e)	Operation and Maintenance (tCO_2e)*	Decommissioning (tCO_2e)	Net Effects (tCO_2e)
Proposed offshore export corridor(s) and Proposed onshore transmission infrastructure	1,225,180	1,801,293	49,528	3,076,000
Array	9,539,051	607,989 to -141,591,681	385,615	10,532,665 to -131,667,006
Total (Ossian)	**10,764,230**	**2,409,282 to -139,790,388**	**435,142**	**13,608,654 to -128,591,016**

* The range presented in this table reflects displacement of alternative energy generation sources from a range of future baseline scenarios.

Construction phase

177. The below considers the embodied carbon emissions associated with materials, associated transportation emissions and disturbance of blue carbon habitats for the cumulative assessment.

178. Construction GHG emissions from the Array are set out in Table 17.20.

179. Major components of the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure are likely to be:

- offshore export cables and cable protection;
- scour protection;
- onshore export cables;
- onshore converter stations; and
- cables from the converter stations to National Grid substations.

180. Construction phase emissions from the cables, cable protection, offshore booster station(s)/OSP(s) and scour protection have been estimated using appropriate material emission intensities, as in paragraph 108 above, using MDS parameters as stated in Table 17.19. Construction phase emissions from the converter stations have been estimated using the same methodology as in paragraph 109 above.

181. Emissions resulting from disturbance to blue carbon habitats have been calculated based on the total length of offshore export cable required for the Array. In the absence of detailed information regarding the extent of disturbance during construction of the Proposed offshore export cable corridor(s), it is assumed that the offshore export cable(s) will have the same area of disturbance per kilometre as the inter-array and interconnector cables of the Array. This area of disturbance was then scaled by the Array blue carbon emissions factor of 5.00 tC/ha (see paragraph 86).

182. In the absence of indicative vessel and traffic information, emissions from transportation have been estimated by applying an uplift to the total construction emissions, based on the relative contribution of construction transport emissions for the Array.

183. Table 17.20 presents the total construction phase emissions for the cumulative assessment. More details on the calculation methodology can be found in volume 3, appendix 17.1.

Magnitude of impact

184. The impact is predicted to be of international spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. In order to assess the most adverse scenario, albeit likely to constitute a significant overestimate, the magnitude has been considered to be 10,764,230 tCO_2e for the construction phase.

Sensitivity of receptor

185. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of effect

186. Overall, the magnitude of the cumulative impact is deemed to be a precautionary 10,764,230 tCO_2e and the sensitivity of the receptor is considered to be high. Consistent with paragraph 73, the magnitude of emissions comprise 0.35% of the Fifth and Sixth UK Carbon Budgets (set out in Table 17.1). It should be noted however that construction phase emissions have been calculated based on precautionary calculations of material quantities as set out in paragraphs 43 and 50, which will be refined throughout the design stage. Further, as detailed within paragraph 105 and 113, the magnitude of such emissions do not account for designed in measures adopted to reduce emissions associated with the construction phase. As such, calculated emissions represent a conservative (reasonable adverse case) scenario.

187. Owing to the designed in measures adopted as part of the Array (comprising adherence to a NZTAP, alignment with the principles of PAS 2080, and incorporation of sustainable procurement practices), it can be concluded that the Array's impacts are consistent with good practice design aligned with a 1.5°C

compatible trajectory towards net zero. Based on the definitions as set out in Table 17.9, the cumulative effect will, therefore be of **minor adverse** effect, which is not significant in EIA terms.

Secondary mitigation and residual effect

188. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

Operation and maintenance phase

189. Operation and maintenance GHG emissions from the Array, are set out in Table 17.20. The range reflects displacement of alternative energy generation sources from a range of future baseline scenarios, in order to provide additional context to the assessment.

190. Operation and maintenance GHG emissions from the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure will arise from the consumption of materials and activities required to facilitate operation and maintenance. These emissions are presented in Table 17.20, and further details are included in volume 3, appendix 17.1. The majority of emissions result from the vessel, traffic and helicopter movements required to undertake maintenance activities. Remaining emissions are associated with the replacement of cables and electrical equipment. Emissions from the vessel and helicopter movements and cable and electrical equipment replacement have been calculated following the methodology outlined in paragraphs 108 to 110, representing the greatest potential for GHG emissions from the operation and maintenance of the Array as a conservative estimate of impact. Further, the designed in measures adopted as part of the Array (detailed in Table 17.11) have not been able to be quantitatively assessed given the early stage in the Array's design. As such, it can be expected that their implementation will result in a reduced magnitude of emissions than that presented within this assessment. Their impact on the significance of effect assessed has been considered qualitatively.

191. As stated in paragraph 92, there is not anticipated to be any material change in the blue carbon stocks over the operational lifetime of the Array. This is also assumed for the Proposed offshore export cable corridor(s) in the absence of further detailed information. As such, it is not anticipated that there will be additional disturbance (and associated emissions) to blue carbon habitats for the Proposed offshore export cable corridor(s) during the operation and maintenance and decommissioning phases, as activities are not likely to disturb blue carbon habitats additional to those accounted for during the construction phase.

Magnitude of impact

192. The impact is predicted to be of international spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is considered to be an emissions impact of between 2,409,282 tCO_2e and -139,790,388 tCO_2e.

Sensitivity of receptor

193. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of effect

194. Overall, the magnitude of the cumulative impact is deemed to be between 2,409,282 tCO_2e and -139,790,388 tCO_2e and the sensitivity of the receptor is considered to be high. As discussed in paragraph 126, it is likely that the use of the long-run marginal projections represents an underestimate of the true value of avoided emissions from the Array (and hence Ossian). Additionally, emissions associated with operations and maintenance have been calculated based on precautionary calculations of material quantities and do not account for the designed in measures adopted as part of the Array, which are not able to be quantified at this stage in the Array's design, or for continued decarbonisation of UK industry, as set out in paragraphs 43 and 50. Both of which are anticipated to reduce emissions associated with the operation and maintenance phase. The magnitude of emissions is unable to be contextualised within the UK Carbon Budgets given the operation and maintenance phase falls outside of such budgets.

195. The Array, in combination with the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure, will produce electricity at an emissions intensity of 9.8 gCO_2e/kWh, based on the lifetime generation output presented in Table 17.14 and the cumulative operation and maintenance emissions set out in Table 17.20. This is lower than the current grid average (207 gCO_2e/kWh), fossil fuel generation (424 gCO_2e/kWh) and the Climate Change Committee's electricity emissions intensity target for 2035 (10 gCO_2e/kWh) (Climate Change Committee, 2020).

196. Within the context of national policy, the purpose of Ossian is to provide a source of renewable energy, thereby contributing towards UK and Scottish climate change policy goals and associated renewable energy targets. Based on the definitions set out in Table 17.9, the cumulative effect will, therefore be of **beneficial** effect, which is significant in EIA terms.

Secondary mitigation and residual effect

197. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is beneficial.

Decommissioning phase

198. Decommissioning emissions from the Array are set out in Table 17.20.

199. Although the approach to decommissioning of the Proposed offshore export corridor(s) and Proposed onshore transmission infrastructure is yet to be determined, the required infrastructure will either be left *in situ* or removed from site. The components of the Proposed offshore export corridor(s) and Proposed onshore transmission infrastructure are considered to be highly recyclable. As discussed in paragraph 138, emissions associated with the disposal of materials at the end of their lifetime is considered to be immaterial and may even result in future avoided emissions. This impact is not assessed further. As such emissions associated with either leaving components *in situ* or removal and disposal are likely to be limited to the vessel and vehicle movements during decommissioning activities.

200. In alignment with the approach to decommissioning phase transport emissions for the Array (set out in paragraph 139), it has been assumed that cumulative transport emissions equal those associated with the construction phase. These emissions are presented in Table 17.20.

Magnitude of impact

201. The impact is predicted to be of international spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is determined to be 435,142 tCO_2e. As mentioned in paragraph 139, this value is precautionary and likely to be reduced after final design of the Array.

Sensitivity of receptor

202. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of effect

203. Overall, the magnitude of the cumulative impact is deemed to be 435,142 tCO_2e and the sensitivity of the receptor is considered to be high. The magnitude of emissions is unable to be contextualised within the UK Carbon Budgets, as required by paragraph 73, given the decommissioning phase falls outside of such budgets when the UK will have achieved net zero. It is expected that the decommissioning activities will have achieved good levels of decarbonisation in line with applicable policy requirements at that time. Based on the definitions set out in Table 17.9, the cumulative effect will, therefore be of **minor adverse** effect, which is not significant in EIA terms.

Secondary mitigation and residual effect

204. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

Net Whole Life GHG Emissions

Magnitude of impact

205. The below considers the lifetime cumulative net GHG emissions, including the net emissions from the Array and the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure. This has been summarised within Table 17.20.

206. Although the whole lifecycle and combined emission totals likely overstate the predicted GHG impact due to conservative assumptions, as set out in paragraphs 43 and 50, avoided emissions during the operation and maintenance of the Array through the displacement of alternative electricity generation sources result in a beneficial contribution to the UK and Scotland meeting its emission reduction targets.

207. Ossian would likely have a carbon payback period of 3 years (at the earliest) when accounting for construction, operation and maintenance and decommissioning phase emissions from both the Array and associated transmission infrastructure.

208. The cumulative impact is predicted to be of international spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be between 13,608,654 tCO_2e and -128,591,016 tCO_2e.

209. In accordance with IEMA (2022) guidance, the magnitude of impact has also been contextualised against the UK carbon budgets. Note that these carbon budgets do not cover the whole lifetime of Ossian, as discussed in paragraph 153. Cumulative net emissions have been contextualised within the UK Fifth and Sixth Carbon Budgets (Table 17.21).

Table 17.21: Cumulative GHG Impacts in the Context of the UK's Fifth and Sixth Carbon Budgets

	2028-2032	2033-2037	Total
UK Carbon Budget (tCO_2e)	1,725,000,000	960,000,000	2,685,000,000
Cumulative GHG Impacts (tCO_2e)	2,691,058	6,727,644	9,418,701
Cumulative emissions as percentage of UK Carbon Budget (%)	0.16%	0.70%	0.35%

210. Ossian's cumulative net emission intensity, when accounting for cumulative construction, operation and maintenance and decommissioning emissions alongside total generation output is 42.9 gCO_2e/kWh. There are no established net emission intensity benchmarks available for the industry that Ossian's net emission intensity can be compared against.

Sensitivity of receptor

211. In accordance with paragraph 71, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of effect

212. Overall, the magnitude of the cumulative effect is deemed to be between 13,608,654 tCO_2e and -128,591,016 tCO_2e. As discussed in paragraph 126, it is likely that the use of the long-run marginal projections represents an underestimate of the true value of avoided emissions from the Array. Further, the construction and operational phase emissions are likely to provide an overestimate of emissions due to the use of a conservative MDS. Such emissions will likely reduce as the design of the Array and transmission elements are refined, and designed in measures adopted as part of the Array are able to be accounted for quantitatively. Operation and maintenance and decommissioning emissions have also not taken into account future decarbonisation of UK industry, as set out in paragraph 43.

213. Consistent with paragraph 73, cumulative emissions up to 2037 represent 0.35% of the UK's carbon budget over this period.

214. The sensitivity of the receptor is considered to be high.

215. In addition, within the context of national policy, the purpose of the Array is to provide a source of renewable energy, thereby contributing towards UK and Scottish climate change policy goals and associated renewable energy targets (in particular the respective net zero targets). Based on the definitions set out in Table 17.9, the cumulative effect will, therefore, be **beneficial**, which is significant in EIA terms.

Secondary mitigation and residual effect

216. No climatic effects mitigation is considered necessary because the likely effect in the absence of mitigation is beneficial.

17.13. PROPOSED MONITORING

217. No climatic effects monitoring to test the predictions made within the assessment of LSE[1] on and from climate change is considered necessary.

218. No monitoring as a result of the CEA is proposed.

17.14. TRANSBOUNDARY EFFECTS

219. All developments which emit GHGs have the potential to impact the atmospheric mass of GHGs as a receptor (this includes manufacturing of materials in other territories), and so may have a transboundary impact on climate change. Consequently, transboundary effects due to other specific international development projects are not individually identified but would be taken into account when considering the impact of the Array by defining the atmospheric mass of GHGs as a high sensitivity receptor. Each country has its own policy and targets concerning carbon and climate change which are intended to limit GHG emissions to acceptable levels within that country's defined budget and international commitments.

17.15. INTER-RELATED EFFECTS (AND ECOSYSTEM ASSESSMENT)

220. In accordance with IEMA (2020) guidance, an in-combination climate impact (ICCI) assessment has been carried out, and is presented in volume 3, appendix 17.3 of the Array EIA Report.

221. As noted above, effects from climate change also have the potential to have secondary effects on other receptors and these effects are fully considered in the topic-specific chapters. These receptors and effects are:

- volume 2, chapter 7:
  - potential changes in the tidal, storm or wind regimes due to the effects of climate change.
- volume 2, chapters 8 to 11:
  - potential changes in the sensitivity of habitats or species to development impacts in the future due to the effects of climate change (e.g. due to changes to species distribution patterns and/or local, national or international rarity).
- volume 2, chapter 12:
  - consideration of GHG emissions associated with deviation of ferry and cargo routes.

17.16. SUMMARY OF IMPACTS, MITIGATION, LIKELY SIGNIFICANT EFFECTS AND MONITORING

222. Information on climatic effects within the climatic effects study area was collected through desktop review. This information is summarised in Table 17.22 and Table 17.23.

223. Table 17.22 presents a summary of the potential impacts, designed in measures and the conclusion of LSE[1] in EIA terms in respect to climatic effects. The impacts assessed include:

- GHG emissions arising from disturbance to blue carbon stocks during the construction, operation and maintenance and decommissioning of the Array;
- GHG emissions arising from the manufacturing and installation of the Array;
- GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the Array and estimated abatement of UK Grid emissions;
- GHG emissions arising from decommissioning works of the Array;
- effects of climate change on the Array; and
- net GHG impacts of the Array.

224. Only those impacts where effects have been concluded to be significant have been further detailed within this summary section.

225. As set out in paragraph 73, the following factors have been used in the assessment of significance of GHG emissions, in accordance with IEMA (2022) guidance:

- the magnitude of net GHG emissions as a percentage of UK national carbon budgets (where feasible and where carbon budgets are available); and
- whether the Array contributes to, and is in line with, the UK's policy for GHG emissions reductions, where these are consistent with science-based commitments to limit global climate change to an internationally agreed level (as determined by the UK's nationally determined contribution (NDC) to the Paris Agreement (BEIS, 2022a)).

226. Overall, it is concluded that there will be the following LSE[1] arising from the Array:

- Operation and maintenance phase: This phase would enable the provision of up to 3.6 GW of additional renewable electricity generation capacity and the displacement of fossil fuel electricity generation. When considering the avoided emissions, in addition to emissions arising from the operation and maintenance of the Array, the operation and maintenance impact results in the order of between 605,756 tCO_2e and -141,593,914 tCO_2e by 2073 (negative values represent avoided emissions). This range represents the displacement of alternative energy generation sources, in order to provide context to the assessment. The magnitude of emissions is unable to be contextualised within the UK Carbon Budgets given the operation and maintenance phase falls outside of such budgets. The Array will produce electricity at an emissions intensity of 4.4 gCO_2e/kWh. This is lower than the current grid average (207 gCO_2e/kWh), fossil fuel generation (424 gCO_2e/kWh) and the Climate Change Committee's electricity emissions intensity target for 2035 (10 gCO_2e/kWh) (Climate Change Committee, 2020). As such, the Array is in line with UK and Scottish climate change policy goals and net zero targets. Considering these factors, this would result in a significant beneficial effect in EIA terms.

227. All phases: net GHG effects from the construction, operation and maintenance and decommissioning of the Array. This impact considers the total emissions associated with the Array, including the consumption of fuel and materials used throughout the lifetime of the Array, GHG emissions from the disturbance of blue carbon stocks and the displacement of fossil fuels during the operation and maintenance phase. This would result in net GHG emissions of between 10,532,655 tCO_2e and -131,667,016 tCO_2e (negative emissions represent net avoided emissions). It should be noted that emissions have been calculated based on precautionary calculations of material quantities and will be refined throughout the design stage. Additionally, given the operation of the Array would avoid the need for fossil fuel generators through the provision of renewable electricity, the associated avoided emissions would likely be greater than those presented in the conservative case (i.e. when using the long-run marginal projections) resulting in a reduction to the conservative net effect scenario presented above.

- As such, calculated emissions represent a conservative (reasonable adverse case) scenario. Operation and maintenance and decommissioning emissions have also not taken into account future decarbonisation of UK industry. The magnitude of emissions comprise 0.31% of the Fifth and Sixth UK Carbon Budgets (set out in Table 17.1). Within the context of national policy, the purpose of the Array is to provide a source of renewable energy, thereby contributing towards UK and Scottish climate change policy goals and associated renewable energy targets (in particular the respective net zero targets). Considering these factors, this would result in a significant beneficial effect in EIA terms.

228. In summary, the assessment estimates that the Array will produce approximately 337,457,750 MWh of low carbon electricity during its 35 year operational phase. Over its lifetime the Array will produce an operational emission intensity of 4.4 gCO2e/kWh. The electricity generated by the Project will save between 882,416 and 143,082,086 tCO_2e from being emitted into the atmosphere that may otherwise have been emitted from conventional, higher carbon emitting forms of energy generation (i.e. fossil fuels). When emissions resulting from the construction, operation and maintenance and decommissioning of the Array are also included (11,415,070 tCO_2e), the Array will save up to 131,667,016 tCO_2e from being emitted into the atmosphere over its lifecycle (net emissions). The assessment explains that it will take Ossian two years at the earliest to 'pay back' the GHG emissions relating to the construction, operation and maintenance and decommissioning phases.

229. Table 17.23 presents a summary of the potential impacts, designed in measures and the conclusion of LSE[1] in EIA terms in respect to cumulative assessment of climatic effects. The cumulative impacts assessed include:

- Emissions resultant from the Array together with (enabled by) the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure, resulting in lifetime emissions for Ossian.

230. Overall, it is concluded that there will be the following likely significant cumulative effects from the Array alongside other projects/plans.

- Operation and maintenance: Cumulative GHG emissions of between 2,409,282 tCO_2e and -139,790,388 tCO_2e, when accounting for avoided emissions during the operation of the Array (enabled by the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure). The range reflects displacement of alternative energy generation sources from a range of future baseline scenarios. The magnitude of emissions is unable to be contextualised within the UK Carbon Budgets given the operation and maintenance phase falls outside of such budgets. The Array, in combination with the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure, will produce electricity at an emissions intensity of 9.8 gCO_2e/kWh. This is lower than the current grid average (207 gCO_2e/kWh), fossil fuel generation (424 gCO_2e/kWh) and the Climate Change Committee's electricity emissions intensity target for 2035 (10 gCO_2e/kWh) (Climate Change Committee, 2020). As such, the Array is in line with UK and Scottish climate change policy goals and net zero targets. Considering these factors, this would result in a significant beneficial effect in EIA terms.
- Net effects: Lifetime cumulative GHG emissions of between 13,608,654 tCO_2e and -128,591,016 tCO_2e. This range has been calculated based on a precautionary MDS, which will be refined during final Array design. Furthermore, given the operation of the Array would avoid the need for fossil fuel generators through the provision of renewable electricity, the associated avoided emissions would likely be greater than those presented in the conservative case (i.e. when using the long-run marginal projections) resulting in a reduction to the conservative net effect scenario presented above. The assessment explains that it will take Ossian three years at the earliest to 'pay back' the GHG emissions relating to the construction, operation and maintenance and decommissioning phase emissions from both the Array and associated transmission infrastructure. This figure has been calculated using precautionary calculations of material quantities in the absence of detailed design information. Operation and maintenance and decommissioning emissions have also not taken into account future decarbonisation of UK industry. The magnitude of emissions comprise 0.35% of the UK's carbon budget over this period. Within the context of national policy, the purpose of the Array is to provide a source of renewable energy, thereby contributing towards UK and Scottish climate change policy goals and associated renewable energy targets (in particular the respective net zero targets). Considering these factors, this would result in a significant beneficial effect in EIA terms.

231. All developments which emit GHGs have the potential to impact the atmospheric mass of GHGs as a receptor (this includes manufacturing of materials in other territories), and so may have a transboundary impact on climate change. Consequently, transboundary effects due to other specific international development projects are not individually identified but would be taken into account when considering the impact of the Array by defining the atmospheric mass of GHGs as a high sensitivity receptor. Each country has its own policy and targets concerning carbon and climate change which are intended to limit GHG emissions to acceptable levels within that County's defined budget and international commitments.

Table 17.22: Summary of Likely Significant Environmental Effects, Secondary Mitigation and Monitoring

Description of Impact	Phase	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Additional Measures	Significance of Residual Effect	Proposed Monitoring
GHG emissions arising from seabed change	Construction Operation and maintenance Decommissioning	Between 11,813 tCO_2 and 59,067 tCO_2 Between 447 tCO_2 and 2,233 tCO_2 Negligible	High High High	Minor adverse Minor adverse Negligible	None	Minor adverse Minor adverse Negligible	None None None
GHG emissions arising from the manufacturing and installation of the Array during construction	Construction	9,479,984 tCO_2e	High	Minor adverse	None	Minor adverse	None
GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the array and estimated abatement of UK Grid emissions	Operation and maintenance	Between 605,756 tCO_2e and -141,593,914 tCO_2e	High	Beneficial	None	Beneficial	None
GHG emissions (plant, fuel and vessel use) and recovery or disposal of materials during decommissioning	Decommissioning	385,615 tCO_2e	High	Minor adverse	None	Minor adverse	None
The impact of climate change on the Array	Operation and maintenance	N/A	N/A	Negligible	None	Negligible	None
Net GHG impacts of the Array	N/A	Between 10,532,655 tCO_2e and -131,667,016 tCO_2e	High	Beneficial	None	Beneficial	None

Table 17.23: Summary of Likely Significant Cumulative Environment Effects, Mitigation and Monitoring

Description of Impact	Phase	Cumulative Effects Assessment Tier	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Additional Measures	Significance of Residual Effect	Proposed Monitoring
Lifetime emissions resultant from the Array together with (enabled by) the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure, resulting in lifetime emissions for Ossian	Construction Operation and maintenance Decommissioning	Tier 1	10,764,230 tCO_2e Between 2,409,282 tCO_2e and -139,790,388 tCO_2e 435,142 tCO_2e	High High High	Minor adverse Beneficial Minor adverse	Construction: None Operation and maintenance: None Decommissioning: None	Minor adverse Beneficial Minor adverse	None
Net cumulative GHG impacts of Ossian	N/A	Tier 1	Between 13,608,654 tCO_2e and -128,591,016 tCO_2e	High	Beneficial	None	Beneficial	None

17.17. REFERENCES

ABB (2003). *Environmental Product Declaration: Power transformer TrafoStar 500 MVA*. Available at: https://library.e.abb.com/public/566748ad75116903c1256d630042f1af/ProductdeclarationStarTrafo500.pdf. Accessed on: 03 February 2024.

BEIS (2017). *Clean Growth Strategy.* Available at: https://www.gov.uk/government/publications/clean-growth-strategy Accessed on: 29 February 2024

BEIS (2020). *Energy White Paper: Powering our Net Zero Future.* Available at: https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future Accessed on: 29 February 2024

BEIS (2021). *Net Zero Strategy: Build Back Greener*. Available at: https://www.gov.uk/government/publications/net-zero-strategy Accessed on: 20 February 2024

BEIS (2022a). *United Kingdom of Great Britain and Northern Ireland's Nationally Determined Contribution*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1109429/uk-nationally-determined-contribution.pdf Accessed on: 29 February 2024

BEIS (2022b). *British Energy Security Strategy.* Available at: https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy Accessed on: 29 February 2024

BEIS (2022c). *UK Offshore Energy Strategic Environmental Assessment: Appendix 1F: Climate and Meteorology*. Available at: https://assets.publishing.service.gov.uk/media/623332cd8fa8f504a584cfd1/Appendix_1f_-_Climate___Meteorology.pdf. Accessed on: 19 February 2024.

British Standards Institution (2023) *PAS 2080:2023 Carbon management in buildings and infrastructure.*

Climate Change Committee (2020). *The Sixth Carbon Budget: The UK's path to net zero.* Available at: https://www.theccc.org.uk/publication/sixth-carbon-budget/ Accessed on: 22 May 2024

Climate Change Committee. (2021). *Independent Assessment of Climate Risk. Advice to Government for the UK's third Climate Change Risk Assessment (CCRA3).* Available at: https://www.theccc.org.uk/wp-content/uploads/2021/07/Independent-Assessment-of-UK-Climate-Risk-Advice-to-Govt-for-CCRA3-CCC.pdf. Accessed on: 19 February 2024.

Cunningham, C. and Hunt, C. (2023). *Scottish Blue Carbon – a literature review of the current evidence for Scotland's blue carbon habitats.* NatureScot Research Report 1326. Available at: https://www.nature.scot/doc/naturescot-research-report-1326-scottish-blue-carbon-literature-review-current-evidence-scotlands Accessed on: 03 February 2024.

Defra (2011). *UK Marine Policy Statement.* Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed on: 11 March 2024

DESNZ (2023a). *Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book* [online] Available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal Accessed on: 03 February 2024.

DESNZ (2023b). *Digest of UK Energy Statistics, Load factors for renewable electricity generation.* Available at: https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes Accessed on: 03 February 2024.

DESNZ (2023c). *Powering up Britain: Net Zero Growth Plan.* Available at: https://assets.publishing.service.gov.uk/media/642556c560a35e000c0cb167/powering-up-britain-net-zero-growth-plan.pdf Accessed on: 29 February 2024

DESNZ (2023d). *2023 Government Greenhouse Gas Conversion Factors for Company Reporting: Methodology Paper for Conversion Factors.* Available at: 2023 Government greenhouse gas conversion factors for company reporting: Methodology paper (publishing.service.gov.uk) Accessed on: 10 June 2024

DESNZ and Defra (2023). *Greenhouse gas reporting: conversion factors 2023.* Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023 Accessed on: 03 February 2024.

Folk, R. L. (1954). *The distinction between grain size and mineral composition in sedimentary rock nomenclature*. Jour. Geology, 62, pp 344-359.

HM Government (2019). *Climate Change Act 2008 (2050 Target Amendment) Order 2019*. Available at: https://www.legislation.gov.uk/ukdsi/2019/9780111187654

HM Treasury (2020). *National Infrastructure Strategy.* Available at: https://www.gov.uk/government/publications/national-infrastructure-strategy Accessed on: 29 February 2024

HM Treasury and DESNZ (2023). *Addressing carbon leakage risk to support decarbonisation*. Available at: https://www.gov.uk/government/consultations/addressing-carbon-leakage-risk-to-support-decarbonisation Accessed on: 29 February 2024

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

IEMA (2022). *Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance.* 2nd Edition. Available at: https://www.iema.net/resources/blog/2022/02/28/launch-of-the-updated-eia-guidance-on-assessing-ghg-emissions accessed on: 29 February 2024.

IPCC (2013). *Climate Change 2013: The Physical Science Basis.* Available at: https://www.ipcc.ch/report/ar5/wg1/ Accessed on: 03 February 2024.

IPCC. (2021). *Climate Change 2021: The Physical Science Basis.* Available at: https://www.ipcc.ch/report/ar6/wg1/. Accessed on: 19 February 2024.

Jaroszweski, D., Wood, R., and Chapman, L. (2021). *Infrastructure. In: The Third UK Climate Change Risk Assessment Technical Report. [Betts, R.A., Haward, A.B., Pearson, K.V. (eds)]* Prepared for the Climate Change Committee, London.

Jones and Hammond (2019). *Inventory of Carbon and Energy (ICE) Database.* Available at: https://circularecology.com/embodied-carbon-footprint-database.html Accessed on 20 February 2024

MD-LOT (2023). *Ossian Array Scoping Opinion*

National Grid ESO (2023). *Future Energy Scenarios.* Available at: https://www.nationalgrideso.com/future-energy/future-energy-scenarios Accessed on: 03 February 2024.

Palmer, M., Howard, T., Tinker, J., Lowe, J., Bricheno, L., Calvert, D., Edwards, T., Gregory, J., Harris, G., Krijnen, J., Pickering, M., Roberts, C. and Wolf, J. (2018). *UKCP18 Marine Report.* Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-marine-report-updated.pdf .Accessed on: 19 February 2024.

Scottish Government (2009). *Climate Change (Scotland) Act 2009*. Available at: https://www.legislation.gov.uk/asp/2009/12/contents

Scottish Government (2015). *Scottish National Marine Plan.* Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2015/03/scotlands-national-marine-plan/documents/00475466-pdf/00475466-pdf/govscot%3Adocument/00475466.pdf Accessed on: 09 February 2024

Scottish Government (2020a). *Sectoral Marine Plan for Offshore Wind Energy*. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2020/10/sectoral-marine-plan-offshore-wind-energy/documents/sectoral-marine-plan-offshore-wind-energy/sectoral-marine-plan-offshore-wind-energy/govscot%3Adocument/sectoral-marine-plan-offshore-wind-energy.pdf Accessed on: 29 February 2024

Scottish Government (2020b). *Climate Change Plan 2018-2032*. Available at: https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/documents/. Accessed on: 29 February 2024

Scottish Government (2023). *Draft Energy Strategy and Just Transition Plan.* Available at: https://www.gov.scot/publications/draft-energy-strategy-transition-plan/ Accessed on: 29 February 2024

Smeaton, C., Austin, W. and Turrel, W. (2020). *Re-Evaluating Scotland's Sedimentary Carbon Stocks*. Marine Scotland Science Research Report, *Scottish Marine and Freshwater Science*, 11 Available at:: https://data.marine.gov.scot/sites/default/files//SMFS%201102.pdf Accessed on: 03 February 2024

Smeaton, C. and Austin, W. (2022). *Quality not Quantity: Prioritising the Management of Sedimentary Organic Matter Across Continental Shelf Seas.* Geophysical Research Letters, 49 Available at:: https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2021GL097481. Accessed on: February 2024. Accessed on: 03 February 2024

Staffell, I. and Green, R. (2014). *How does wind farm performance decline with age?* Volume 66, Renewable Energy. Available at: https://www.sciencedirect.com/science/article/pii/S0960148113005727 Accessed on: 03 February 2024.

United Nations (2015). *The Paris Agreement.* Available at: https://unfccc.int/sites/default/files/english_paris_agreement.pdf. Accessed on: 19 February 2024.

WRI and WBSCD (2004) *A Corporate Accounting and Reporting Standard*. Available at: https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf. Accessed on: 03 February 2024.

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