MachairWind Offshore Windfarm

Chapter 20 Climate Change Risk Assessment

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Glossary of Acronyms

Term	Definition
BEIS	Department for Business, Energy and Industrial Strategy
CCR	Climate Change Risk
CCRA	Climate Change Risk Assessment
CMS	Construction Method Statement
EC	European Commission
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
ERCoP	Emergency Response Cooperation Plan
GHG	Greenhouse gases
IACs	Inter-array cables
ICPC	International Cable Protection Committee
IEMA	Institute of Environmental Management and Assessment
IPCC	Intergovernmental Panel on Climate Change
MCA	Maritime and Coastguard Agency
MCCIP	Marine Climate Change Impacts Partnership
MD-LOT	Marine Directorate - Licensing Operations Team
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
NAP	National Adaptation Programme
NPF4	National Planning Framework 4
NYSERDA	New York State Energy Research and Development Authority
O&M	Operation and Maintenance
OAA	Option Agreement Area
OnTDA	Onshore Transmission Development Area
OREI	Offshore Renewable Energy Installations
OSP	Offshore Substation Platform
RCP	Representative Concentration Pathway
SAR	Search and Rescue
SCCAP	Scottish Climate Change Adaptation Programme
SEPA	Scottish Environment Protection Agency
SNAP3	Scottish National Adaptation Plan 2024–2029
SSP	Shared socioeconomic pathway

Term	Definition
UK	United Kingdom
UKCP18	UK Climate Projections 2018
VMS	Vessel Monitoring System
WDA	Windfarm Development Area
WTG	Wind Turbine Generator

Glossary of Terms

Term	Definition
Adaptive Capacity	The ability of a system to adjust to climate change (including climate variability and extremes), to moderate the potential damage from it, to take advantage of its opportunities, or to cope with its consequences.
Cable protection	Protective measure to minimise the effects of scour and hazards along the offshore cables (e.g. to prevent cable exposure or snagging of vessel anchors or fishing gear), as well as for protecting these cables at infrastructure crossing points.
Climate Change Impact	Climate Change Impact is defined as an impact from a climate hazard, such as asset damage or failure, which affects the ability of the receptor to maintain its function or purpose.
Climate Hazard	Climate Hazard is defined as a weather or climate-related event or trend in climate variable, such as storms or heatwaves, which has potential to do harm to receptors.
Climate Variable	Climate variable is defined as a measurable, monitorable aspect of the weather or climate such as temperature or wind speed.
Climate resilience	Climate resilience refers to the ability of a system, community, or asset to anticipate, prepare for, respond to, and recover from significant climate-related threats with minimal damage to social well-being, the economy, and the environment.
Combined Assessment	A whole-Project assessment considering interactions between the Windfarm Development Area, Offshore Export Cable Corridor and Onshore Transmission Development Area (i.e. considering impact interactions and additive effects to determine if any effects would be materially elevated from those assessed for the Windfarm Development Area-alone assessment). Due to long delays in securing confirmation of the Project's grid connection location, the level of detail available for the Offshore Export Cable Corridor and Onshore Transmission Development Area is limited and therefore the assessment is commensurate with the level of detail available at the time of carrying out the assessment. Within the upcoming Offshore Export Cable Corridor and Onshore Transmission Development Area consent applications, their respective scoping and Environmental Impact Assessment Report / Environmental Report will take account of all likely effects predicted within the WDA EIA and present updated combined assessments using the latest available information covering all aspects of the Project.
Development Area	Application boundary for consenting purposes which, for the Project, consists of a Windfarm Development Area, Offshore Export Cable Corridor, and Onshore Transmission Development Area. Separate consent and marine licence applications will be submitted for each Development Area where applicable.
Embedded mitigation measure	Mitigation measures, including industry good practice measures, that are directly incorporated into the design for the MachairWind Windfarm Development Area to avoid or reduce environmental effects.
Environmental Impact Assessment (EIA)	The process of evaluating the likely significant environmental effects of a proposed development over and above the existing circumstances (or 'baseline').
Environmental Impact Assessment (EIA) Regulations	A collective term referring to The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017.
Greenhouse gas	A gas in the Earth's atmosphere that traps heat by absorbing and emitting infrared radiation, a process known as the greenhouse effect. Also known by the collective shorthand "carbon".

Term	Definition
Inter-array cables (IACs)	Armoured cable containing electrical and fibre optic cores which link the wind turbine generators to each other and to the offshore substation platform(s).
Landfall	The area from Mean Low Water Springs to a transition bay(s), where the offshore export cable(s) come ashore.
Landings	Quantitative description of the amount of fish returned to port for sale, in terms of value or weight.
MachairWind Offshore Windfarm	An offshore windfarm capable of exporting around 2 GW of renewable energy to the National Electricity Transmission System. MachairWind Offshore Windfarm comprises three Development Areas: • The WDA – located on the west coast of Scotland to the northwest of Islay and west of Colonsay; • The Offshore Export Cable Corridor – a preliminary boundary extending from the WDA to mean high water springs at a landfall location near Girvan, South Ayrshire; and • The Onshore Transmission Development Area – a preliminary boundary which extends landward from mean low water springs and includes the land required for the landfall of the offshore export cables and their route up to but not including the proposed high voltage direct current switching station which will be developed and constructed by Transmission Owner, ScottishPower Transmission. Separate consent and licence applications will be submitted for each Development Area.
Mean High Water Springs (MHWS)	The average, over a year, of the heights of two successive high waters during those periods of 24 hours (once every fortnight) when the range of the tide is greatest.
Mean Low Water Springs (MLWS)	The average, over a year, of the heights of two successive low waters during those periods of 24 hours (once every fortnight) when the range of the tide is greatest.
Mean sea level	The average level of the sea taking account of all tidal effects but excluding surge events.
National Electricity Transmission System	The high-voltage electricity power transmission network serving Great Britain which receives electricity from generators (such as offshore windfarms) and transmits that electricity to anywhere on the National Electricity Transmission System to satisfy demand.
Offshore export cable	Armoured cable containing electrical cores between the offshore substation platform(s) and landfall. Offshore export cables will include bundled fibre optic cables. The offshore export cables are subject to Marine Licence applications under the Marine (Scotland) Act 2010. The portion of the offshore export cable(s) located within the WDA is assessed as part of this MachairWind WDA EIA and a marine licence application to construct, alter or improve this portion has been submitted alongside the WDA application. A separate marine licence application will be submitted for the portion of the offshore export cable(s) from the WDA boundary to Mean High Water Springs.
Offshore Export Cable Corridor (ECC)	The preliminary boundary extending from the WDA to mean high water springs near Girvan, South Ayrshire and within which the offshore export cable(s) will be located. A separate marine licence application will be submitted for the offshore export cable(s) located within the Offshore ECC.
Offshore Substation Platform (OSP)	An offshore platform with a fixed foundation located within the WDA which houses electrical equipment such as transformers, switchgear, protection and control systems, and enables the windfarm's renewable electricity to be collected via inter-array cables and exported to the National Electricity Transmission System via offshore export cables.
Offshore Substation Platform (OSP) link cables	Electrical cables which link OSPs (if more than one OSP is required). These cables will include fibre optic cores or bundled fibre optic cables. OSP link cables will be wholly located within the WDA.

Term	Definition
Onshore Transmission Development Area (OnTDA)	The preliminary boundary which extends landward from mean low water springs and includes the land required for the landfall of the offshore export cables and their route up to but not including the proposed high voltage direct current switching station which will be developed and constructed by Transmission Owner, ScottishPower Transmission. This Transmission Owner is responsible for consenting the high voltage direct current switching station. Onward connections to the National Electricity Transmission System will be consented by National Grid Electricity Transmission and ScottishPower Transmission. Where relevant, these are considered as part of cumulative effects assessment in the EIA.
Operational life	The operational life is the expected length of time from final commissioning of the WDA until the cessation of commercial operations. This is anticipated to be 35 years.
Option Agreement Area (OAA)	The seabed area awarded to ScottishPower Renewables in January 2022 through the ScotWind leasing round.
Plan Option	A spatial plan area proposed through the Sectoral Marine Plan for offshore wind energy (as adopted in 2020). As part of the ScotWind leasing round, offshore wind developers submitted bids for Plan Options which, following a successful bid, become OAAs.
Pre-construction works	Pre-construction works are activities undertaken prior to formal commencement of construction. Examples include survey works such as geotechnical and geophysical surveys and seabed preparation activities.
Receptor	An entity or system with potential to be affected by climate *Hazards* and therefore vulnerable to experiencing climate change impacts such as infrastructure (WTGs affected by extreme weather conditions like high winds and storms; operational disruptions) and site personnel (personnel working on the WDA face risks such as increased frequency and intensity of storms and heatwaves).
Representative Concentration Pathway (RCP)	Different possible trajectories of atmospheric concentrations based on socioeconomic and policy assumptions used in climate change projection modelling. The RCP scenarios are related to the concentrations of GHG that would result in target amounts of radiative forcing (measured in watts per square metre (W/m^2)) at the top of the atmosphere by 2100, relative to pre-industrial levels. Radiative forcing is a measure of the influence of factors (like GHG) on the energy balance of the Earth's atmosphere. The RCP scenarios are: • RCP2.6: Pathway where radiative forcing peaks at approximately 3 W/m^2 mid-century and then declines to 2.6 W/m^2 by 2100. This would require significant reductions in greenhouse gas emissions and aims to limit global warming to below 2°C; • RCP4.5: Represents a stabilisation of radiative forcing at 4.5 W/m^2 by 2100 without overshooting. It assumes that emissions will peak around 2040 and then decline; • RCP6.0: Pathway stabilises radiative forcing at 6 W/m^2 by 2100. Emissions peak around 2080 and then decline; and • RCP8.5: Radiative forcing reaches 8.5 W/m^2 by 2100. It assumes continued increases in greenhouse gas emissions throughout the 21st century. More details provided in Section 1.1 of **Appendix 20.1 Climate Projection Data**.
ScotWind	A Crown Estate Scotland seabed leasing round which enabled developers to propose offshore wind projects and apply for seabed rights to plan and build windfarms in Scottish waters.
Scour protection	Protective measures to avoid sediment being eroded away from the base of the wind turbine generator foundations as a result of the flow of water.
Sensitivity	Sensitivity is the degree to which a receptor is affected, either adversely or beneficially, by climate variability or change.

Term	Definition
Shared socioeconomic pathways (SSP)	Climate change scenarios that project socioeconomic global changes up to 2100. They are used to derive greenhouse gas emissions scenarios based on different climate policies and socioeconomic developments. SSPs provide narratives describing alternative pathways for human society, particularly in relation to fossil fuel use and the social and economic factors driving it.
Site preparation works *(in an offshore context)*	Preparatory activities undertaken within the WDA prior to the commencement of construction of the WDA Infrastructure, which may comprise (and which may require separate consents): • Geophysical surveys, geotechnical surveys, and non-archaeological/archaeological diver/ROV surveys; • Seabed preparation including sand wave levelling and boulder clearance; • UXO survey and/or clearance; • Debris clearance; and • Out of service cable/pipeline removal.
Switchgear	Electrical equipment used to control, protect, and isolate electrical circuits and equipment.
The Applicant	The legal entity submitting consent applications for the MachairWind Offshore Windfarm, namely MachairWind Limited.
The Lighthouse	The Dubh Artach lighthouse.
The Project	MachairWind Offshore Windfarm including all its Development Areas and associated infrastructure.
UK Climate Projections 2018 (UKCP18)	The UK Climate Projections 2018 (UKCP18) are a set of climate change projections produced by the UK Met Office on behalf of the UK Government. UKCP18 provides probabilistic and scenario-based projections of future changes in climate variables (such as temperature, precipitation, sea level rise, and extreme weather) for the UK under different greenhouse gas emissions scenarios.
Vulnerability	Vulnerability is the degree to which a receptor (e.g. people, infrastructure, ecosystems) is susceptible to, or unable to cope with, adverse effects of climate change. It is typically a function of: • Exposure (presence in areas affected by climate Hazards); • Sensitivity (degree to which it is affected); and • Adaptive capacity (ability to adjust, cope, or recover).
Vessel Monitoring System (VMS)	A system used in commercial fishing to allow environmental and fisheries regulatory organisations to monitor, minimally, the position, time at a position, and course and speed of fishing vessels.
Windfarm Development Area (WDA)	The application boundary within the OAA where consent will be sought for the proposed WDA infrastructure. The WDA infrastructure is subject to Section 36 consent and marine licence applications (generation and transmission) which are being applied for separately from the Offshore ECC infrastructure and OnTDA infrastructure.
WDA infrastructure	The offshore generation and transmission infrastructure located within the WDA including but not limited to: WTGs, WTG fixed foundations (and associated scour protection), OSP(s), OSP fixed foundations (and associated scour protection), IACs, OSP link and offshore export cable(s) and their associated external cable protection (insofar as these are located within the WDA) and fibre optic cables.
WDA restricted build area	Refers to the area within the WDA which is considered unsuitable for the installation of WTG and OSP foundations for engineering and environmental reasons.
Wind Turbine Generator (WTG)	A wind turbine generator which converts wind energy into electrical energy. Each wind turbine generator is a complex system composed of a high number of components.

Term	Definition
	Typically, the main components include the rotor assembly (composed of three blades and a hub); the nacelle (containing a generator, shaft and gearbox, power electronic converter and transformer); and the tower (containing lifting equipment and the switchgear).

20 CLIMATE CHANGE RISK ASSESSMENT

20.1 INTRODUCTION

1. This chapter presents an assessment of potential impacts and likely significant effect(s) of climate change that may arise during the construction, operation and maintenance (O&M), and decommissioning of the MachairWind Windfarm Development Area (WDA) infrastructure.

2. The grid connection location for the Project was confirmed in August 2025 following lengthy delays stemming from the National Electricity System Operator's 2022 Holistic Network Desing (HND) process see **Chapter 1 Introduction** for further information). Consequently, this topic chapter considers the WDA Study Area and existing environment only. Separate consent and marine licence applications will be sought for the Offshore Export Cable Corridor (ECC) and Onshore Transmission Development Area (OnTDA). A combined assessment of the construction, O&M and decommissioning of the WDA activities, Offshore ECC and OnTDA activities (commensurate with the level of detail that is available at the time of carrying out that appraisal) is also provided. This approach will provide a meaningful and proportionate assessment of the Project as a whole. As noted in **Chapter 1 Introduction**, the assessment of potential effects on all receptors associated with the Offshore ECC and OnTDA will be presented in individual Environmental Impact Assessment (EIA) Reports (EIARs), which will be submitted separately in accordance with the relevant Environmental Impact Assessment Regulations.

3. The purpose of the Climate Change Risk (CCR) assessment is to identify and evaluate the vulnerability of the WDA infrastructure and its associated activities to the projected effects of climate change during the construction, O&M, and decommissioning phases. Unlike other EIA chapters, this chapter does not aim to determine the significance of impacts in terms of magnitude. Instead, it focuses on identifying potential climate-related risks, assessing their implications, and recommending appropriate measures to reduce these risks and enhance the overall resilience of the project.

4. For the purpose of the CCR assessment, the following key terms are adopted:

- **Climate resilience**: Climate resilience refers to the ability of a system, community, or asset to anticipate, prepare for, respond to, and recover from significant climate-related threats with minimal damage to social well-being, the economy, and the environment;
- **Receptor**: An entity or system with potential to be affected by climate *Hazards* and therefore which is vulnerable to experiencing climate change impacts, such as infrastructure (wind turbine generator (WTGs) affected by extreme weather conditions like high winds and storms; operational disruptions) and site personnel (personnel working on the Project face risks such as increased frequency and intensity of storms and heatwaves);
- **Climate variable**: A measurable, monitorable aspect of the weather or climate conditions such as temperature and wind speed;
- **Climate hazard**: A climate or weather-related event or trend in climate conditions, which has potential to do harm to receptors such as increased precipitation or storms;
- **Climate change impact**: The resulting impact from a climate *Hazard* which affects the ability of the *Receptor* to achieve or maintain its functions or purpose;
- **Risk:** The potential for adverse consequences resulting from the interaction of climate *Hazards* with exposed and vulnerable systems.
  Risk = Hazard × Exposure × Vulnerability;
- **Exposure:** The presence of people, assets, systems, or services in locations that could be affected by climate *Hazards*; and

- **Vulnerability:** The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change.

  Vulnerability = Sensitivity × Adaptive Capacity;
  - **Sensitivity:** The degree to which a receptor is affected when it experiences a climate hazard; and
  - **Adaptive Capacity:** The ability of a system, organization, or asset to adjust to climate impacts, reduce damage, and recover effectively.

5. This chapter considers the following WDA infrastructure: wind turbine generators (WTGs), Offshore Substation Platforms (OSP) and associated fixed foundations and scour protection, inter-array cables (IACs), OSP link cables, the portion of the offshore export cable located within the WDA and associated cable protection.

6. The WDA infrastructure may be exposed to a range of climate *Hazards*, defined as extreme weather events and chronic climatic changes which have the potential to harm human, environmental or infrastructure receptors (Institute of Environmental Management and Assessment (IEMA), 2020). Exposure to climate *Hazards* may lead to climate change impacts on the WDA's receptors i.e. infrastructure and associated activities. The nature of the climate change impact will depend on the type of climate *Hazard* and *Receptor*, but may include impacts such as physical damage, loss or deterioration of infrastructure and other assets, disruptions to activities resulting in delays, decline in performance of infrastructure and other assets, adverse working conditions posing health and safety risks, and cost implications.

7. This chapter has been prepared to provide the Marine Directorate - Licensing and Operations Team (MD-LOT) (administering on behalf of the Scottish Ministers) and stakeholders with sufficient information to determine the likely significant effect(s) of the Project on the receiving environment.

8. This chapter should be read in conjunction with the following related EIAR chapters:

- **Chapter 19 Greenhouse Gas Assessment** – This chapter focuses on key climate change considerations, particularly mitigation measures. While this chapter does not directly overlap with other chapters, together they form a comprehensive approach to resilience from climate change risks. Specifically, the assessment supports resilience through decarbonisation, which is a critical strategy for reducing long-term climate risks.
- **Chapter 21 Major Accidents and Disasters** – This chapter will use the hazards identified in Chapter 20 to inform its conclusions.

9. Additional information to support the CCR assessment includes:

- **Appendix 20.1 Climate Projection Data** –This appendix presents the climate projection data used to characterise future changes in relevant climate variables for the WDA, forming the evidence base for the Exposure assessment. The data describes plausible future climate conditions over the Construction, O&M and Decommissioning phases, allowing the magnitude, frequency and likelihood of climate *Hazards* to be identified. The data is presented for multiple emission pathway scenarios.

- **Appendix 20.2 Climate Change Vulnerability Assessment** – This appendix evaluates the vulnerability of identified *Receptors* during the construction, O&M and decommissioning phases by assessing *Receptor Sensitivity* and *Adaptive Capacity* to projected climate *Hazards*, taking account of embedded mitigation measures.

20.2 LEGISLATION, POLICY AND GUIDANCE

10. The overarching policy and legislation relevant to the EIA is described in **Chapter 2 Policy and Legislative Context**. **Table 20.1** sets out the relevant legislation, policy and guidance that informs the assessment of climate change risks.

Table 20.1 Summary of relevant legislation, policy and guidance for the assessment of climate change risks

Relevant Policy or Guidance	Relevance to the Assessment
Legislation	
The Climate Change Act 2008 and Climate Change (Scotland) Act 2009	The Climate Change Act 2008 requires the UK Government to undertake a Climate Change Risk Assessment (CCRA) every five years and identify key climate risks and opportunities to national communities and economic sectors. The Climate Change (Scotland) Act 2009 poses a similar requirement for the preparation of strategic programmes for climate change adaptation in Scotland following the publication of each UK CCRA. The third UK CCRA was published in 2022, followed by the third National Adaptation Programme (NAP), which outlines priority adaptation actions to be taken. The Scottish Climate Change Adaptation Programme (SCCAP) 2019-2024 and the Draft Scottish National Adaptation Plan 2024-2029 (published in draft in March 2024) identify specific actions for Scotland, including a need for resilient infrastructure systems.
Policy	
National Planning Framework 4 (NPF4)	As a long-term vision for spatial development, NPF4 supports the enhancement of the climate resilience of existing and future developments. NPF4 requires developments to be sited and designed to adapt to current and future risks from climate change (Policy 2). **The key references are:** **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 -** *" Development proposals will be sited and designed to minimise lifecycle greenhouse gas emissions as far as possible…"* **Policy 11: Energy –** "*Development proposals for all forms of renewable, low-carbon and zero emissions technologies will be supported…"*
Scottish National Adaptation Plan (SNAP3 / Draft 2024–2029)	Sets out Scotland's strategic response to climate risks identified in the UK CCRA, including actions to improve the resilience of infrastructure and essential services. The Plan reinforces the need for projects to assess Exposure, Vulnerability and Adaptive Capacity over their lifecycle and demonstrates policy support for adaptation-led design.
Sectoral Marine Plan for Offshore Wind Energy (Draft Updated SMP-OWE, 2025)	Provides the strategic spatial and policy framework for offshore wind development in Scottish waters. The Plan recognises climate change as a key consideration, including changing storm patterns and sea level rise, and informs project-level assessments undertaken under Section 36 and marine licensing regimes.
Guidance	
C40 Cities: Climate Change Risk Assessment Guidance (2018)	The guidance document includes a Climate Hazard Taxonomy based on the United Nations Disaster Risk Reduction classification, which provides the basis for identifying and screening climate hazards. Although geared towards cities, the approach is largely applicable to all built environment projects.

Relevant Policy or Guidance	Relevance to the Assessment
IEMA: Environment Impact Assessment Guide to Climate Change Resilience and Adaptation (2020)	The guidance document provides a methodology for characterising the climate baseline and assessing a development's vulnerability and resilience to climate change in the EIA process.
European Commission: Technical Guidance on the Climate Proofing of Infrastructure in the Period 2021 – 2027 (2021)	The guidance document outlines climate adaptation considerations for infrastructure projects and a risk assessment methodology for integration into impact assessments.
Scottish Government – Keeping Scotland Running: Building Resilience to a Changing Climate (2020)	Provides guidance for operators of critical infrastructure on managing climate risks, cascading failures and long-term resilience planning. Particularly relevant to offshore energy infrastructure and grid-connected assets.
Adaptation Scotland – Adaptation Capability Framework	Provides an evidence-based framework for assessing adaptive capacity across organizations and sectors. The framework supports structured evaluation of resilience measures, governance and operational readiness relevant to infrastructure projects.
Scottish Environment Protection Agency (SEPA) – Climate Change Allowances for Flood Risk Assessment in Land-Use Planning (2025)	Sets out climate change allowances for rainfall, river flows and coastal flooding to be used in assessments. The guidance informs how projected climate change should be incorporated into exposure and design considerations for flood-related climate hazards.

20.3 CONSULTATION

11. Consultation undertaken for the WDA in relation to climate change risk has followed the general process described in **Chapter 5 EIA Methodology**. As part of the consultation process, the Applicant presented the approach to the assessment to stakeholders, to offer transparency around the scoping methodology and rationale, capture stakeholder advice and guidance, and incorporate stakeholder feedback, where appropriate. A summary of the approach to stakeholder communication and consultation is outlined in **Chapter 6 Consultation and Stakeholder Engagement**. There were no comments received regarding the CCR assessment within the Projects' Scoping Opinion.

12. The topic of climate change was a key theme of the Pre-Application Consultation (PAC) held by Project through two rounds of six-week public consultations in 2025, with feedback being sought from the communities regarding the perception of the importance of climate change and the role of offshore wind in addressing climate change. During both statutory consultation periods, respondents identified climate change as being a key issue that should be addressed (see **Pre-Application Consultation Report** for further information).

13. Chapter 19 of the WDA Scoping Report considered the scope of the WDA infrastructure's vulnerability and resilience to climate change impacts. The chapter set out an overview of the existing environment for the WDA and also described the broad methodology for evaluating future trends in climate change impacts and in the WDA infrastructure's vulnerability and resilience to such changes.

14. The existing environment and climate conditions as described in Section 19.6.2 of the **WDA Scoping Report** has been presented in **Section 20.7.1** of this report.

15. This assessment has included the potential impacts outlined in Section 19.6.4 of the **WDA Scoping Report** and described in **Table 20.2**.

Table 20.2 Potential climate change risk impacts ‘scoped in’ to the WDA EIAR

Climate Hazard	Type of Climate Hazard	Potential Climate Change Impacts to the WDA
Extreme precipitation	Extreme weather event	• Delays to programme such as inability to undertake construction or maintenance activities; • Physical damage to built assets, equipment, and vessels; • Increased maintenance, repair and replacement requirements due to faster asset deterioration; • Reduced windfarm efficiency and functioning from operational downtime; and • Occupational health and safety impacts to personnel associated with the WDA.
Storm and wind (e.g. gales, storm surge, thunderstorms)		
Extreme temperatures (e.g. cold and heat waves)		
Changes in marine climate and extreme weather events	Chronic climatic change	
Sea level rise		
Changes in sea conditions (e.g. wave and currents, salinity)		

16. The climate *Hazards* from **Table 20.2** have been further elaborated **Section 20.10.2.1** of this report. The potential impacts from the above table have been enhanced in **Section 20.10** and **Appendix 20.2 Climate Change Vulnerability Assessment**.

20.4 EXISTING DATA SOURCES

17. The primary guidance document that has been used to inform the baseline characterisation, assessment methodology and mitigation design for the CCR assessment is IEMA’s “Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation” (IEMA, 2020). This guidance document provides a framework for the consideration of climate change resilience and adaptation in the EIA process and advises that future climate conditions within a development’s Study Area should be identified and assessed with consideration of how adaptation and resilience measures have been built into the design of a development. **Table 20.3** sets out the key desk-based information and data sources that have been used to inform the CCR baseline.

Table 20.3 Key data and information sources for climate change risks

Dataset	Year(s)	Description
CCR Assessment		
Met Office UK Climate Projection (UKCP18) Database and supporting reports	Various	Climate change projection data and summaries for the UK for various climate variables such as air temperature and precipitation. Note: UKCP data is most applicable to onshore and coastal areas. ‘18’ refers to the year that the data was first approved and published, although updates and enhancements to the data have been published since 2018. As such the data are considered to be applicable.
Met Office’s UK Climate Averages and Regional Climate Summaries	Various	Historical climate observations and current climate conditions for the UK.

Dataset	Year(s)	Description
Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report	Various	Current state of knowledge on climate science and possible climate futures. Provides the most up-to-date and comprehensive assessment of the global state of scientific knowledge on climate change, including observed and projected climate impacts, risks, mitigation pathways, and adaptation options under a range of future climate scenarios.
Marine Climate Change Impacts Partnership (MCCIP) Reports	Various	A collection of evidence reviews and summary reports on climate change effects in the marine environment.
Offshore Wind Climate Adaptation and Resiliency Study (New York State Energy Research and Development authority (NYSERDA), 2021)	2021	Review of key climate factors for the offshore wind sector and opportunities for climate resilience.
Department for Business, Energy and Industrial Strategy's (BEIS) Offshore Energy Strategic Environment Assessment 4 (SEA4)	2022	Observed meteorological conditions for seas around the UK.
IPCC Fifth Assessment Report	2014	Provides a comprehensive assessment of climate change science and defines a set of Representative Concentration Pathways (RCPs), which describe possible future trajectories of atmospheric greenhouse gas concentrations based on different socio-economic and policy assumptions. These RCPs are widely used in climate projection modelling to assess future climate conditions.
Scotland's Marine Assessment (Moffat et al., 2020).	2020	Reports on the vision for the (Scottish) seas: '*clean, healthy, safe, productive, biologically diverse marine and coastal environments, managed to meet the long-term needs of nature and people*'. The assessment presents, where possible, trends for the period 2014 to 2018 with longer term data presented where this sets the 2014 to 2018 period in a longer term context.
Scottish Government – Keeping Scotland Running: Building Resilience to a Changing Climate.	2020	Provides guidance for operators of critical infrastructure on managing climate risks, cascading failures and long-term resilience planning. Particularly relevant to offshore energy infrastructure and grid-connected assets.
Adaptation Scotland – Adaptation Capability Framework	2024	Provides an evidence-based framework for assessing adaptive capacity across organizations and sectors. The framework supports structured evaluation of resilience measures, governance and operational readiness relevant to infrastructure projects.
SEPA – Climate Change Allowances for Flood Risk Assessment in Land-Use Planning	2025	Sets out climate change allowances for rainfall, river flows and coastal flooding to be used in

Dataset	Year(s)	Description
		assessments. The guidance informs how projected climate change should be incorporated into exposure and design considerations for flood-related climate hazards.

20.5 CLIMATE CHANGE RISK ASSESSMENT STUDY AREA

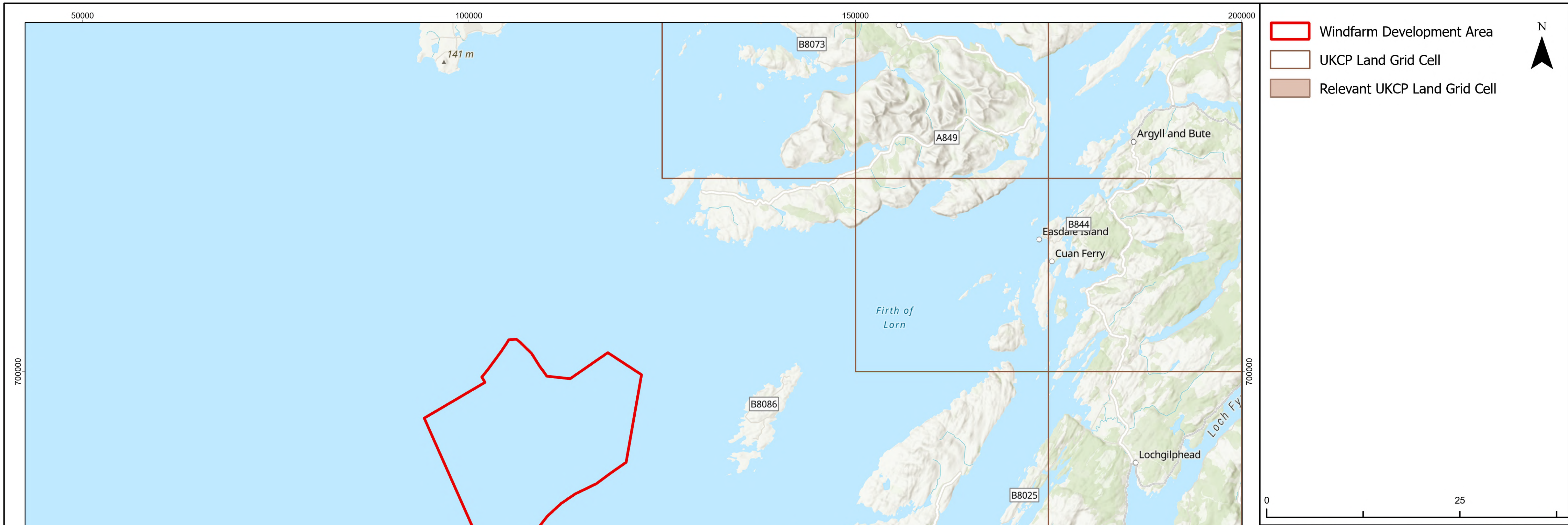
18. The spatial scope of the assessment reflects the current status of the Project design and consenting process. For the WDA, the application boundary is fixed, therefore the scope of the CCR assessment has been limited to evaluating the *Vulnerability* and resilience of the WDA and its *Receptors* to the effects of climate change. Therefore, the CCR assessment Study Area is geographically bounded and defined by the WDA.

19. The WDA CCR assessment has therefore been informed by location-specific climate projection data derived from the relevant UKCP18 grid cell closest to the WDA. The grid cells used for the UKCP18 land-based projections are shown in **Figure 20.1**. The grid cell is closest to Colonsay (Homefield) weather station, which increases the accuracy of the cell data. **Figure 20.2** shows the administrative region of West Scotland which has been used for wind projections.

20. The CCR assessment has been informed by historical observations and future projections for the climate variables. The spatial resolution of the baseline data collected for the CCR assessment has provided representative coverage of the WDA and the wider region of Eastern Scotland (Met Office, 2016). This supporting data can be found in **Appendix 20.1 Climate Projection Data**.

21. The temporal boundary of the CCR assessment will be defined by the phases of the WDA: construction, O&M and decommissioning:

- The construction period for the WDA is assumed to be up to 5 years, from 2030 to 2035.
- The operational lifetime is assumed to be up to 35 years, from 2035 to 2070. The design life will be dictated primarily by the equipment suppliers, such as the WTG suppliers, and will reflect market maturity and operational experience globally at the time of construction and during operations. At the end of the design life, any repowering will be subject to separate consents.
- The duration of the decommissioning period will depend on the WDA end-of-life strategy. For EIA purposes, this is assumed to be similar in duration to the construction period, that is up to 5 years, from 2070 to 2075.



1	28/11/2025	AB	GC	BF	PM
REV	REV DATE	GIS CREATOR	GIS REVIEWER	TECHNICAL CHECKER	TECHNICAL APPROVER

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DATUM	ETRS89	PROJECTION	UTM Zone 29N
SCALE	1:500,000	PAGE SIZE	A3
PROJECT TITLE	MachairWind		

Figure 20.1: UKCP Grid Cell used for Temperature and Precipitation Data for the Windfarm Development Area

Service Layer Credits: World Ocean Reference: Sources: Esri, TomTom, Garmin, GEBCO, National Geographic, NOAA, and the GIS User Community
World_Hillshade: Esri, CGIAR, N Robinson, NCEAS, USGS
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

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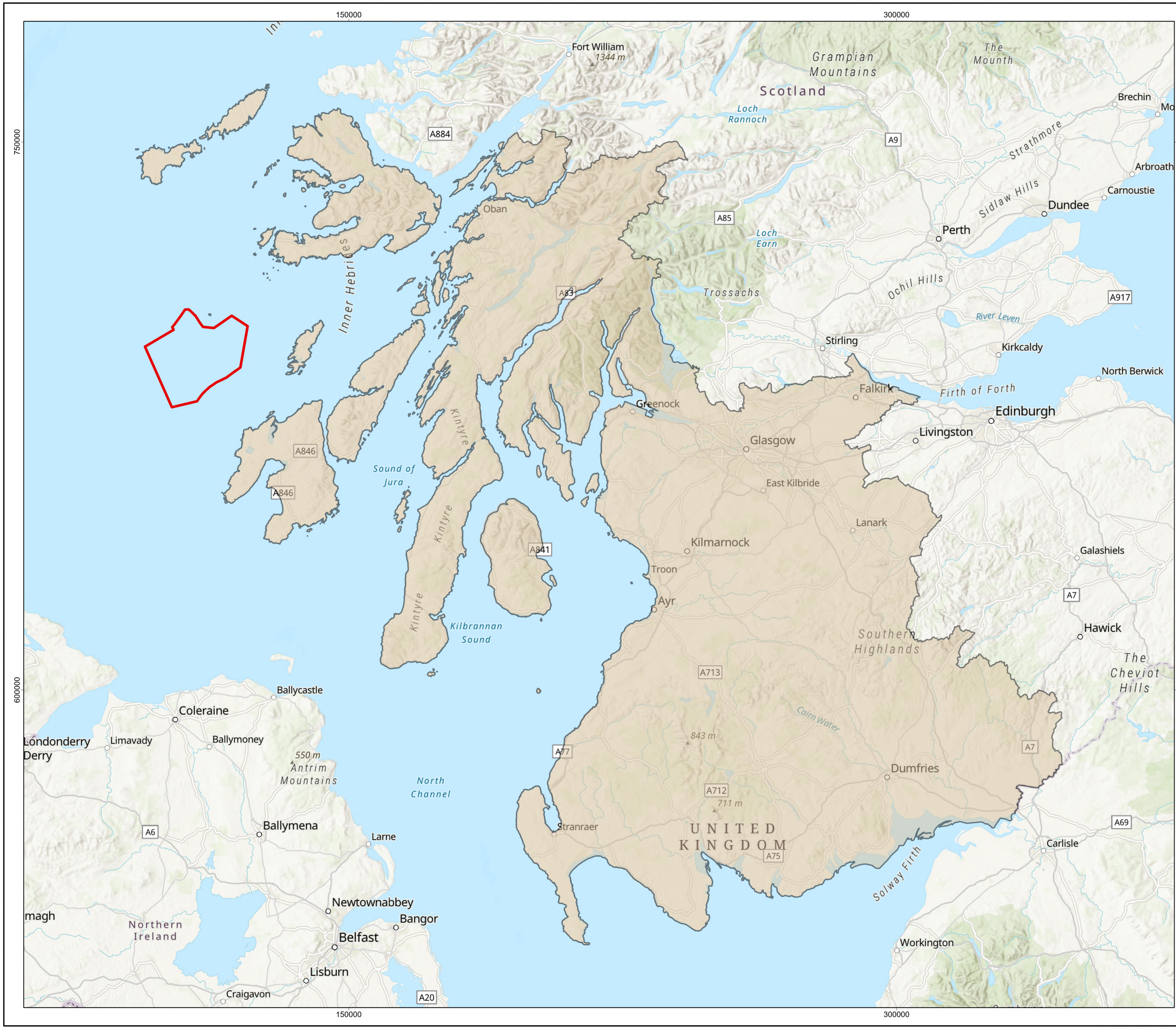
Haskoning Enhancing Society Together

ScottishPower Renewables

Project: C:\Users\304634\OneDrive - Royal HaskoningDHV\WIP\03 GIS\A02_Figures\03_EIA\01_WDA\Chap_20_ClimateChange\MCW_EIA_WDA_ClimateChange.aprx
Name: Fig_20-1_MCW-DWF-ENV-MAP-RHS-000098_UKCP



Windfarm Development Area

UKCP18 West Scotland

N

0 25 50 Kilometres

REV	REV DATE	GIS CREATOR	GIS REVIEWER	TECHNICAL CHECKER	TECHNICAL APPROVER
1	28/11/2025	AB	GC	BF	PM

DRAWING NUMBER	MCW-DWF-ENV-MAP-RHS-000099		
DATUM	ETRS89	PROJECTION	UTM Zone 29N
SCALE	1:1,000,000	PAGE SIZE	A3
PROJECT TITLE	MachairWind		

Figure 20.2: West Scotland admin region used for wind speed data for Windfarm Development Area

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Renewables

Project: C:\Users\304634\OneDrive - Royal HaskoningDHV\WIP\03 GIS\A02_Figures\03_EIA\01_WDA\Chap_20_ClimateChange\MCW_EIA_WDA_ClimateChange.aprx
Name: Fig_20-2_MCW-DWF-ENV-MAP-RHS-000099_AdminRegion

20.6 REALISTIC WORST-CASE SCENARIO

22. The final design of the WDA infrastructure will be confirmed during detailed design, which takes place post-consent. To undertake a robust and precautionary impact assessment, the realistic worst-case design scenario has been defined. The realistic worst-case scenario (i.e., those that would cause the greatest impact) is derived from the project design statement such that all other design scenarios would have equal or less impact. Please see **Chapter 5 EIA Methodology** for further details on the design envelope approach.

23. There is uncertainty surrounding the scale and rate of climate change due to the complex interactions between the various natural and human factors that influence the Earth's climate system. Predicting "worst-case" scenarios with respect to climate change impacts is challenging because of the variability in future greenhouse gas (GHG) emissions, socioeconomic developments and technological advancements. It is therefore difficult to pinpoint a single "worst-case" scenario, as the outcomes depend on a wide range of unpredictable variables. Guidance for climate change risk assessment recommends that a range of climate change scenarios are considered.

24. To provide a precautionary, but robust, evaluation to inform this CCR assessment, realistic worst-case scenarios have been defined in **Table 20.4** below. These are based on the Project design as described in **Chapter 3 Project Description** as well as the temporal scope defined in **Section 20.7.3**.

25. The realistic worst-case scenarios have been incorporated into Step 1, **Section 20.10.1**. Further details are in **Appendix 20.1 Climate Projection Data**.

26. The timeframes for the Construction, O&M, and Decommissioning phases of the WDA align with different climate periods. For the CCR assessment, realistic worst-case scenarios have been defined for each phase and the RCP scenario that is expected to be most relevant. More details about the RCP scenarios and the reasons for their selection are provided in **Appendix 20.1 Climate Projection Data**.

Table 20.4 Realistic worst-case scenario for impacts of climate change

Impact	Realistic Worst-Case Scenario	Rationale
Construction		
Climate change impacts from marine climate hazards during construction. Impacts on offshore human, WDA infrastructure and environmental receptors.	Construction phase: 2030 to 2035 (total construction duration of up to five years), which aligns with the climate period[2] of 2030s (2020 to 2039). The RCP4.5 is considered to provide a suitable representation of the expected climate conditions during the construction phase of the WDA infrastructure.	The most recent Met Office long-term climate averages extend to 1991-2020. Climate projection data are required to understand how those conditions are likely to change during construction compared to the baseline. RCP4.5 is often considered to be the realistic emissions pathway for 2030-2035 because it aligns most closely with observed emissions trends and current policy implementation. Global emissions have slowed but have not yet peaked, making low-emissions pathways like RCP2.6 implausible in the near term, while high-end scenarios like RCP8.5 overstate fossil-fuel growth. RCP4.5 represents

Impact	Realistic Worst-Case Scenario	Rationale
		a moderate mitigation trajectory consistent with announced policies and energy system transitions already underway, making it a credible "central" scenario for near-term climate impact and adaptation planning rather than a best-case or worst-case assumption.
Operation and Maintenance		
Climate change impacts from marine climate hazards during operation. Impacts on offshore human, WDA infrastructure and environmental receptors.	Commercial Operation start date: 2037 Operational life: 35 years Operation phase: 2035 to 2070, which aligns with the climate periods of 2040s (2030 to 2049) and 2060s (2050 to 2069) RCP scenario: RCP8.5 (very high emission scenario)	For the operational phase, the RCP8.5 scenario has been selected as the realistic worst-case scenario to provide a conservative assessment. RCP8.5 is more suited to the 2035-2070 period because scenario divergence becomes larger after the early 2030s, when long-term policy success or failure begins to influence climate outcomes. While RCP8.5 is not considered the most likely pathway, it coherently represents the upper bound of plausible climate risk associated with sustained mitigation failure, accumulated fossil-fuel lock-in, and delayed emissions reductions. For mid-century planning – particularly where systems face thresholds, non-linear impacts, or long asset lifetimes – RCP8.5 provides a necessary high-impact stress-test that cannot be captured by intermediate scenarios alone.
Decommissioning		
Climate change impacts from marine climate hazards during decommissioning. Impacts on offshore human, WDA infrastructure and environmental receptors.	Details of the decommissioning of the WDA infrastructure will be included in the Decommissioning Programme for the WDA. It is recognised that legislation and industry best practices change over time, and the Decommissioning Programme will consider good industry practice, guidance and legislation for decommissioning works which includes anticipated costs and financial securities. It is also likely that the WDA infrastructure would be removed and reused or recycled where practicable. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning. Further details on decommissioning are provided in **Chapter 3 Project Description**. For the purpose of the CCR assessment, the decommissioning phase is assumed to start at the end of the operational lifetime of the WDA and last for a similar duration as the Construction phase. This aligns with the climate period of 2070s (2070 to 2089). The RCP8.5 scenario has been selected as	

Impact	Realistic Worst-Case Scenario	Rationale
	the realistic worst-case scenario to provide a conservative assessment, for similar reasons to the O&M phase (as described above).	
Notes: [2] Climate change projection data are provided as a time series in 20-year time slices – see **Section 20.7.3** or details of the temporal resolution of climate data.		

20.7 EXISTING ENVIRONMENT

20.7.1 Existing Baseline

27. The WDA is located offshore in Scottish waters, to the northwest of Islay and west of Colonsay. The WDA lies approximately 12.4 km from the nearest island landmass. The WDA covers approximately 448 km².

28. The existing baseline for the CCR assessment is the representative present-day climate conditions within the WDA and the wider region of western Scotland.

29. The most recent Met Office long-term climate averages cover 1991–2020. This data is used to characterise the present-day climate conditions. Climate projection data are required to understand how those conditions are likely to change during the construction, O&M and decommissioning phases. This approach enables future climate risks to be assessed relative to a well-defined current baseline.

30. The current climate of the wider region encompassing the WDA has been characterised using published regional and national climate information. This includes Met Office regional climate summaries for Scotland, which present observed climate conditions using standard 30-year averaging periods, and evidence from Scotland's Marine Assessment 2020 (Moffat et al., 2020), which provides information on Scotland's marine climate and prevailing meteorological and oceanographic conditions.

20.7.1.1 Western Scotland

31. Western Scotland experiences a maritime climate, resulting in relatively mild temperatures throughout the year compared with eastern and inland parts of the UK. Mean annual temperatures are typically 9.5–9.9 °C in coastal locations, decreasing to 8.0–9.4 °C inland and at higher elevations, reflecting the influence of altitude and reduced maritime moderation.

32. The coldest month varies spatially across the region. In inland areas, where marine influence is weaker, January is generally the coldest month, with mean daily minimum temperatures typically ranging from −3 to 0 °C. In the coastal zones and islands February is often coldest, as sea temperatures lag behind winter air cooling, with mean minima of 1–2 °C.

33. The warmest months are July and August, during which mean daily maximum temperatures range from less than 15 °C over high ground to more than 19 °C in lower-lying inland areas, such as the Clyde Valley and southern Dumfries and Galloway.

34. Temperature extremes are uncommon due to maritime moderation; however, exceptional cold events have occurred, including minimum temperatures of −24.8 °C recorded at Carnwath in January 1982. Conversely, extreme high temperatures are rare but may exceed 30 °C during short-lived continental heat events, with recorded maxima above 32 °C in parts of southern Scotland.

35. Prolonged heatwaves are rare due to sustained maritime influence. Elevated temperatures typically occur only during short-lived episodes of continental airflow, which can temporarily suppress cloud cover and increase daytime maximum temperatures.

36. The region is among the wettest regions of the UK, reflecting exposure to Atlantic weather systems and significant orographic enhancement. Average annual rainfall totals range from less than 1,000 mm in low-lying coastal and inland areas to over 3,500 mm across the higher ground of the western Highlands, with rainfall distribution closely linked to topography.

37. Rainfall occurs throughout the year but displays a clear seasonal pattern, with autumn and early winter (October to January) typically representing the wettest period. Spring and early summer (April to June) are generally the driest months, although rainfall levels remain higher than those observed in eastern parts of the UK.

38. The frequency of wet days broadly mirrors rainfall totals. Coastal areas generally experience around 45 days per season with measurable rainfall (>1 mm) during autumn and winter, increasing to over 55 days per season in upland locations. Spring and summer typically have fewer wet days.

39. Air frost occurs regularly, with notable spatial variation. Typical annual air-frost frequencies range from fewer than 25 days per year on the Hebridean islands to approximately 40 days along mainland coasts, increasing to over 80 days per year in inland upland areas and elevated valleys.

40. Ground frost is more widespread and frequent than air frost, ranging from less than 60 days per year in coastal locations to in excess of 140 days per year across higher ground. Ground frost may occur at any time of year, particularly in sheltered inland locations.

41. Snowfall is closely linked to temperature and elevation, with snow primarily occurring between November and April. Low-lying coastal areas generally experience fewer than 20 days of snowfall per winter, while upland areas of the western Highlands may experience more than 60 snowfall days annually.

42. Lying snow is uncommon at sea level, averaging fewer than five days per year along coasts and on the islands. In contrast, higher elevation areas frequently experience more than 30 days with lying snow, with prolonged snow cover possible during severe winters.

43. Western Scotland is one of the most wind-exposed regions of the UK due to its proximity to the Atlantic Ocean. Mean wind speeds and peak gusts are highest between November and March, associated with Atlantic depressions. June to August generally experience the lowest average wind speeds.

44. The frequency of gales shows strong spatial variation, with around five gale days per year in sheltered inland areas, increasing to more than 25 days per year in exposed coastal, island and upland locations, where strong winds can occasionally result in transport disruption and infrastructure impacts.

45. Sea fog may occur intermittently in coastal and near-shore areas, particularly during spring and early summer when relatively warm air passes over cooler sea surfaces. However, persistent fog is less common than along the east coast due to generally higher wind speeds.

46. Met Office UK Climate Averages (Met Office, 2026) are only available for onshore meteorological sites because the weather stations used for data are land-based and therefore do not provide direct coverage of the WDA. Existing historic climate data for the period 1991 to 2020 has been obtained from the Colonsay (Homefield) meteorological recording station, which is the closest recording station to the WDA and is considered to provide an appropriate representation of the temperature

anomaly, precipitation anomaly and wind speed anomaly for the WDA. Climate data for station Colonsay (Homefield), West Scotland, Scotland and the UK are provided in **Table 20.5** (Met Office, 2022b).

Table 20.5 Existing local, regional and national climate for the 1991 to 2020 period

Climate Variable	Units	Annual Average			
		Station: Colonsay (Homefield)	District: Scotland W	Region: Scotland	UK
Maximum temperature	°C	12.48	11.65	11.07	12.79
Minimum temperature	°C	7.09	5.02	4.41	5.53
Days of air frost	Days	13.48	57.58	71.70	53.38
Sunshine	Hours	1436.89	1240.71	1199.63	1402.61
Rainfall	mm	1207.50	1817.58	1572.66	1162.68
Days of rainfall ≥ 1	Days	194.97	196.86	191.28	159.08
Monthly mean wind speed at 10m	Knots	-	10.6	10.76	9.27
Monthly mean wind speed at 10m	m/s	-	5.45	5.54	4.77

47. The climate data presented above shows that the temperatures at the WDA are marginally higher than they are across western Scotland. The rainfall in the region is also slightly lower than the western Scotland averages, despite a similar number of wet days. These variations are consistent with expectations for a low-lying Hebridean island and show a distinct local climatic regime relative to the wider West Scotland and Scotland district and regional averages.

20.7.2 Predicted Future Baseline

48. Representative concentration pathways (RCP) and shared socioeconomic pathways (SSP) are defined by the Intergovernmental Panel on Climate Change (IPCC, 2023). They represent the different possible trajectories of GHG atmospheric concentrations for the next 100 years. Each pathway includes assumptions about future human behaviour and policy decisions (IPCC, 2023). **Appendix 20.1 Climate Projection Data** provides further explanation of the RCP and SSP scenarios relevant to the CCR assessment and data for multiple RCP scenarios, showcasing the differences in these trajectories and their impact on the climate variables.

49. Marine Climate Change Impacts Partnership (2020) identifies continued warming, sea level rise, increased flood risk from compound coastal and rainfall events, and heightened exposure to extreme waves and storms as key climate change trends affecting Western Scotland and its islands. These changes are expected to intensify throughout the 21st century and have significant implications for low-lying coastal environments, infrastructure and ecosystems.

50. Climate change projection data from the Met Office's UKCP18 database is used to characterise the predicted future baseline within the WDA. Where information gaps exist in the UKCP18 data, these are supplemented with other available literature sources. This data is presented in **Appendix 20.1 Climate Projection Data**.

51. The Met Office's UKCP18 database provides probabilistic climate change projections for the UK at a spatial resolution of 25 km grid squares, for the time period of 1961 to 2100. Probabilistic projections are based on possible changes in future climate based on an assessment of climate model uncertainties and are most suitable for characterising future extremes in risk assessments, as they provide the broadest range of potential climate outcomes.

52. The UKCP18 grid cells closest to the WDA were used to obtain the relevant climate change projection data to represent the spatial scope of predicted future climate conditions within the WDA. The grid cells used for the UKCP18 land-based projections are shown in **Figure 20.1**. The grid cell used for the UKCP18 wind projections is shown in **Figure 20.2**. The cell used also has closest proximity to the Colonsay (Homefield) weather station, thereby increasing the accuracy of the cell data, thereby making it most appropriate.

53. The majority of the UKCP18 probabilistic projections are land-based and therefore do not provide direct coverage of the WDA. The land-based projection data for the grid cells closest to the WDA shows limited spatial variation, so is considered to provide an appropriate representation of the temperature anomaly and precipitation anomaly for the WDA.

54. Future climate projections are modelled projections and are strongly dependent on future global GHG emissions. Uncertainties associated with these projections are detailed in **Table 20.6**. For some climate variables, projections are only available for standard future time horizons (often up to 2100), rather than for the specific assessment periods required by the Project.

55. Long-term climate change projections for Scotland indicate that average temperatures will continue to rise across all seasons, with a corresponding reduction in frost frequency and snowfall. While Scotland's climate will remain variable, evidence suggests that overall variability is likely to increase, with greater contrasts between seasons and more frequent extreme weather events. Typical summers are expected to become warmer and, on average, drier, although periods of intense rainfall are projected to occur more frequently. In contrast, winters are anticipated to be milder and wetter overall, with an increase in total rainfall and a higher likelihood of heavy rainfall events. However, the increasing variability may also result in an increasing frequency of extreme cold weather events and icy conditions. Sea levels around the Scottish coastline are projected to rise throughout the 21st century, increasing long-term risks associated with coastal flooding and erosion, particularly for low-lying and exposed coastal locations.

20.7.2.1 Temperature, Precipitation, Wind

56. Changes in the annual average temperature and precipitation rate anomalies compared to the 1981-2000 baseline are presented for the WDA in **Appendix 20.1 Climate Projection Data**. The scenarios RCP4.5 (intermediate emissions scenario) and RCP8.5 (very high emissions scenario) are included (Met Office, 2022). These scenarios are considered the most likely to occur during the construction, O&M, and decommissioning phases of the Project and present a range of outcomes.

57. Projected changes in temperature and rainfall are modelled with a high confidence by the global climate change models that are the basis for the UKCP18 data. Other climate parameters considered in the CCR assessment such as wind speed have more uncertainty.

58. Climate projections indicate that the WDA is likely to experience a clear warming trend during the period from the mid-2030s to around 2070 under both the RCP4.5 and RCP8.5 scenarios. Median projections indicate that annual mean air temperatures increase by approximately 0.8°C under RCP4.5 and around 1.0°C under RCP8.5 during the 2030–2049 period. The projected increase rises to approximately 1.1°C and 1.6°C for RCP4.5 and RCP8.5 respectively by 2050–2069, relative to the historical baseline. Warming is evident across all percentiles and seasons, indicating a high level

of confidence in this direction of change, with temperature increases consistently greater under the higher-emissions RCP8.5 scenario.

59. By the 2050s and 2060s, upper-end (90th percentile) projections indicate that annual mean temperatures within the WDA could increase by up to approximately 1.9°C under RCP4.5 and by up to approximately 2.5°C under RCP8.5. Seasonal temperature changes broadly follow this pattern, with projected increases in both summer maximum and winter minimum temperatures across all time slices assessed. These changes indicate progressively warmer conditions through time, particularly under the higher-emissions scenario.

60. Summer maximum temperatures are projected to increase over the assessment period. Median projections indicate increases of approximately 0.6°C under RCP4.5 and 0.8°C under RCP8.5 during the 2030–2049 period. The projected increase rises to approximately 0.9°C and 1.5°C for RCP4.5 and RCP8.5 respectively by 2050-2069. Although lower-end (10th percentile) projections in the earlier time slice suggest more limited change in some model realisations, by the 2050s and 2060s summer temperatures consistently show warming under both scenarios. Winter minimum temperatures show a clearer and more pronounced increase, with median increases of approximately 1.3°C under RCP4.5 and 1.8°C under RCP8.5 by 2050–2069, indicating milder winter conditions.

61. Changes in precipitation are more variable than those projected for temperature. Annual mean precipitation is projected to increase on average under both RCP4.5 and RCP8.5 across the assessment period. The range of outcomes also includes small decreases and notable increases. Median projections indicate annual precipitation increases of around 7% by 2030–2049 under both scenarios, rising to approximately 7% under RCP4.5 and approximately 9% under RCP8.5 by 2050-2069. Upper-end projections indicate the potential for annual precipitation increases of up to approximately 18% and 22% for RCP4.5 and RCP8.5 respectively by the 2050s and 2060s.

62. Seasonal changes in precipitation show a contrasting pattern between summer and winter. Summer precipitation is projected to decrease under both scenarios, with median reductions of approximately 2–3% by 2030–2049 and larger decreases of approximately 6% under RCP4.5 and 8% under RCP8.5 by 2050–2069. In contrast, winter precipitation is projected to increase across the assessment period, with median increases of approximately 12–14% during the 2030–2049 period and approximately 13–18% by 2050–2069. Upper-end projections indicate winter precipitation increases of up to approximately 34% under RCP4.5 and 44% under RCP8.5, with winter wetting consistently stronger under the higher-emissions scenario.

20.7.2.2 Marine Climate Projections – Sea Level Rise, Storm Surge and Coastal Erosion

63. While no long-term tide gauge is located directly on Colonsay, regional sea-level rise projections for western Scotland and the Inner Hebrides are considered applicable to the Study Area. Relative sea level around the west coast of Scotland, including the Inner Hebrides, is currently rising and is projected to continue to rise throughout the 21st century. Although post-glacial land uplift is still occurring in parts of Scotland, the rate of uplift is now exceeded by global mean sea-level rise, resulting in a net increase in relative sea level across all Scottish coastlines, including island communities such as Colonsay. UKCP18 indicates that relative sea level around Scotland is projected to rise by approximately 0.3–0.6 m by 2100 under lower emissions pathways, increasing to approximately 0.6–1.0 m by 2100 under higher emissions scenarios. Higher-end (90th percentile) projections indicate the potential for greater sea-level rise where more rapid Antarctic ice-sheet mass loss is assumed, although these represent less likely but higher-impact outcomes (Scottish Government, 2023).

64. Storm surge is recognised as a key coastal flooding risk for western Scotland, particularly when occurring in combination with rising mean sea levels and high spring tides. Scottish Government and SEPA guidance identifies that, as baseline sea levels continue to rise, the magnitude of storm surge is expected to increase over time, even in the absence of an increase in storm frequency. Outer and Inner Hebridean islands, including Colonsay, are exposed to Atlantic weather systems, which can generate elevated coastal water levels, wave action and surge effects, particularly during winter storm events. The National Flood Resilience Strategy identifies island communities as being more exposed to compound coastal flooding mechanisms, where storm surge coincides with high tidal conditions and energetic wave climates. While site-specific storm surge datasets for Colonsay are limited, regional coastal flood risk mapping and national policy assessments treat island coastlines in Argyll and Bute as susceptible to an increasing likelihood and severity of coastal flooding over the course of the 21st century. This increase in flood risk is projected to be more pronounced under higher greenhouse gas emissions scenarios, reflecting the combined influence of sea-level rise and storm-driven coastal processes.

65. Dynamic Coast mapping confirms that soft and mixed sediment coastlines in western Scotland are already experiencing erosion, with erosion rates increasing since the mid-20th century. Scotland-wide analysis shows that coastal erosion has increased by approximately 39% since the 1970s, with future rates expected to accelerate under climate change (Rennie et al., 2021). Under the high emissions scenario RCP8.5, projections indicate that up to 75% of Scotland's soft coastline could be eroding by 2050 (Rennie et al., 2021), with further increases by 2100. This includes island coastlines similar in exposure and geomorphology to those found on Colonsay.

20.7.3 Data Limitations and Assumptions

66. The assumptions made in the CCR assessment are set out in **Table 20.6.**

Table 20.6 Data limitations and assumptions

Assumption/Limitation	Further Detail/Discussion
Climate change projections	A key assumption of the climate change projection data from UKCP18 is that the model is strongly dependent on the future global GHG atmospheric concentrations and emission trajectories. The RCP scenarios considered by UKCP18 (refer to **Table 20.8** and **Appendix 20.1 Climate Projection Data**) cover a recent set of assumptions based upon future population dynamics, economic development, and account for international targets on reducing GHG emissions. Each RCP scenario has a different climate outcome, given that they are based upon a different set of assumptions. Noting that the UKCP18 guidance cautions against reliably placing probabilities on which scenario of GHG emissions is most likely, two RCP scenarios (RCP4.5 and RCP8.5) have been selected due to their relevance in presenting a range of possible outcomes over the operation and decommissioning phases of the WDA. Due to the intrinsic uncertainty within climate change projection data, the UKCP18 data is based upon probabilistic projections, generating a normally distributed model per output. The model outputs values for the 10^{th}, 50^{th} and 90^{th} percentiles, which represents the range of uncertainty, and is therefore presented in this CCR assessment. In addition, UKCP18 data do not cover all climate variables which may be relevant to the WDA. Where information gaps exist, these are supplemented with other available literature sources, and it is considered that sufficient information is available upon which to base the assessment of the WDA's vulnerability to climate change.

Assumption/Limitation	Further Detail/Discussion
Spatial resolution of the climate baseline	Climate change projection data are provided for defined grid cells in the UKCP18 database. The size of the grid cell determines the spatial resolution of the projection data and how it corresponds to the WDA. It is considered that the climate baseline across the WDA is adequately described by the selected grid cell. It should be noted that limited quantitative climate data is available for offshore locations and therefore the most appropriate onshore data has been used. The selected grid cell is within reasonable proximity of the WDA and also the one closest to the Colonsay (Homefield) weather station, which is the closest weather station to the WDA, thereby increasing the accuracy of the data. The grid cells used for the UKCP18 land-based projections are shown in **Figure 20.1**. The grid cell used for the UKCP18 wind projections is shown in **Figure 20.2**.
Temporal resolution of the climate baseline	Climate change projection data are provided as a time series. For the purpose of the CCR assessment, the data is summarised, and average values are presented by 20-year time slices, which are selected based on the development phase, as set out in **Table 20.4**. It is considered that these time slices are representative of current and future conditions within the WDA and provide sufficient temporal coverage. Three different temporal scales are considered – Construction (Short Term / 2030s / 2020 - 2039), Operation (Medium Term / 2040s / 2030 - 2049 and 2050s / 2050 - 2069) and Decommissioning phases (Long Term / 2070s / 2070 - 2089).

20.8 EMBEDDED MITIGATION

67. **Table 20.7** outlines the embedded mitigation relevant to the CCR assessment. Where additional mitigation measures are proposed, these are detailed in the impact assessment.

Table 20.7 Embedded mitigation measures relevant to climate change risks

ID	Embedded Mitigation Measure(s)	Mitigation Type	Securing Mechanism
M-1	Use of scour protection	Regular and periodic inspections and maintenance of all components of the WDA infrastructure will be undertaken over the operational lifetime to identify and remediate any damage and deterioration and maintain good working conditions. These will be included in the O&M Programme. Monitoring of site-specific weather and metocean conditions, recent extreme weather events and up-to-date climate change projection data will be undertaken to provide a dynamic risk assessment of climate change impacts and inform O&M planning. *Relevance* Mitigates the risks of climate change impacts on the conditions and performance of the WDA infrastructure and enables it to adapt to future climate conditions and remains resilient over its operational lifetime. The O&M strategy will be adaptive, with the frequency of maintenance, repair and replacement activities being adjusted based on need (i.e.	Section 36 and marine licence consent conditions. Secured via the requirement for a Development Specification and Layout Plan, which will be submitted to Scottish Ministers for approval prior to the commencement of construction.

ID	Embedded Mitigation Measure(s)	Mitigation Type	Securing Mechanism
		increasing planned O&M visits for components with higher deterioration rates than anticipated).	
M-15	Wind Turbine Generator Selection	The Design Specification and Layout Plan of offshore windfarms and associated occupational health and safety requirements provide an inherent degree of climate change readiness and resilience. The CCR assessment accounts for the technical requirements of the WDA infrastructure, design specifications and operational strategy which are built upon best practice engineering codes and standards in the offshore wind sector, and standard health and safety procedures outlined in relevant management plans. Where likely significant effects are predicted, additional mitigation will be identified from available literature sources and in collaboration with the engineering team to support the resilience of the WDA infrastructure to impacts arising from current extreme weather events and prevailing climatic conditions. Recognising uncertainties associated with longer-term climate change projections and their implications for the WDA, adaptive management measures will also be reviewed in line with IEMA guidance (2020) to support the implementation of mitigation where and when appropriate. *Relevance* Confirms that climate change resilience is built into the design from the outset to mitigate the risk of climate change impacts on the conditions and performance of the WDA infrastructure during the operational lifetime.	Section 36 and marine licence consent conditions. Secured via the requirement for a Design Specification and Layout Plan, which will be submitted to Scottish Ministers for approval prior to the commencement of construction.
M-27	Emergency Response and Cooperation Plan	Development of, and adherence to, an Emergency Response Cooperation Plan (ERCoP) for each development phase**.** Emergency response protocols will be implemented in accordance with the ERCoP to enable fast recovery and continuity of offshore activities following emergency incidents. The protocol will also provide for the timely mobilisation of rescue and medical services for offshore personnel. *Relevance* The plan will detail protocols that would be undertaken in the event of an emergency, including occupational health and safety, and set out clear roles and responsibilities, emergency contacts and reporting and escalation pathways. Protocols for certain extreme weather events will also be included. Mitigates the risk of climate change impacts on construction site personnel, plant and equipment and other assets and the risk of delays to the Construction programme due to extreme weather events, which are becoming more frequent and intense due to climate change.	Section 36 and marine licence consent conditions. Secured via an Emergency Response and Cooperation Plan which will be developed and submitted prior to construction.

ID	Embedded Mitigation Measure(s)	Mitigation Type	Securing Mechanism
		Supports the implementation of response protocols in the event of emergencies for offshore activities.	
M-32	Vessel Management Plan	The Applicant will ensure compliance with the Maritime and Coastguard Agency's MGN 654 (M+F) Offshore Renewable Energy Installations (OREI) safety response (MCA, 2021) and its annexes, where applicable, including the completion of an ERCoP for each development phase and Search and Rescue (SAR) Checklist in consultation with the MCA. *Relevance* Supports the implementation of emergency response protocols in the event of emergencies associated with offshore activities.	Section 36 and marine licence consent conditions. Secured via **Appendix 13 Outline Vessel Management Plan and NSP**.
M-46	Decommissioning Programme	A Decommissioning Programme will be developed. *Relevance* Similar climate change resilience measures adopted for construction activities will be included in the Decommissioning Programme to be developed prior to the commencement of decommissioning activities. A review of site-specific weather and metocean conditions, recent extreme weather events, and up-to-date climate change projection data will be undertaken to inform risk assessments., health and safety protocols and guidelines on safe working practices are suitable for future climate conditions at the time of O&M and decommissioning works. The Decommissioning Programme will be refreshed prior to decommissioning activities commencing. Mitigates the risk of climate change impacts on decommissioning site personnel, plant and equipment and other assets and the risk of delays to the decommissioning programme due to extreme weather events, which are becoming more frequent and intense due to climate change.	Section 36 and marine licence consent conditions. Secured via a Decommissioning Programme, which will be developed and submitted to Scottish Ministers for approval before commencement of construction.
M-47	Construction Method Statement	Development of, and adherence to, a Construction Method Statement (CMS), to set out good working practices during construction. This will include a clear outline of roles and responsibilities and reference to health and safety protocols. The CMS will outline how the Construction programme is adaptable to adverse weather. *Relevance* The CMS will provide a clear outline of roles and responsibilities and reference to health and safety protocols so that occupational health and safety standards are maintained under future climate conditions during construction. While health and safety standards are not included under the consent plans, the CMS (and other consent plans as	Section 36 and marine licence consent conditions. Secured via a CMS, which will be developed and submitted to Scottish Ministers for approval before commencement of construction.

ID	Embedded Mitigation Measure(s)	Mitigation Type	Securing Mechanism
		appropriate) will set out where such information is available. This may include measures such as: • Monitoring of site weather and metocean conditions and severe weather alert services, including the Met Office and SEPA for extreme weather warnings; • Construction activities to be scheduled considering seasonality and short to medium range weather and metocean forecasts from the Met Office or other approved providers; • Specific to storms, measures may include designating safe shelter for personnel on board vessels, securing loose equipment and stored materials during periods of high winds and waves and determining safe limits for working conditions above which vessel activities and crane and rig operations would be halted; and • Risk assessments, health and safety protocols, and guidelines on safe working practices will take into account site-specific weather and metocean conditions, including the potential for relevant extreme weather events during construction, to make sure that appropriate preparation and response measures are in place. Mitigates the risk of climate change impacts on construction site personnel, plant and equipment and other assets and the risk of delays to the Construction programme due to extreme weather events, which are becoming more frequent and intense due to climate change. Supports the implementation of emergency response protocols in the event of emergencies associated with offshore activities.	

20.9 APPROACH TO ASSESSMENT

20.9.1 Impact Assessment Methodology

68. The methodology adopted for the CCR assessment is informed by IEMA's "Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation" (2020). As the CCR assessment considers climate change impacts on the WDA infrastructure, as opposed to the impacts of the WDA infrastructure on other receptors, the assessment methodology differs from the general EIA approach presented in **Chapter 5 EIA Methodology**.

69. A three-step methodology has been adopted for the CCR assessment in line with industry good practice for assessments of climate change risks particularly IEMA's "Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation". First, relevant future climate hazards are identified using historic climate data and climate change projections, and the *Exposure* of the WDA is assessed for the construction, O&M and decommissioning phases. Second, the *Vulnerability* of project *Receptors* is evaluated by considering their *Sensitivity* to climate *Hazards* and their *Adaptive Capacity*, taking account of embedded design and management measures. Finally, *Exposure* and *Vulnerability* are combined to determine the climate-related *Risks* and to confirm whether additional adaptation measures are required. The step-by-step approach undertaken for the CCR assessment is set out below in **Plate 20.1** and **Sections 20.9.1.1** to **Section 20.9.1.3**.

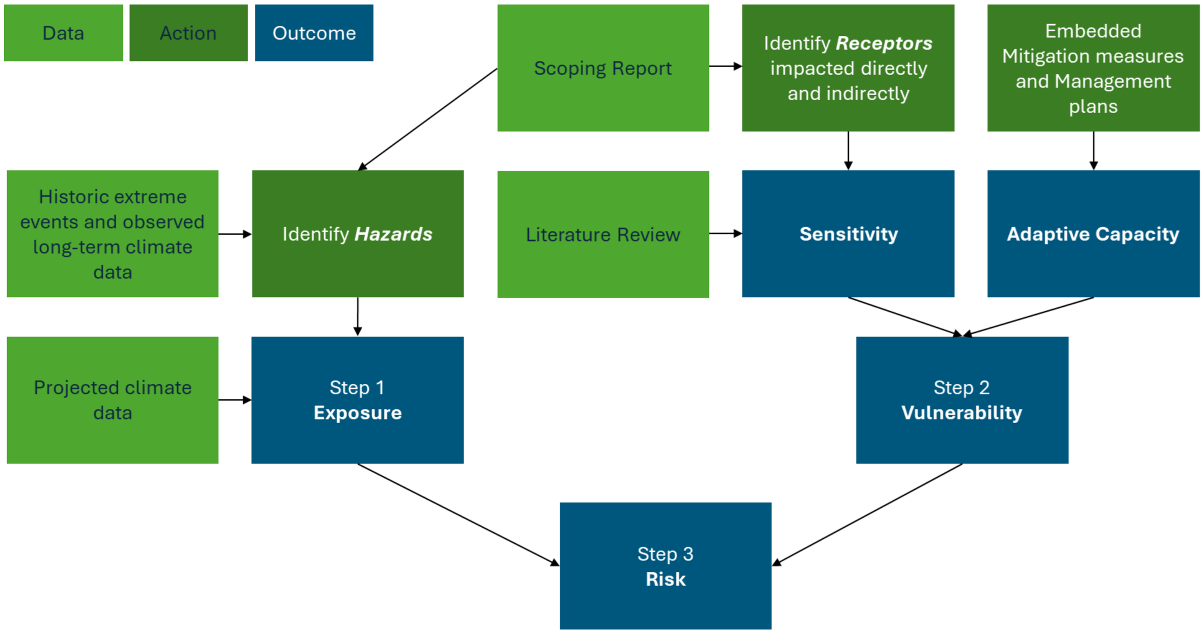

Plate 20.1 Three-step CCR Assessment Methodology

20.9.1.1 Step 1 – Hazard and Exposure Assessment

70. Step 1 establishes the climate change *Hazards* that are relevant to the Project and how exposed the Project is to those hazards over its lifetime. It provides the evidence base upon which *Vulnerability*, risk and mitigation are subsequently assessed. This includes the climate *Hazards* selected in Section 19.6.7.1 of the **WDA Scoping Report**, as well as drawing on historic climate conditions and future projections.

71. An existing-environment baseline is defined using long-term historic observed climate data and information about extreme weather events. This baseline represents current conditions against which future climate change is assessed.

72. Future climate conditions are assessed using UKCP18 climate projections for multiple emissions scenarios/pathways. These projections are assessed over time horizons aligned with the phases of the WDA infrastructure - Construction (short term), Operation (medium term) and Decommissioning (long term). The climate projections relevant to the WDA have been presented in **Appendix 20.1 Climate Projection Data**.

73. The entire Project is assumed to be exposed to climate change. *Exposure* ratings vary by hazard, project phase and climate scenario.

74. *Hazard Exposure* is rated Low, Medium or High using the criteria in **Table 20.8**, which consider projected changes in Temperature anomalies, Precipitation changes, Wind speed and Sea level rise (where applicable).

Table 20.8 Criteria for exposure rating

Exposure Rating	Criteria
High Exposure	Hazard is almost certain to occur numerous times/several occasions during the design lifetime of the Project.
Medium Exposure	Hazard is likely to occur on limited occasions during the design lifetime of the Project.
Low Exposure	Hazards are likely to occur infrequently or unlikely to occur during the design lifetime of the Project.

75. The outcome of Step 1 includes a list of relevant climate change *Hazards* for the Project, *Exposure* ratings for each *Hazard* across the construction, O&M and decommissioning phases and identification of realistic worst-case exposure scenarios, which are then carried forward into Step 2 (*Vulnerability Assessment*) and Step 3 (*Risk Assessment*).

20.9.1.2 Step 2 –Vulnerability Assessment

76. Step 2 of the methodology is the *Vulnerability Assessment*. The purpose of this step is to evaluate how susceptible the Projects' *Receptors* are to harm from the climate *Hazards* identified in Step 1, taking into account both their *Sensitivity* to climate impacts and their *Adaptive Capacity* to cope with or respond to those impacts. This step builds directly on the *Hazard* and *Exposure* Assessment and provides the basis for determining overall climate risk in Step 3.

77. *Receptors* have been identified for all Project phases – construction, O&M and decommissioning. The same *Receptor* may be affected differently by different climate *Hazards* and at different stages of the Project lifecycle. These include:

- **Human receptors**, such as offshore and onshore personnel;
- **Temporary infrastructure**, including construction compounds, marine vessels, plant and equipment;
- **Permanent infrastructure**, including wind turbines, offshore platforms, subsea cables, landfall infrastructure, onshore cables, link boxes and the onshore substation; and
- **Operational activities and asset performance**, including access, maintenance and service continuity.

78. A *Sensitivity* assessment has been undertaken for each ***Hazard–Receptor* combination**. *Sensitivity* considers:

- The potential severity of damage or degradation;
- The likelihood of disruption to activities or performance;
- Health and safety implications for personnel;
- The potential duration and reversibility of impacts; and
- The influence of Project phase and asset condition (e.g. ageing infrastructure).

79. The same receptor may have different *Sensitivity* ratings for different hazards or Project phases. *Sensitivity* has been rated using defined qualitative criteria and classified **as Low, Medium or High**. The criteria for the *Sensitivity* Rating are presented in **Table 20.9**.

Table 20.9 Criteria for sensitivity rating

Sensitivity Rating	Criteria
High Sensitivity	Hazard impacts on Receptor can lead to major or permanent damage causing prolonged (higher than 1 day) disruptions, reduced performance, significant costs, and serious or irreversible health and safety risks.
Medium Sensitivity	Hazard impacts on Receptor may cause moderate but recoverable damage to infrastructure and assets, or deterioration of infrastructure and assets, leading to temporary disruptions, manageable cost implications, and health and safety risks that are generally limited in severity and duration.
Low Sensitivity	Hazard impacts on Receptor may result in minor to negligible localized damage to infrastructure and assets, causing limited disruptions, minimal cost implications, and low health and safety risks.

80. The *Adaptive Capacity* assessment considers:

- The extent to which climate-resilient design features have been incorporated into the WDA infrastructure;
- The presence of embedded mitigation measures and management plans;
- Operational procedures, emergency response protocols and monitoring systems; and
- The ease with which additional measures could be implemented if required.

81. Embedded mitigation measures from **Appendix 5 WDA Mitigation and Commitments Register** and associated management plans (industry standard) have been taken into account. These measures enhance the WDA infrastructure's ability to withstand and respond to climate *Hazards* and are reflected in higher *Adaptive Capacity* ratings where appropriate. The applicability of the relevant embedded mitigation measure is presented in **Section 20.8** of this report.

82. *Adaptive Capacity* has been rated as **Low, Medium or High** for each *Hazard–Receptor* pairing. The criteria for the *Adaptive Capacity* rating is presented in **Table 20.10**.

Table 20.10 Criteria for adaptive capacity

Rating	Qualitative Description	Key Indicators
Low Adaptive Capacity	Systems or activities lack resilience, use outdated or vulnerable materials, and have limited access to climate-resilient technologies. Implementation of solutions is difficult or reactive.	• Minimal or no use of resilient materials. • Non-standard or improvised practices. • Poor access to tools, parts, or skilled labour. • No formal emergency plans or training. • High reliance on external support during crises.
Medium Adaptive Capacity	Some resilience measures are in place but may rely on partially available materials or less standardized practices. Existing practices are moderately easy to implement but may face delays or limitations during extreme events.	• Partial use of resilient materials or retrofitting. • Some adherence to industry standards. • Limited access to spare parts or tools. • Emergency response plans exist but may lack resources. • Moderate training and logistical support.
High Adaptive Capacity	Systems or activities are highly resilient, using industry-standard practices and easily accessible, climate-resilient materials and technologies. Solutions are well-integrated, easy to implement, and regularly maintained.	• Use of climate-resilient design and materials (e.g., elevated platforms, corrosion-resistant components). • Standardized construction, operation, and demolition protocols. • Reliable access to replacement parts and skilled labour.

Rating	Qualitative Description	Key Indicators
		• Redundant systems and remote monitoring. • Clear SOPs and trained local teams.

83. *Vulnerability* is determined by combining the *Sensitivity* and *Adaptive Capacity* ratings for each *Hazard-Receptor* combination using the *Vulnerability* matrix defined in **Table 20.11**. *Vulnerability* ratings reflect the inherent susceptibility of receptors to climate impacts, before taking account of overall *Exposure* and prior to formal risk classification.

Table 20.11 Vulnerability matrix

Sensitivity	Adaptive Capacity		
	H	**M**	**L**
H	Medium Vulnerability	High Vulnerability	High Vulnerability
M	Low Vulnerability	Medium Vulnerability	High Vulnerability
L	Low Vulnerability	Low Vulnerability	Medium Vulnerability

84. The outputs of Step 2 include a comprehensive list of Project *Receptors* potentially affected by climate *Hazards*, *Sensitivity* ratings for each *Hazard–Receptor* combination, *Adaptive Capacity* ratings reflecting embedded mitigation and management controls and finally, an overall Vulnerability rating for each combination. These outputs are documented in **Appendix 20.2 Climate Change Vulnerability Assessment** and are carried forward into Step 3 (Risk Assessment), where *Vulnerability* is combined with *Exposure* to determine overall climate risk levels.

20.9.1.3 Step 3 – Risk Assessment

85. Step 3 of the methodology is the *Risk Assessment* to determine the overall level of climate-related risk to the WDA infrastructure by systematically combining the *Exposure* to climate *Hazards* (identified in Step 1) with the *Vulnerability* of *Receptors* (assessed in Step 2).

86. The assessment considers both acute risks (arising from extreme weather events) and chronic risks (arising from long-term changes in climate conditions).

87. Overall risk levels are determined using the Risk matrix defined in **Table 20.12**.

Table 20.12 Risk matrix

Receptor Vulnerability	Hazard Exposure		
	L	**M**	**H**
H	Medium Risk	High Risk	High Risk
M	Low Risk	Medium Risk	High Risk
L	Low Risk	Low Risk	Medium Risk

88. The outputs of Step 3 include overall Risk ratings for all *Hazard–Receptor–Phase* combinations, the identification of High and Medium risks and an evidence base for the identification of any required additional mitigation measures.

20.9.2 Cumulative Effects Assessment Methodology

89. Cumulative effects are not relevant to the CCR assessment, as the assessment considers the effects of climate change on the Project, rather than the Projects' effects on the environment or in combination with other developments. This is in line with the approach detailed in Section 19.6.5 of the **WDA Scoping Report**.

20.9.3 Transboundary Effects Assessment Methodology

90. It is not relevant to assess transboundary effects relating to climate change risks, as the assessment focusses on the effects of climate change on the WDA infrastructure only. Therefore, transboundary effects are scoped out of the CCR assessment. This is in line with the approach detailed in Section 19.6.6 of the **WDA Scoping Report**.

20.10 Assessment of Significance

91. The likely significant effects with respect to CCR that may occur during construction, O&M, and decommissioning of the WDA infrastructure are assessed in the following sections. The CCR assessment follows the three-step methodology set out in **Section 20.9.1**. It is based on the realistic worst-case scenarios defined in **Section 20.6**, with consideration of the embedded mitigation measures identified in **Section 20.8**.

92. As noted above, this topic chapter considers the WDA Study Area and existing environment only. A combined assessment of the construction, O&M and decommissioning of the WDA activities, Offshore ECC and OnTDA activities (commensurate with the level of detail that is available at the time of carrying out that assessment) is also provided and the methodology for this is described in **Section 20.10.4**. This approach will ensure a holistic view is undertaken of the whole Project.

20.10.1 Scope

93. The CCR assessment considers the effects of climate change on the WDA infrastructure. The scope of the assessment therefore differs from other EIA topics, which consider the effects of the WDA infrastructure on the receiving environment. Therefore, the WDA infrastructure outlined in **Table 20.13** are *Receptors* identified to have the potential to be affected by climate change during the construction, O&M and decommissioning phases.

Table 20.13 Impacts scoped into the CCR assessment resulting from extreme weather events and chronic climatic change

Impact and Activity	Receptors	Rationale
Climate change impacts from marine climate hazards during construction.	Offshore human and WDA infrastructure receptors. Vessel movement to and from the WDA. Transport of plant and equipment to and from the WDA.	The construction activities for the WDA infrastructure have the potential to be vulnerable to marine climate hazards such as storms, sea-level rise, and extreme weather events. The assessment of resilience will inform the design and construction planning for the WDA so that the Project can withstand these conditions during the construction phase, minimising delays, costs, and safety risks.
Climate change impacts from marine climate hazards during operation.	Offshore human and WDA infrastructure receptors.	During operation, the WDA infrastructure and O&M activities have the potential for continuous exposure to

Impact and Activity	Receptors	Rationale
	Vessel movement to and from the WDA.	marine climate hazards. Evaluating resilience informs the development of robust maintenance and emergency response plans to improve the longevity and reliability of WDA infrastructure and the safety of O&M personnel.
Climate change impacts from marine climate hazards during decommissioning [1].	Offshore human and WDA infrastructure receptors. Vessel movement to and from the WDA. Transport of plant and equipment to and from the WDA.	The decommissioning activities for the WDA have the potential to be vulnerable to marine climate hazards. The resilience assessment will inform the development of offshore decommissioning plans which are adaptable to changing conditions, reducing risks to decommissioning plant and personnel.
Notes: [1] Full details of the decommissioning of the WDA will be included in the Decommissioning Programme for the WDA. Decommissioning activities are considered in the CCR assessment based on the assumption that the receptors would be similar to the construction phase. It is anticipated that a CCR assessment or similar will be undertaken during the preparation of the Decommissioning Programme based on a review of recent extreme weather events and the latest climate change projection data. Further details on decommissioning are provided in **Chapter 3 Project Description**.		

20.10.2 Windfarm Development Area-Alone Assessment of Significance

20.10.2.1 Step 1 – Hazard and Exposure Assessment

94. The main climate variables which could be affected by climate change and that are relevant to the WDA are extreme temperatures, extreme precipitation, extreme storms, sea level rise, and changes to average precipitation and temperatures. This is based on the existing baseline information presented in **Section 20.7.1**, the predicted future environment described in **Section 20.7.2** and the climate trends in **Appendix 20.1 Climate Projection Data**. The key climate *Hazards* that have the potential to adversely affect the Projects' *Receptors* are shown in **Table 20.14**.

Table 20.14 Climate variables and hazards relevant to the WDA Study Area

Climate Variable	Climate Hazard	Rationale
Temperature	Increased frequency and severity of heatwaves.	Extreme high temperatures, particularly in summer, can lead to increased frequency and severity of heatwaves, impacting the health of workers, and causing damage or affecting the condition or performance of assets. Projections indicate temperature increases of more than 1.5 °C in the 2050s for both RCP4.5 and RCP8.5.
Temperature	Increase in average temperatures	Increase in average temperatures can warm ambient environments, impacting the health of workers, and affecting the condition and performance of assets. Projections indicate temperature increases of more than 1.5 °C in the 2050s for both RCP4.5 and RCP8.5.
Combined environmental change	Change in various environmental conditions, e.g. increase in average sea	Combined changes in environmental conditions, e.g. increased average sea surface temperatures, stronger waves and increasing sea salinity can increase corrosion risks. Projections indicate warmer

Climate Variable	Climate Hazard	Rationale
	surface temperatures, salinity, strong waves and sea level rise can increase water damage and corrosion risks.	temperatures and increased frequency and severity of extreme events which might result in more frequent severe wave conditions.
Combined environmental change	Increased frequency and/or severity of all types of extreme weather event or climate hazard, including heatwaves, storms, wave height, precipitation, lightning, tidal range, coastal erosion and changes in marine environmental conditions.	A combined environmental change category should be included in the CCR assessment to reflect the potential for multiple climate hazards to interact and occur concurrently. This approach recognises that WDA infrastructure and operations may be affected by compound and cumulative climate drivers, including extreme weather events and changes in marine conditions, and aligns with current best practice in climate risk assessment.
Extreme Weather Events	Increase in storm intensity (wind speed). Increase in frequency of storm conditions. Increase in extreme wave height. Change in storm patterns, e.g. wind direction.	Increase in storm intensity (wind speed) can impact wind turbines and workforce. Increase in frequency of storm conditions can impact downtime and back-to-back events causing damage to assets can compromise structural integrity. Change in storm patterns, e.g. wind direction can impact maintenance schedules and asset performance.
Extreme Weather Events	Lightning	Increase in the frequency of lightning events can cause damage to wind turbines and onshore substations.
Precipitation	Increase in frequency and intensity of extreme precipitation events.	Extreme precipitation leading to increased frequency and intensity of extreme precipitation events can cause harm to workforce and deterioration in the condition of assets.

95. In **Table 20.15**, the above *Hazards* have been rated for *Exposure* across the two different RCP Scenarios (RCP4.5 and RCP8.5) for the three different temporal scales – Construction (Short Term / 2030s), Operation (Medium Term / 2040s and 2050s) and Decommissioning phases (Long Term / 2070s). The *Hazards* have been assigned the *Exposure* categories defined in **Table 20.8**, based on the trends in the climate variables set out in **Appendix 20.1 Climate Projection Data**.

Table 20.15 Exposure ratings for short/medium/long-term time horizons for RCP4.5 and RCP8.5

Climate Hazard	RCP4.5			RCP8.5		
	Short Term / 2030s	Medium Term / 2040s and 2050s	Long Term / 2060s	Short Term / 2030s	Medium Term / 2040s and 2050s	Long Term / 2060s
Increased frequency and severity of heatwaves.	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
Increase in average temperatures	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
Change in various environmental conditions, e.g. increase in average sea surface temperatures, salinity, strong waves and sea level rise can increase water damage and corrosion risks.	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
Increased frequency and/or severity of all types of extreme weather event or climate hazard, including heatwaves, storms, wave height, precipitation, lightning, tidal range, coastal erosion and changes in marine environmental conditions.	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	HIGH
Increase in storm intensity (wind speed). Increase in frequency of storm conditions. Increase in extreme wave height. Change in storm patterns, e.g. wind direction.	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	HIGH
Lightning	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	HIGH
Increase in frequency and intensity of extreme precipitation events.	LOW	MEDIUM	MEDIUM	LOW	MEDIUM	MEDIUM

96. **Table 20.16** gives the Exposure ratings for the worst-case scenarios for each *Hazard*.

Table 20.16 Exposure ratings for realistic worst-case scenarios

Climate Hazard	RCP4.5	RCP8.5	
	Short Term / 2030s	Medium Term / 2040s and 2050s	Long Term / 2060s
Increased frequency and severity of heatwaves.	LOW	MEDIUM	HIGH
Increase in average temperatures	LOW	MEDIUM	HIGH
Change in various environmental conditions, e.g. increase in average sea surface temperatures, salinity, strong waves and sea level rise can increase water damage and corrosion risks.	LOW	MEDIUM	HIGH
Increased frequency and/or severity of all types of extreme weather event or climate hazard, including heatwaves, storms, wave height, precipitation, lightning, tidal range, coastal erosion and changes in marine environmental conditions.	MEDIUM	HIGH	HIGH
Increase in storm intensity (wind speed). Increase in frequency of storm conditions. Increase in extreme wave height. Change in storm patterns, e.g. wind direction.	MEDIUM	HIGH	HIGH
Lightning	MEDIUM	HIGH	HIGH
Increase in frequency and intensity of extreme precipitation events.	LOW	MEDIUM	MEDIUM

20.10.2.2 Step 2 – Vulnerability Assessment

97. Based on the methodology described in **Section 20.9.1.2**, the climate *Vulnerability* assessment is used to evaluate the resulting impact from a climate change which affects the ability of the *Receptor* to achieve or maintain its functions or purpose. This is done by determining the *Sensitivity* of *Receptors* (how strongly they are affected by hazards) and their *Adaptive Capacity* (ability to adjust, cope, or recover), taking into account embedded mitigation measures.

98. From the *Hazards* identified in **Section 20.10.2.1**, and the *Receptors* identified in **Section 20.9.1.2** and **Section 20.10.1**, potential impacts from combinations of *Hazard x Receptor* were identified. The *Sensitivity* assessment, *Adaptive Capacity* assessment and subsequent *Vulnerability* assessment is detailed in **Appendix 20.2 Climate Change Vulnerability Assessment**.

99. Of the potential climate change impacts assessed in the climate *Vulnerability* assessment, three impacts were determined to have a high *Vulnerability* despite the implementation of embedded mitigation measures.

100. The *Vulnerability* rating of *Receptors* from impacts during from the construction, O&M and decommissioning phases are presented in **Table 20.17** to **Table 20.19** respectively.

Table 20.17 Climate change vulnerability assessment – construction phase.

Climate Hazard	Receptor	Potential climate change impact	Vulnerability
• Increased frequency and severity of heatwaves. • Increase in average temperatures.	Offshore construction personnel.	Heatwaves and increased average temperatures can lead to increased risk of heat stroke and exhaustion among the workforce.	High
	Condition and performance of windfarm infrastructure.	High temperatures may reduce the strength and durability of construction materials used during installation of windfarm infrastructure and affect the flexibility and integrity of cables during laying of the IACs.	Low
• Increase in storm intensity (wind speed). • Increase in frequency of storm conditions. • Increase in extreme wave height. • Change in storm patterns, e.g. wind direction.	Marine vessels and offshore plant and equipment.	High winds and waves during extreme storm events can result in physical damage to marine vessels and plant and equipment.	Low
	Offshore construction personnel.	Extreme storminess can lead to unsafe working conditions.	Low
• Increased frequency and/or severity of all types of extreme weather event, including heatwaves, storms and wave heights.	Offshore construction personnel, marine vessels and plant and equipment.	Increased risk of disruption to offshore construction activities during extreme weather events can lead to programme delays and associated cost implications. Prolonged or successive disruptions can result in impacts to the overall WDA infrastructure construction programme.	Low

Table 20.18 Climate change vulnerability assessment – O&M phase.

Climate Hazard	Receptor	Potential climate change impact	Vulnerability
• Change in various environmental conditions, e.g. increase in average sea surface temperatures, salinity, strong waves and sea level rise can increase water damage and corrosion risks.	Condition and performance of windfarm infrastructure.	Exposure to strong waves, increasing sea salinity and surface temperatures, compounded by sea level rise, storm surges and tidal changes, can increase the risk of water damage and saltwater corrosion to submerged structures. This may result in physical damage and deterioration and decline in operational performance.	Low
• Change in frequency of ice conditions.	Condition and performance of WTGs.	Cold weather can lead to ice accretion on WTGs and therefore decreasing their operational performance.	Low
• Increased frequency and severity of heatwaves. • Increase in average temperatures.	Condition and performance of offshore platform(s)	Overheating of electrical equipment in offshore platform(s) such as switchgears and transformers can result in physical damage and deterioration and decline in operational performance due to shutdowns.	Low
• Increase in frequency and intensity of extreme precipitation events.	Condition and performance of WTGs.	Increase in precipitation and moisture can result in physical damage and deterioration of WTGs due to blade edge erosion and decline in operational performance.	Low
• Increase in storm intensity (wind speed). • Increase in frequency of storm conditions. • Change in storm patterns, e.g. wind direction.	Condition and performance of WTGs.	Extreme storm events can result in physical damage and deterioration of WTGs and decline in operational performance due to shutdowns.	Low

Climate Hazard	Receptor	Potential climate change impact	Vulnerability
• Increase in storm intensity (wind speed). • Increase in extreme wave height. • Increase in frequency of storm conditions. • Change in storm patterns, e.g. wind direction.	Offshore O&M personnel	Extreme storm events can lead to unsafe working conditions and disrupt O&M activities.	Low
• Increased tidal range. • Increase in extreme wave height.	Condition and performance of windfarm infrastructure.	Increased wave and tidal activities can increase loading and sediment transport across the seabed, resulting in physical damage and deterioration of submerged structures and decline in operational performance due to scour and erosion.	Low
• Increased frequency and/or severity of all types of extreme weather event or climate hazard, including heatwaves, storms, wave height, precipitation, lightning, tidal range, coastal erosion and changes in marine environmental conditions.	Condition and performance of windfarm infrastructure.	Major damage and/or increased rate of deterioration in condition due to extreme weather events could require more frequent repairs and replacements, raising O&M costs and disrupting activities.	Low

Table 20.19 Climate change vulnerability assessment – decommissioning phase.

Climate Hazard	Receptor	Potential climate change impact	Vulnerability
• Increased frequency and severity of heatwaves. • Increase in average temperatures.	Offshore decommissioning personnel.	Heatwaves and increased average temperatures can lead to increased risk of heat stroke and exhaustion among the workforce.	High
• Increase in storm intensity (wind speed). • Increase in frequency of storm conditions. • Increase in extreme wave height. • Change in storm patterns, e.g. wind direction.	Marine vessels and offshore plant and equipment.	High winds and waves during extreme storm events can result in physical damage to marine vessels and plant and equipment.	Low
	Offshore decommissioning personnel.	Extreme storminess can lead to unsafe working conditions.	Low
• Increased frequency and/or severity of all types of extreme weather event, including heatwaves, storms and wave heights.	Offshore decommissioning personnel, marine vessels and plant and equipment.	Increased risk of disruption to offshore decommissioning activities during extreme weather events can lead to programme delays and associated cost implications. Prolonged or successive disruptions can result in impacts on the overall Decommissioning programme.	High

20.10.2.3 Step 3 – Risk Assessment

101. Step 3 of the methodology (as described in **Section 20.9.1.3**) is the Risk Assessment to determine the overall level of climate-related risk to the WDA infrastructure by systematically combining the *Exposure* to climate *Hazards* (identified in Step 1 in **Section 20.10.2.1** in **Table 20.16**) with the *Vulnerability* of *Receptors* (assessed in Step 2 **Section 20.10.2.2** in **Table 20.17**, **Table 20.18** and **Table 20.19**).

102. The climate change risk assessment for the Construction phase is presented in **Table 20.20** below. There is one medium Risk, relating to the health and safety of the construction personnel.

103. The climate change risk assessment for the operation phase is presented in **Table 20.21** below. There are three medium Risks, from increased storms and the potential impact on personnel and WDA infrastructure.

104. The climate change risk assessment for the Decommissioning phase is presented in **Table 20.22** below. There is one high Risk from increased temperatures for the decommissioning personnel, and three medium Risks from increased storms and extreme weather events.

Table 20.20 Climate change risk assessment – construction phase.

Climate Hazard	Exposure	Receptor	Potential climate change impact	Vulnerability	Risk
• Increased frequency and severity of heatwaves. • Increase in average temperatures.	Low	Offshore construction personnel.	Heatwaves and increased average temperatures can lead to increased risk of heat stroke and exhaustion among the workforce.	High	Medium
		Condition and performance of windfarm infrastructure.	High temperatures may reduce the strength and durability of construction materials used during installation of windfarm infrastructure and affect the flexibility and integrity of cables during laying of the IACs.	Low	Low
• Increase in storm intensity (wind speed). • Increase in frequency of storm conditions. • Increase in extreme wave height. • Change in storm patterns, e.g. wind direction.	Medium	Marine vessels and offshore plant and equipment.	High winds and waves during extreme storm events can result in physical damage to marine vessels and plant and equipment.	Low	Low
		Offshore construction personnel.	Extreme storminess can lead to unsafe working conditions.	Low	Low
• Increased frequency and/or severity of all types of extreme weather event, including heatwaves, storms and wave heights.	Medium	Offshore construction personnel, marine vessels and plant and equipment.	Increased risk of disruption to offshore construction activities during extreme weather events can lead to programme delays and associated cost implications. Prolonged or successive disruptions can result in impacts to the overall WDA infrastructure construction programme.	Low	Low

Table 20.21 Climate change risk assessment – operation phase.

Climate Hazard	Exposure	Receptor	Potential climate change impact	Vulnerability	Risk
• Change in various environmental conditions, e.g. increase in average sea surface temperatures, salinity, strong waves and sea level rise can increase water damage and corrosion risks.	Medium	Condition and performance of windfarm infrastructure.	Exposure to strong waves, increasing sea salinity and surface temperatures, compounded by sea level rise, storm surges and tidal changes, can increase the risk of water damage and saltwater corrosion to submerged structures. This may result in physical damage and deterioration and decline in operational performance.	Low	Low
• Change in frequency of ice conditions.	Low	Condition and performance of WTGs.	Cold weather can lead to ice accretion on WTGs and therefore decreasing their operational performance.	Low	Low
• Increased frequency and severity of heatwaves. • Increase in average temperatures.	Medium	Condition and performance of offshore platform(s)	Overheating of electrical equipment in offshore platform(s) such as switchgears and transformers can result in physical damage and deterioration and decline in operational performance due to shutdowns.	Low	Low
• Increase in frequency and intensity of extreme precipitation events.	Medium	Condition and performance of WTGs.	Increased in precipitation and moisture can result in physical damage and deterioration of WTGs due to blade edge erosion and decline in operational performance.	Low	Low
• Increase in storm intensity (wind speed). • Increase in frequency of storm conditions. • Change in storm patterns, e.g. wind direction.	High	Condition and performance of WTGs.	Extreme storm events can result in physical damage and deterioration of WTGs and decline in operational performance due to shutdowns.	Low	Medium
• Increase in storm intensity (wind speed). • Increase in extreme wave height. • Increase in frequency of storm conditions. • Change in storm patterns, e.g. wind direction.	High	Offshore O&M personnel	Extreme storm events can lead to unsafe working conditions and disrupt O&M activities.	Low	Medium

Climate Hazard	Exposure	Receptor	Potential climate change impact	Vulnerability	Risk
• Increased tidal range. • Increase in extreme wave height.	High	Condition and performance of windfarm infrastructure.	Increased wave and tidal activities can increase loading and sediment transport across the seabed, resulting in physical damage and deterioration of submerged structures and decline in operational performance due to scour and erosion.	Low	Medium
• Increased frequency and/or severity of all types of extreme weather event or climate hazard, including heatwaves, storms, wave height, precipitation, lightning, tidal range, coastal erosion and changes in marine environmental conditions.	Medium	Condition and performance of windfarm infrastructure.	Major damage and/or increased rate of deterioration in condition due to extreme weather events could require more frequent repairs and replacements, raising O&M costs and disrupting activities.	Low	Low

Table 20.22 Climate change risk assessment – decommissioning phase.

Climate Hazard	Exposure	Receptor	Potential climate change impact	Vulnerability	Risk
• Increased frequency and severity of heatwaves. • Increase in average temperatures.	High	Offshore decommissioning personnel.	Heatwaves and increased average temperatures can lead to increased risk of heat stroke and exhaustion among the workforce.	High	High
• Increase in storm intensity (wind speed). • Increase in frequency of storm conditions. • Increase in extreme wave height. • Change in storm patterns, e.g. wind direction.	High	Marine vessels and offshore plant and equipment.	High winds and waves during extreme storm events can result in physical damage to marine vessels and plant and equipment.	Low	Medium
		Offshore decommissioning personnel.	Extreme storminess can lead to unsafe working conditions.	Low	Medium
• Increased frequency and/or severity of all types of extreme weather event, including heatwaves, storms and wave heights.	High	Offshore decommissioning personnel, marine vessels and plant and equipment.	Increased risk of disruption to offshore decommissioning activities during extreme weather events can lead to programme delays and associated cost implications. Prolonged or successive disruptions can result in impacts on the overall Decommissioning programme.	High	Medium

105. Of the potential impacts determined across the life cycle of the Project, one impact has been determined to be a high Risk, and seven impacts have been determined to be medium Risk.

106. Additional steps are recommended to deal with the high Risk impacts of *Heatwaves and increased average temperatures leading to heat stroke and exhaustion among the workforce.* These impacts can be managed through Construction Phase Plans and Health & Safety Management Systems in line with UK HSE and maritime standards, including heat stress risk assessments, task scheduling to avoid peak heat, rest breaks, hydration, suitable personal protective equipment, toolbox talks and workforce training. These are standard practices across offshore construction, O&M and decommissioning. With the implementation of these steps, the residual effects are not of concern.

107. The impacts identified are well understood climate stressors that are routinely encountered and managed within the offshore wind sector. The project design, construction methodology, operational controls and decommissioning strategy already incorporate robust, industry-proven embedded mitigation, resulting in low residual risk. Consequently, no additional mitigation measures are required beyond standard practice.

20.10.3 Offshore Export Cable Corridor (ECC) and Onshore Transmission Development Area (OnTDA)

108. A high level CCR assessment has been carried out for the Offshore ECC and OnTDA areas. The precise location of the OnTDA remains subject to refinement at this stage. As a result, the onshore component of the CCR assessment has been undertaken at a proportionate, high-level using available regional and gridded[1] climate projection information that is representative of the wider onshore Study Area. This provides an initial assessment of climate-related *Hazards* and *Exposure* sufficient to inform the EIA, while recognising the current level of design flexibility. A more detailed, grid-cell specific assessment will be undertaken as part of the OnTDA EIAR, once the final landfall and onshore alignment have been confirmed. This staged approach is consistent with the *principle of proportionality* and reflects current best practice, ensuring that the level of detail presented at each consenting stage is commensurate with the certainty of the Project design.

109. The climate predictions for the area consistently raise concerns around sea level rise, increased frequency and intensity of storms. There are predictions of high intensity but short duration rainfall periods in the winter and overall increasing ambient temperature.

110. A summary of potential climate risks is presented in **Table 20.23**.

[1] Gridded climate projection information refers to outputs from the UK Climate Projections (UKCP), in which future climate variables are modelled and presented on a regular spatial grid. Each grid cell represents averaged climate conditions over a defined area (e.g. ~12 km × 12 km for UKCP18 regional projections, or finer resolution where available). UKCP gridded datasets are designed to support regional-scale climate risk assessments and are appropriate for high-level analysis where site-specific location or alignment is not yet fixed.

Table 20.23 Climate variables and hazards relevant to the Offshore ECC and OnTDA Study Area

Climate Variable	Climate Hazard	Potential Risks
Temperature	Heatwaves	Extreme high temperatures, particularly in summer, can lead to increased frequency and severity of heatwaves, impacting health of workers, and causing damage or affecting the condition or performance of assets. Projections indicate temperature increases of more than 1.5 °C in the 2050s for both RCP4.5 and RCP8.5.
Temperature	Warming	Increase in average temperatures can warm ambient environments, impacting health of workers, and affecting the condition and performance of assets. Projections indicate temperature increase of higher than 1.5 °C in the 2050s for both RCP4.5 and RCP8.5.
Combined environmental change	Dry Spells	Combined change in environmental conditions, e.g. dry spells and increase in temperatures, can result in wildfires, subsidence and dust creation risks and affect vegetation health. Projections indicate warmer and drier summers.
Combined environmental change	Extreme Weather Events	Increased frequency and / or severity of all types of extreme weather event or climate hazard.
Precipitation	Fluvial Flooding	Extreme precipitation leading to extreme river flows and levels (fluvial flooding).
Precipitation	Pluvial Flooding	Extreme precipitation leading to extreme surface water flows and levels (potentially resulting in pluvial flooding). Onshore substation at risk of damage/failure from water ingress and compromised condition of assets due to repeated exposure to water.
Precipitation	Extreme Precipitation Events	Extreme precipitation leading to increased frequency and intensity of extreme precipitation events can cause harm to workforce and deterioration in the condition of assets.
Extreme Weather Events	Extreme storms	Increase in storm intensity (wind speed) can impact wind turbines and workforce. Increase in frequency of storm conditions can impact downtime and back-to-back events causing damage to assets can compromise structural integrity. Change in storm patterns, e.g. wind direction can impact maintenance schedules and asset performance.
Extreme Weather Events	Lightning	Increase in the frequency of lightning events can cause damage to wind turbines and onshore substations.

20.10.4 Combined Assessment: Windfarm Development Area, Offshore Export Cable Corridor and Onshore Development Transmission Development Area

111. A detailed CCR assessment has been undertaken for the WDA, while the Offshore ECC and OnTDA have been assessed at a higher level. To inform the combined assessment, a set of assumptions were developed which includes a preliminary boundary for the Offshore ECC and OnTDA, anticipated project components and associated construction methods and timelines. These are set out in **Chapter 3 Project Description**, Sections 3.7 and 3.8. A number of climate-related interdependencies have been identified across the offshore and transmission elements.

112. Climate-driven risks originating offshore can reasonably cascade into the transmission elements through timing, design, and exposure pathways.

20.10.4.1 Impact 1 - Extreme Weather and Metocean Conditions Affecting Construction

113. Projected increases in the frequency and intensity of extreme weather and metocean conditions, including higher wave heights, stronger winds, and more severe storms, may adversely affect offshore construction activities within the WDA, resulting in delays to foundation installation, export cable laying, and turbine commissioning, and potentially limiting available seasonal weather windows. Such climate-related delays could lead to rescheduling of Offshore ECC and OnTDA construction or commissioning activities into periods of increased exposure to extreme weather events, including winter storm seasons and times of increased fluvial or surface water flood risk onshore.

114. Notwithstanding the potential for climate-related delays to offshore and onshore activities, there are no common physical, operational, or temporal interfaces between offshore construction activities within the WDA and onshore construction or commissioning activities that would give rise to an interaction or escalation of effects. As such, the identified climate-related risks apply independently to the offshore and onshore environments, and do not result in any additional or compounded risk.

20.10.4.2 Impact 2 - Climate-Driven Offshore Design Adaptations

115. Allowances made for future climate change in the offshore environment, including increased wave loading, greater seabed mobility, and enhanced scour potential under higher storm energy conditions, may necessitate design adaptations within the WDA, such as deeper foundation embedment and changes to export cable burial depth or protection. These offshore climate-driven design changes have the potential to influence the cable landfall design and associated coastal protection requirements within the Offshore ECC, as well as the routeing, thermal performance requirements, and layout of onshore transmission infrastructure within the OnTDA.

116. However, the likelihood that offshore climate-driven design adaptations would necessitate consequential changes to cable landfall design or onshore transmission infrastructure is considered low. Offshore and onshore design processes are undertaken independently and incorporate appropriate climate change allowances specific to their respective environments. Accordingly, any climate-related design changes would be managed within the relevant project component and are not expected to result in an increased or combined risk.

20.10.4.3 Impact 3 - Climate-Driven Changes to Coastal Processes

117. Climate-driven changes to coastal processes, including sea level rise, increased storm surge, and accelerated coastal erosion, have the potential to affect the stability of export cable landfall locations and impose constraints on the siting and protection requirements of infrastructure within the Offshore ECC. Offshore export cable alignment or landfall modifications required in response to coastal climate risks may, in turn, constrain onshore cable route options and reduce design flexibility within the OnTDA.

118. Residual effects are not of concern, as climate-driven changes to coastal processes are expected to be localised and manageable through routeing flexibility, landfall selection informed by climate projections, and embedded coastal protection measures. Adaptive design reduces the risk of impacts on offshore alignment, Offshore ECC infrastructure, and onshore routeing remain within acceptable tolerances.

119. Notwithstanding that the detailed Offshore ECC routeing and OnTDA locations are not yet finalised, climate-driven changes to coastal processes represent a cross-cutting risk affecting the WDA, Offshore ECC and OnTDA. In particular, sea level rise, increased storm surge and coastal erosion at cable landfall have the potential to influence offshore export cable alignment within the WDA and

constrain onshore routeing and design flexibility within the OnTDA. Although the coastal climate change acts as a key interface risk linking offshore and onshore elements of the Project, the identified climate-related risks apply independently to the offshore and onshore environments, and do not result in any additional or compounded risk.

20.10.4.4 Impact 4 - Extreme Weather Events

120. Projected increases in the frequency and severity of extreme weather events represent a shared climate stressor across all project elements, with implications for offshore installation and access within the WDA, coastal and transitional construction activities within the Offshore ECC, and onshore construction operations and equipment resilience within the OnTDA. These conditions may result in reduced available weather windows, increased construction downtime, and greater uncertainty in programme delivery. While the specific mechanisms and receptors differ by location, the cumulative effect of extreme weather has the potential to affect construction and commissioning activities across all assets simultaneously or sequentially.

121. Effects are not concerning as extreme weather primarily results in temporary and reversible construction disruption, which is inherent to offshore and onshore works. Programme contingency, seasonal planning, and flexible sequencing limit the magnitude and duration of residual effects.

20.10.4.5 Impact 5 - Long-Term Climate Change and Asset Resilience

122. Over the operational lifetime of the Project, the WDA, Offshore ECC, and OnTDA may each be exposed to the effects of long-term climate change, including higher ambient temperatures affecting electrical efficiency and cooling requirements, increased corrosion rates associated with prolonged saline exposure, and accelerated asset deterioration resulting from more frequent and intense extreme weather events. It is necessary to apply consistent climate change adaptation assumptions across offshore and onshore asset design to warrant long-term resilience and performance.

123. Long-term climate effects are not of concern as assets will be designed to incorporate appropriate climate change allowances, including for temperature, corrosion, and extreme events. Engineered infrastructure has a low to medium *Sensitivity*, and adaptation measures promote continued performance over the operational lifetime.

20.10.4.6 Combined Assessment Summary

124. Across all impacts, climate change effects are characterised by manageable magnitudes, engineering resilience, and the ability to adapt through design, rather than by irreversible or widespread harm. When considered individually and cumulatively, the residual effects remain not significant within the meaning of the EIA Regulations. A summary of the combined assessment is detailed in **Table 20.24** below.

Table 20.24 CCR combined assessment summary

Receptor/Topic	WDA Residual Effect	Offshore ECC assessment of effects	OnTDA assessment of effects	Combined assessment
Impact 1: Extreme weather and metocean conditions affecting construction	Increased frequency and intensity of extreme weather may reduce offshore working windows and cause delays to foundation installation, export cable laying, and turbine commissioning. The effect does not represent a meaningful risk to the project.	Offshore ECC construction or commissioning activities may be rescheduled into periods of increased exposure to extreme weather, including winter storms. The effect does not represent a meaningful risk to the project.	OnTDA construction or commissioning may experience increased exposure to extreme rainfall, wind, or flood risk as a result of programme slippage. The effect does not represent a meaningful risk to the project.	Extreme weather may result in interdependent, temporary programme effects across offshore and onshore elements; with contingency and sequencing measures, combined effects remain manageable.
Impact 2: Climate-driven offshore design adaptations	Allowances for future climate change may require offshore design adaptations, including increased foundation embedment and changes to export cable burial depth or protection. The effect does not represent a meaningful risk to the project.	Offshore climate-driven design changes may influence cable landfall design and coastal protection requirements within the Offshore ECC. The effect does not represent a meaningful risk to the project.	Downstream changes to landfall approach may affect onshore routeing, thermal performance requirements, or substation layout. The effect does not represent a meaningful risk to the project.	Climate-driven offshore design adjustments may influence transmission interfaces; with adaptive design and flexibility, combined effects across WDA, Offshore ECC, and OnTDA remain manageable.
Impact 3: Climate-driven changes to coastal processes	Climate-driven changes may influence export cable alignment and landfall approach. The effect does not represent a meaningful risk to the project.	Coastal change may affect landfall siting and protection requirements. The effect does not represent a meaningful risk to the project.	Landfall or alignment changes may constrain onshore routeing flexibility. The effect does not represent a meaningful risk to the project.	Interdependent coastal climate risks across offshore and onshore elements; effects remain Not significant with adaptive manageable.
Impact 4: Extreme weather events	Extreme weather may reduce offshore installation and access windows. The effect does not represent a meaningful risk to the project.	Extreme weather may constrain coastal construction activities. The effect does not represent a meaningful risk to the project.	Extreme rainfall and wind may affect onshore construction and equipment. The effect does not represent a meaningful risk to the project.	Extreme weather is a shared climate stressor; combined effects on construction and commissioning are manageable.

Receptor/Topic	WDA Residual Effect	Offshore ECC assessment of effects	OnTDA assessment of effects	Combined assessment
Impact 5: Long-term climate change and asset resilience	Long-term climate effects may influence offshore asset performance. The effect does not represent a meaningful risk to the project.	Climate change may increase corrosion and flood exposure risks to Offshore ECC assets. The effect does not represent a meaningful risk to the project.	Climate change may affect cooling requirements and asset durability onshore. The effect does not represent a meaningful risk to the project.	With consistent climate adaptation allowances applied, long-term effects remain manageable across all assets.

20.11 INTER-RELATED AND INTERACTING IMPACTS

20.11.1 Inter-Relationships

125. The CCR assessment considers effects of climate change on the WDA infrastructure, while other topics consider the effects of the WDA on receptors in the surrounding environment. Therefore there are not considered to be any inter-relationships with other environmental effects with respect to climate change risks.

126. It is acknowledged that combined or sequential extreme weather events have the potential to exacerbate climate-related effects beyond those associated with individual events assessed in isolation. Whilst the current understanding of compound climate risks is limited, combined impacts due to multiple extreme weather events are not expected to change the effect significance presented in the CCR assessment. The embedded mitigation measures identified through the CCR assessment ensure that the WDA Infrastructure as a whole remains resilient to both current and future climate conditions during the construction, O&M and decommissioning phases, and these mitigation measures remain appropriate if more than one climate change impact occurs at the same time.

127. In the absence of sufficient evidence, the CCR assessment prioritises robust mitigation of individual climate hazards, recognising this as a necessary and proportionate step towards enhancing overall climate resilience. This approach will be supported by adaptive management and review mechanisms to respond to future advances in climate science.

20.12 Summary

128. A three-step assessment process has been undertaken to evaluate future trends in climate change impacts and the effect on the WDA's *Vulnerability* and resilience to such changes.

129. The CCR assessment has been informed by considerations of the existing baseline and predicted future baseline climates based on observed meteorological and climate conditions and climate change projection data. Relevant climate variables and hazards have been identified and their *Exposure* ratings determined in Step 1.

130. The *Vulnerability* assessment considered whether and how the WDA's *Receptors* may be potentially vulnerable to climate *Hazards* and therefore experience climate change impacts during the construction, O&M and decommissioning phases in Step 2. The improved resilience from embedded mitigation measures was also incorporated into the *Vulnerability* Assessment.

131. In step 3, the Risk rating was determined based on the *Exposure* of the *Hazard* and *Vulnerability* of the *Receptors*. One Risk was rated high and seven Risks were rated medium. Recommendations to address these risks were presented.

132. The WDA CCR assessment has concluded that there are no likely significant effects on the Project as a result of climate change impacts during the construction, O&M and decommissioning phases.

133. In addition, the WDA, Offshore ECC and OnTDA combined assessment concluded that there are no likely significant effects on the Project as a result of climate change impacts during the construction, O&M and decommissioning phases.

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