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TABLES

17.0 CLIMATE CHANGE AND SUSTAINABILITY

17.1 Introduction

17.1.1 This Chapter of the Environmental Statement (ES) assesses the potential effects of the construction, operation (including maintenance) and decommissioning of the Proposed Development in terms of Climate Change and Sustainability. As well as considering potential effects arising from the Proposed Development, this assessment also considers the potential impact of projected future climate change on the Proposed Development and the surrounding environment.

17.1.2 The Proposed Development would be fitted with carbon capture technology that will be designed to be capable of capturing over 90% of carbon emissions emitted from the generating station in the reference case. The conditioned and dehydrated carbon dioxide produced from the carbon capture plant (CCP) would be compressed to a pressure (to be agreed with National Grid Carbon) and after metering, discharged into the carbon dioxide gathering networkfor onwards transport to an offshore carbon store for permanent storage and not released to the atmosphere.

17.1.3 In accordance with the requirements of The Infrastructure Planning (Environmental Impact Assessment (EIA)) Regulations 2017 (HMSO, 2017), guidance from the Institute of Environmental Management and Assessment (IEMA) for climate change mitigation (IEMA, 2017) and climate change resilience and adaptation (IEMA, 2020) has been applied. This Chapter addresses three separate main aspects:

- **Lifecycle Greenhouse Gas (GHG) impact assessment** – the potential effects on the climate from GHG emissions arising from the Proposed Development, including how the Proposed Development would affect the ability of the government to meet its carbon reduction targets;
- **In-combination Climate Change Impact (ICCI) assessment** – the in-combination effects of a changing climate and the Proposed Development on receptors in the surrounding environment; and
- **Climate Change Resilience (CCR) assessment** – the resilience of the Proposed Development to projections for climate change, including how the Proposed Development design would be adapted to take account for the projected impacts of climate change.

17.1.4 **Appendix 17A:** Sustainability Review (ES Volume II – **Application Document Ref. 6.3**) accompanies this Chapter and includes an assessment of the Proposed Development during its operational phase against a number of key sustainability themes. This review outlines where measures have been incorporated to minimise adverse impacts and where the Proposed Development will provide beneficial effects, thus contributing to the wider sustainability of the Proposed Development.

17.2 Legislation, Planning Policy and Guidance

17.2.1 This section identifies and describes legislation, policy, and guidance of relevance to the assessment of the potential sustainability and climate impacts associated with the construction, operation (including maintenance) and decommissioning of the Proposed Development. Legislation, policy and other relevant guidance has been considered on an international, national and local level.

International

Kyoto Protocol

17.2.2 An international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC), which commits its Parties by setting internationally binding emission reduction targets. Under Article 4 of the Kyoto Protocol, the EU created an Effort Sharing Regulation that requires the setting of individual binding GHG emission reduction targets for each of its Member States. The current Effort Sharing Decision (ESD) commits the UK to a 37% reduction in GHG emissions for the period 2021 to 2030 (Regulation (EU) 2018/842, 2018). This ambition is addressed in Section 17.6 and 17.7.

Paris Agreement

17.2.3 The Paris Agreement is an agreement under the UNFCCC dealing with GHG emissions mitigation, adaptation and finance starting in the year 2020. It requires all signatories to strengthen their climate change mitigation efforts to keep global warming to well below 2°C this century and to pursue efforts to limit global warming to 1.5°C (UNFCCC, 2016). This ambition is addressed in Section 17.6 and 17.7.

7th Environment Action Programme (EAP)

17.2.4 The 7th EAP (Decision No. 1386/2013/EU) (European Parliament, 2013) came into force in January 2014, guided by the following long term vision:

"In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society." (Annex, Paragraph 1).

17.2.5 The 7th EAP is based around three priority areas requiring more action, including:

- protect nature and strengthen ecological resilience;
- boost resource-efficient, low-carbon growth; and
- reduce threats to human health and wellbeing linked to pollution, chemical substances, and the impacts of climate change.

17.2.6 In relation to aspects of sustainability covered by **Appendix 17A** (ES Volume II – **Application Document Ref. 6.3**), the first priority area identifies further action on soil protection and sustainable use of land, while the third area covers challenges to human health including air and water pollution, excessive noise and toxic chemicals.

National

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017

17.2.7 The Infrastructure Planning (Environmental Impact Assessment) Regulations ('the EIA Regulations') (UK Government, 2017) state that an EIA (where relevant):

"must include a description of the likely significant effects of the development on the environment resulting from… the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change".

17.2.8 This requirement is addressed in Section 17.6.

Climate Change Act 2008/ Climate Change Act (2050 Target Amendment Order 2019)

17.2.9 The Climate Change Act 2008 (UK Government, 2008) set a legally binding target for the UK to reduce its GHG emissions from 1990 levels by at least 80% by 2050. This target is supported by a system of legally binding five-year 'carbon budgets' and an independent body to monitor progress, the Climate Change Committee (CCC). The UK carbon budgets restrict the amount of GHG emissions the UK can legally emit in a defined five-year period.

17.2.10 The Act was amended in 2019 to revise the existing 80% reduction target and legislate for Net Zero emissions by 2050 (through the Climate Change Act 2008 (2050 Target Amendment) Order 2019) (UK Government, 2019).

17.2.11 In December 2020, the 6th carbon budget was published by the CCC for consideration by Government and is the first budget to reflect the amended trajectory to Net Zero by 2050.

17.2.12 The existing UK carbon budgets are used to determine significance of GHG emissions from the Proposed Development, as described in Section 17.3 and determined in Section 17.6.

UK Nationally Determined Contribution

17.2.13 Under Article 4 of the Paris Agreement, parties are required to communicate their intended domestic GHG mitigation targets. In 2020, the UK communicated its new Nationally Determined Contribution to the UNFCCC. Within this, the UK has committed to reducing GHG emissions by at least 68% by 2030 compared to 1990 levels (UK Government, 2020a).

Planning Policy Context

National Planning Policy

17.2.14 National Policy Statement (NPS) EN-1 (Department for Energy and Climate Change (DECC, 2011a) describes the national policy for energy infrastructure in relation to climate impacts and adaptation; adverse effects and benefits; in relation to the EU Directive and ES requirements; in relation to adaptation measures in response to climate projections; and in relation to climate projections, flood risk and the importance of relevant mitigation.

17.2.15 EN-1 promotes Carbon Capture and Storage as an emerging technology that the Government is aiming to facilitate and encourage, including for gas-fired generating stations. Paragraph 2.2.23 of EN-1 states that Carbon, Capture and Storage (CCS) is part of the UK's plans to "*reduce its dependence on fossil fuels, particularly unabated combustion*".

17.2.16 This Policy Statement further states the benefits of having a diverse mix of power generation, including energy supply security as fossil-fuel generation that can be brought online quickly to meet demand and can complement baseload supply from nuclear and renewables. However, these fossil-fuel power generators will need CCS to be low carbon.

17.2.17 EN-1 states that the consenting of new fossil-fuelled power stations at or over 300MW have to be constructed Carbon Capture Ready (CCR), as described in Section 3.6 and 4.7 of EN-1.

17.2.18 NPS for Fossil Fuel Electricity Generating Infrastructure (EN-2) (DECC, 2011b) describes the need for all new fossil fuel electricity generating plants to assess the viability for supporting carbon capture and storage technologies. This policy has been used to inform this Chapter and the wider submission.

Marine and Coastal Access Act (2009) and the Eastern Marine Plan (2014)

17.2.19 The Marine and Coastal Access Act (MCAA) (Marine Management Organisation, 2009) is the basis upon which the Marine Management Organisation (MMO) determine marine licensing applications.

17.2.20 As the Proposed Development includes works within part of the UK marine area (i.e. the Tidal River Trent), marine policy documents are relevant to consider. In this instance, as prescribed by the MCAA, the published Eastern

Marine Plan (EMP) is the appropriate marine policy document (Marine Management Organisation, 2014).

17.2.21 Section 3.11 of the EMP (Carbon Capture and Storage) recognises that combustion (including gas-fired) power stations may *"want to utilise coastal or estuarine sites within the East Inshore Plan area to make use of once through water cooling systems for efficiency and economic purposes" (paragraph 325).*

17.2.22 Paragraph 326 recognises that:

"The East marine plan areas afford a significant opportunity for the [Carbon Capture, Utilisation and Storage] industry due to the large number of saline aquifers within the Bunter sandstone formation. Saline aquifers are estimated as having around 85% of the United Kingdom's potential storage capacity. Also, there are significant active and inactive hydrocarbon fields that could be used for storage. In addition, several clusters of industrial facilities emitting large amounts of carbon dioxide occur along England's East coast".

The National Planning Policy Framework

17.2.23 The revised National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, 2019a) sets out the Government's planning policies for England. While the NPPF does not set specific policies for NSIP, its policies may be of relevance to decision making.

17.2.24 Those policies of relevance to climate change and sustainability assessment include those achieving sustainable development and meeting the challenge of moving to a low carbon economy, climate change, flooding and coastal change. The NPPF states that the planning system should support this transition by supporting low carbon energy and associated infrastructure.

National Planning Policy Guidance on Climate Change

17.2.25 Guidance published by the Ministry of Housing, Communities and Local Government (2019b) describes how to identify suitable mitigation and climate adaptation measures to incorporate into the planning process, stating that:

"*Effective spatial planning is an important part of a successful response to climate change as it can influence the emission of greenhouse gases… Planning can also help increase resilience to climate change impact through the location, mix and design of development*."

Biodiversity Strategy 2020 (2011)

17.2.26 A strategy for England's wildlife and ecosystem services (Department for Environment, Food and Rural Affairs (Defra), 2011) establishes principles for considering biodiversity and the potential effects of climate change. This assessment will reflect these principles and identify how the effects of the

Proposed Development on the natural environment will be influenced by climate change, and how ecological networks will be maintained.

The Clean Growth Strategy

17.2.27 In 2017, the government published The Clean Growth Strategy – Leading the way to a low carbon future (UK Government, 2017a). This Strategy details how increased investment and collaboration in carbon capture usage and storage in the UK can be used to drive industrial innovation and its importance in long-term emissions reduction.

The Clean Growth Strategy: The UK Carbon Capture Usage and Storage (CCUS) Deployment Pathway- An Action Plan

17.2.28 Clean Growth – The UK Carbon Capture Usage and Storage deployment pathway - An Action Plan (UK Government, 2018) has identified Carbon Capture, Usage and Storage (CCUS) as having a significant part to play in the UK's transition to a low carbon economy. CCUS has been identified as a least cost energy system decarbonisation pathway to 2050. In their Clean Growth CCUS action plan it is stated that:

"CCUS has economy-wide qualities which could be very valuable to delivering clean industrial growth. It could deliver tangible results in tackling some of the biggest challenges we face in decarbonising our economy, contributing to industrial competitiveness and generating new economic opportunities – a key part of our modern Industrial Strategy."

17.2.29 Within this Action Plan, Humberside was identified as a key location for CCUS due to its heavy industry and chemical manufacturing. This strategy has been used to develop this Chapter and the wider submission.

Net Zero - Opportunities for the Power Sector' (National Infrastructure Commission, 2020)

17.2.30 'Net Zero – Opportunities for the Power Sector' states that decarbonising the power sector is integral to achieving the goal of Net Zero by 2050. The National Infrastructure Commission (NIC) provides impartial advice to the government on infrastructure requirements, strategic drivers and solutions. The NIC terms of reference are set by government, and while NIC recommendations do not constitute government policy, the government is required to formally respond to the recommendations, and they may form the evidence base for future policy.

17.2.31 Core to the NIC recommendations (page 7) is that the conclusion that: "*a highly renewable power system, combined with flexible technologies including hydrogen powered generation, could be substantially cheaper than alternatives that rely heavily on a fleet of nuclear power plants*."

17.2.32 Page 18 of the NIC recommendations acknowledges that there will be a mix of technologies in Net Zero power systems, including unabated thermal (with low running hours) and at least 18 gigawatts (GW) of gas CCS capacity by 2050, generating 23 terawatt hours (TWh) of electricity. By 2050 it is expected that gas will primarily play a peaking role in the electricity system. Net Zero – Opportunities for the power sector' therefore highlights the important role of CCS in decarbonising the power sector by capturing carbon dioxide from new gas-fired generation.

Local Planning Policy and Strategy

17.2.33 The North Lincolnshire Local Development Framework (North Lincolnshire Council, 2011) sets out the council's spatial vision, strategy and policies to deliver the strategy up to 2026. The Core Strategy covers several policies related to climate change, including the following, which have been considered in the assessment:

- Policy CS16 North Lincolnshire Landscape, Greenspace and Waterscape;
- Policy CS17 Biodiversity;
- Policy CS18 Sustainable Resource Use and Climate Change;
- Policy CS19 Flood Risk; and
- Policy CS20 Sustainable Waste Management.

17.2.34 The manner in which the Proposed Development supports the Local Development Framework is described in Sections 17.5 and 17.7.

17.2.35 The North Lincolnshire Carbon Management Strategy (North Lincolnshire Council, 2017) details the local council's plan for reducing carbon from 2017 to 2020. It states that this area is one of the top five most vulnerable coasts in the UK, as illustrated by Figure 17.1, below, that illustrates the potential area of flooding by 2100 with a 1m sea level rise.

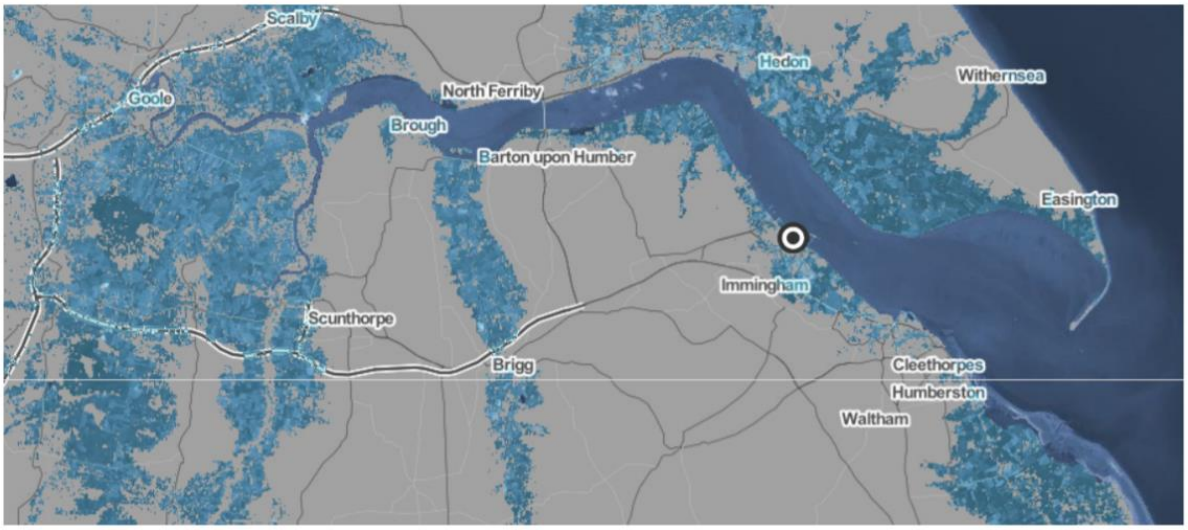

Figure 17.1: Potential Areas of Flooding (2100)

Other Standards and Guidance

Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment

17.2.36 This Guidance aims to help EU Member States improve the way in which climate change and biodiversity are integrated in EIAs undertaken across the EU (EU Commission, 2013). Although the UK is no longer a Member State of the EU, this guidance is still considered relevant in the context of EIA undertaken in respect of developments in the UK .

EC Non-paper Guidelines for Project Managers: Making Vulnerable Investments Climate Resilient

17.2.37 These guidelines aim to help developers of physical assets and infrastructure incorporate resilience to current climate variability and future climate change within their projects (EU Commission, 2011). Although the UK is no longer a Member State of the EU, this guidance is still considered relevant in the context of EIAs undertaken in respect of developments in the UK.

Guidance for the Calculation of Land Carbon Stocks

17.2.38 EU Commission (2010) calculation methodology for calculating carbon stocks from land use. This guidance is applied in Section 17.3.

British Standards

17.2.39 The British Standards Institution BS EN ISO 14064-1:2019 and 14064-2:2019 (2019a and b, respectively) provides specifications for organisational-level and project-level guidance for the quantification and reporting of GHG

emissions and removals. These are used within the GHG emissions calculation methodology, as described in Section 17.3.

IEMA: Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance

17.2.40 In the absence of any widely accepted guidance on assessing the significance of the impacts and effects of GHG emissions, guidance published by IEMA (2017) has been followed. This provides a framework for the consideration of GHG emissions in the EIA process, in line with the 2014 EU Directive. The guidance sets out how to:

- identify the GHG emissions baseline in terms of GHG current and future emissions;
- identify key contributing GHG sources and establish the scope and methodology of the assessment;
- assess the impact of potential GHG emissions and evaluate their significance; and
- consider mitigation in accordance with the hierarchy for managing project related GHG emissions (avoid, reduce, substitute, and compensate).

17.2.41 This guidance is used within the GHG emissions calculation methodology, as described in Section 17.3.

IEMA: Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation.

17.2.42 The IEMA Guidance for assessing climate change resilience and adaptation in EIA (2020) has also been followed. It provides guidance for consideration of the impacts of climate change within project design. The guidance sets out how to:

- define climate change concerns and environmental receptors vulnerable to climate factors;
- define the environmental baseline with changing future climate parameters; and
- determine the resilience of project design and define appropriate mitigation measures to increase resilience to climate change.

17.2.43 This guidance is used within the ICCI and climate change resilience methodology, as described in Section 17.3.

GHG Protocol

17.2.44 The World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) GHG Protocol provides overarching

guidance on developing GHG inventories and reporting standards (2015). This guidance is used within the GHG emissions calculation methodology, as described in Section 17.3.

2015 UK Greenhouse Gas Emissions, Final Figures (Department for Energy and Climate Change, 2017)

17.2.45 This provides the latest estimates of 1990-2015 UK GHG emissions by source and by end user sector.

17.2.46 In 2015, UK emissions of the seven GHG covered by the Kyoto Protocol were estimated to be 495.7 tonnes carbon dioxide (CO_2) equivalent ($MtCO_2e$). This was 3.8% lower than the 2014 figure of 515.1 $MtCO_2e$.

17.2.47 Carbon dioxide is the main GHG, accounting for 81% of total UK GHG emissions in 2015. The drivers for the decrease in emissions were in the energy supply sector (down 12.3%), the business sector (2.6%) and the waste management sector (7.1%). The decrease in the energy supply sector is due to the change in the fuel mix for electricity generation, with less use of coal and greater use of nuclear and renewables.

17.3 Assessment Methodology

Consultation

17.3.1 The consultation undertaken with statutory consultees to inform this Chapter, including a summary of comments raised via the formal Scoping Opinion (**Appendix 1B** (ES Volume II - **Application Document Ref. 6.3**)), and in response to the formal consultation and other pre-application engagement, is summarised in Table 17.1, below.

Table 17.1: Consultation summary table

Consultee or Organisation	Date and nature of consultation	Summary of response	How comments have been addressed in this Chapter
Planning Inspectorate	June 2020 (Scoping Opinion)	ID 4.10.1. GHG lifecycle assessment-decommissioning: the Scoping Report seeks to scope out the "removal and/or renewal" of the Proposed Development arguing that it is not reasonably foreseeable and would be subject to a separate permission. The Inspectorate agrees that the renewal of the scheme would be subject to separate consent and this matter can therefore be scoped out of the assessment. However, a qualitative assessment of the impacts from removal should be included in the ES.	Table 17.3 details the scope of the assessment. Emissions associated with decommissioning are estimated and described in Section 17.6.
		ID 4.10.2. In-combination Climate Change Impact (ICCI) assessment – extreme weather events; sea level rise; and precipitation change leading to flash flooding: the Scoping Report considers that these matters will be adequately addressed in the FRA and therefore a separate Climate Change Assessment on these matters is not necessary. The Inspectorate considers the results of this assessment should also be presented in the climate change chapter, signposting to the relevant information in the FRA.	Table 17.4 details the scope of the ICCI Assessment. Sections 17.6 onwards summarise the ICCI impacts from the Flood Risk Assessment (FRA) presented in **Appendix 12A** (ES Volume II - **Application Document Ref. 6.3**), and any relevant embedded design measures or mitigation measures.

Consultee or Organisation	Date and nature of consultation	Summary of response	How comments have been addressed in this Chapter
		ID 4.10.3. ICCI assessment – temperature change; precipitation change (including low precipitation and drought conditions): The Scoping Report considers that these matters will be adequately addressed in a Landscape and Biodiversity Management Strategy and therefore a separate Climate Change Assessment on these matters is not necessary. No further details are provided concerning the nature of the Landscape and Biodiversity Management Strategy, what relationship it will have to the ES, and whether it will comprise an assessment of effects. Considering this, the Inspectorate does not agree to scope these matters out and they should be addressed in the assessment where significant effects are likely.	Table 17.4 details the scope of the ICCI Assessment. Sections 17.6 onwards assess and examine any ICCI impacts from temperature change and low precipitation.
		ID 4.10.4. ICCI assessment – wind; and Climate Change resilience assessment – wind: The Applicant seeks to scope out the impacts of wind on receptors in the surrounding environment (ICCI assessment) and on the resilience of the Proposed Development (Climate change resilience assessment) as they "are likely to be no worse relative to baseline conditions". Provided these baseline conditions are evidenced and the data source is acknowledged, The Inspectorate is content to scope this matter out.	Section 17.4 summarises the current and likely future climate environment within the vicinity of the Proposed Development Site. Peer-reviewed evidence is provided describing "*no compelling trends in storminess when considering maximum gust speeds over the last five decades*".

Consultee or Organisation	Date and nature of consultation	Summary of response	How comments have been addressed in this Chapter
		ID 4.10.5. Baseline - future climate conditions: No mention is made in the Scoping Report of UK Climate Change Projections (UKCP18) – the most up-to-date assessment of climate change used in National Planning Policy Guidance (NPPG) on Flood Risk Assessment and Climate Change Allowances. The ES should include detailed reference to these projections and associated data, in particular the regional studies; and agree the approach adopted within the ES with the relevant consultation bodies.	Section 17.3 – Determination of the Baseline confirms and describes the use of UKCP18 as the basis for examining the future baseline for the purposes of the ICCI and CCR assessments.
		ID 4.10.6. The Scoping Report asserts that potential GHG emissions can be avoided due to a low carbon approach and the beneficial impact of the Proposed Development on power generation in the UK. There is no detail provided in the Scoping Report regarding the differences between the respective emissions profile and overall carbon impacts with the two main fuel options (natural gas versus hydrogen firing). The Planning Inspectorate ES considers that such detailed information should be provided in the assessment to enable a comparative impact assessment.	Section 17.6 - GHG Impact Assessment details in emissions associated with the different phases and operational scenarios of the Proposed Development. Since the Scoping Report submission, hydrogen fuel is no longer being considered within this application.
		ID 4.10.7. The Scoping Report chapter does not outline the methodology that will be used for the assessment. The differences between an ICCI, a CCI and a CCR Review (Table 7, Table 8) are not clearly	Section 17.3, including sub-section Classification and Significance of Effects describes the methodology for

Consultee or Organisation	Date and nature of consultation	Summary of response	How comments have been addressed in this Chapter
		defined. The ES and/or accompanying appendices should describe the methodology applied to the assessment and how significant effects will be evaluated. Effort should be made to agree the methodology with the relevant consultation bodies.	the GHG, ICCI and CCR assessments including how significant effects will be identified.
		ID 4.10.8. Where relevant, the ES should take into account the following guidance: • IEMA (2017) EIA Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance; and • IEMA (2015) EIA Guide to: Climate Change Resilience and Adaptation.	Section 17.2 - Other Standards and Guidance describes how guidance such as those published by IEMA, have been used within this assessment.
		ID 4.10.9. The CCR acronym is used to refer to the Climate Change Resilience review although it is not defined in the text, and the Glossary defines it as Carbon Capture Ready. The ES will need to ensure there is clarity in the assessment terminology used.	A full abbreviation and acronym list has now been developed.
		ID 4.10.10. The Planning Inspectorate advised that the ES should include a description and assessment (where relevant) of the likely significant effects of the Proposed Development on climate (giving regard to the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change. Consideration should also be given to the adaptive capacity, where relevant.	This Chapter includes a description and assessment of the potential significant effects of the construction, operation and decommissioning of the Proposed Development on climate, along with a GHG emission impact assessment.

Consultee or Organisation	Date and nature of consultation	Summary of response	How comments have been addressed in this Chapter
			Section 17.5 details embedded adaptation measures that aim to increase the resilience of the Proposed Development to climate change hazards.
Lincolnshire Wildlife Trust (LWT)	Stage 2 (Statutory) Consultation January 2021	LWT wish to express their disappointment that a natural gas fired power station is being proposed given the global climate crisis and the well evidenced negative impacts that is having on the natural world. Especially in consideration of the UK Government's targets to reach net zero. The Wildlife Trusts firmly believe that relevant and appropriately located renewable energy generation should be considered the answer.	While the Proposed Development will be gas-fired, the use of carbon capture equipment will be designed to be capable of capturing over 90% of the carbon dioxide emissions from the generating station. Section 17.6 assesses the likely impacts and effects of GHG emissions and includes a significance test against the UK carbon budgets and Net Zero.
Forestry Commission	Stage 2 (Statutory) Consultation January 2021	The Forestry Commission would strongly encourage the applicant to consider climate change when developing their proposed development. The predicted changes in temperature along with introduced plant pests and diseases mean that we there is a need to create and manage woodlands that are more resilient to these threats.	Noted and agreed. Table 17.4 details the scope of the ICCI Assessment, the purpose of which is to understand the influence of climate change on surrounding receptors/ receiving environments in-combination with project-related impacts. Section 17.5

Consultee or Organisation	Date and nature of consultation	Summary of response	How comments have been addressed in this Chapter
			details the embedded measures to reduce the likelihood or severity of combined impacts, and Section 17.6 details the likely impacts and effects combined impacts to surrounding receptors.
Lincolnshire Wildlife Trust	Additional Consultation (April 2021)	LWT reiterate their concerns that natural gas fired power stations will have negative impacts on climate and the UK Government's Net Zero targets. Concerns are also noted about the CCS element not being applied for yet.	This Chapter assesses the impact on GHG emissions and climate change as a result of the construction and operation of the Proposed Development. **Chapter 7**: Legislative Context and Planning Policy (ES Volume I – **Application Document Ref. 6.2**), refers to the Energy White Paper (UK Government 2020) which has at its core the commitment to achieve Net Zero and tackle climate change, recognising that gas with CCS is an important component of the energy mixes to 2050 and is supportive of CCUS clustering

Consultee or Organisation	Date and nature of consultation	Summary of response	How comments have been addressed in this Chapter
			and CCS power generation proposals. Proposals for consenting of the carbon dioxide export pipeline are being progressed under a separate DCO consent by third parties. Details are available on the Planning Inspectorate website.

Summary of Key Changes to Chapter 17 since Publication of the Preliminary Environmental Information (PEI) Report and PEI Report Addendum

17.3.2 The PEI Report was published for statutory consultation in November 2020, allowing consultees the opportunity to provide informed comment on the Proposed Development, the assessment process and preliminary findings through a consultation process, prior to the finalisation of this ES. A PEI Report Addendum was subsequently published in March 2021 following minor changes that were made to the indicative Order Limits since the formal Stage 2 consultation.

17.3.3 The key changes relevant to this Chapter since the PEI Report and PEI Report Addendum were published are summarised in Table 17.2, below. Since the PEI Report, there have been no design changes that have results in any changes to this assessment.

Table 17.2: Summary of key changes to Chapter since publication of the PEI Report and addendum

Summary of change since PEI Report and addendum	Reason for change	Summary of change to Chapter text in the ES
Update of legislation	UK exit of the European Union, and updated UK carbon budgets	Update to Section 17.2, specifically paragraphs 17.2.7, 17.2.9 and 17.2.13 to reflect updates in relevant legislation
Update of consultation	Inclusion of formal consultation matters	Update of consultation from Stage 2, detailed in Table 17.1.
Update of likely impacts and effects	Finalisation of GHG, ICCI and CCR assessments	Update of assessment tables, finalisation of calculations, detailed throughout Section 17.6 and summarised in Section 17.9.

Determination of the Baseline

GHG Emissions Impact Assessment

17.3.4 The baseline conditions for the GHG emissions impact assessment is the 'Do Nothing' scenario where the Proposed Development is not undertaken.

17.3.5 The baseline comprises of existing carbon stocks[1] and sources of GHG within the boundary of the existing Proposed Development Site. The methodology for calculating GHG emissions and removals is consistently used across the baseline, construction, and operational phases of the Proposed Development.

17.3.6 In line with ISO14064 (BSI, 2019a and b) and principles of the GHG Protocol (WRI & WBCSD, 2015), the GHG emissions have been calculated by multiplying activity data by its relevant emission factor:

Activity data x GHG emissions factor = GHG volume

17.3.7 Activity data is a quantifiable measure of activity, such as operating hours or volumes of fuels used. Emission factors convert the activity data into GHG volumes. Activity data has been sourced from client data. Where specific data is not available, a mix of assumptions and industry benchmarks have been used to fill data gaps. Where this is not possible, then a qualitative approach to assessing the GHG impacts has been followed, in line with the IEMA guidance (2017).

17.3.8 Emission factors have been sourced from publicly available sources, Defra (2020), and the University of Bath ICE (2019). Carbon emissions and sinks through land use change have been calculated by using the EU Commission's Guidelines for Land Carbon Stocks (2010).

17.3.9 In line with the ISO standard 14064 and the principles of the GHG Protocol (WRI & WBCSD, 2015) when calculating GHG emissions, the seven Kyoto Protocol GHG have been considered, specifically:

- carbon dioxide (CO_2);
- methane (CH_4);
- nitrous oxide (N_2O);
- sulphur hexafluoride (SF_6);
- hydrofluorocarbons (HFCs);
- perfluorocarbons (PFCs); and
- nitrogen trifluoride (NF_3).

[1] A carbon stock is defined as a quantity of carbon stored within the area, usually in the form of soils and biomass

17.3.10 These gases are broadly referred to in this report under an encompassing definition of 'GHG', with the unit of t CO_2e (tonnes CO_2 equivalent) or Mt CO_2e (mega tonnes of CO_2 equivalent).

ICCI and CCR Assessment

17.3.11 The current baseline for the ICCI and CCR assessment is based on historic climate data obtained from the Met Office (2020a) recorded by the closest meteorological station (Robin Hood Doncaster Sheffield Airport, approximately 21km south-west of the Proposed Development Site) for the period 1981-2010. This is then compared to the future baseline throughout the life of the Proposed Development.

17.3.12 The future baseline for the ICCI and CCR assessment is based on future UK Climate Projections 2018 (UKCP18) (The Met Office, 2020b). This projection data provides probabilistic indications of how global climate change is likely to affect areas of the UK using pre-defined climate variables and time periods.

17.3.13 For the purpose of the assessment, UKCP18 probabilistic projections for pre-defined 20-year periods for the following average climate variables have been obtained and will be further analysed:

- mean annual temperature;
- mean summer temperature;
- mean winter temperature;
- maximum summer temperature;
- minimum winter temperature;
- mean annual precipitation;
- mean summer precipitation;
- mean winter precipitation; and
- sea level rise.

17.3.14 UKCP18 probabilistic projections have been analysed for the 25km grid square within which the Proposed Development is located. These figures are expressed as temperature/ precipitation anomalies in relation to the 1981-2000 baseline. This baseline was selected as it provides projections for 20-year time periods (e.g. 2020-2039) for the parameters analysed within the assessment compared to the 30-year land-based projections that would be generated from the 1981 - 2010 baseline.

17.3.15 UKCP18 uses a range of possible scenarios, classified as Representative Concentration Pathways (RCP), to inform differing future emission trends. These RCPs '[…] *specify the concentrations of GHG that will result in total*

radiative forcing increasing by a target amount by 2100, relative to preindustrial levels'. RCP8.5 is considered to be the worst-case global scenario with the greatest concentration of GHG in the atmosphere and has been used as the purposes of this assessment as a worst-case scenario.

Project Environment

17.3.16 The alternative environment to the 'Do Nothing' scenario in which the Proposed Development is not undertaken is a 'Do Something' scenario with the delivery of the Proposed Development, which includes its construction, operation and decommissioning.

Scope of Assessments

GHG Emissions Impact Assessment

17.3.17 The scope of the assessment includes activities that will emit GHG within the project environment and are detailed in Table 17.3.

17.3.18 As described in **Chapter 1:** Introduction (ES Volume I - **Application Document Ref. 6.2**), the carbon dioxide export pipeline does not form part of this application and is not included within the scope of the GHG assessment (or the wider DCO application) and will be the subject of separate consent applications by third parties.

Table 17.3: Scope of Potential GHG Emission Sources from the Proposed Development

Lifecycle Stage	Activity	Primary Emission Sources	Scoped In/Out
Enabling Works	Any enabling works	GHG emissions from any activities required onsite prior to construction	In
	Land clearance	Loss of carbon sink.	In
Construction Process	On-site construction activity Transport of construction workers	Energy (electricity, fuel, etc.) consumption from plant and vehicles, generators on site, and construction workers commuting. GHG emissions from fuel consumption for transportation of construction workers	In
	Transportation and disposal of construction waste	GHG emissions from energy use and from fuel consumption for transportation of waste	In
	Provision and treatment of water	GHG emissions from the supply of potable water, and the disposal and treatment of wastewater	In
	Raw material extraction and manufacturing of products/materials Transport of products/materials to site.	Embodied GHG emissions. GHG emissions from fuel consumption for transportation of materials.	In
Operations	Operation of the Proposed Development	GHG emissions from electricity generation when not captured by the carbon capture plant and energy use in buildings	In
	Use of vehicles i.e. cars and motorcycles	GHG emissions from vehicle use from worker journeys to and from the Site	In

Lifecycle Stage	Activity	Primary Emission Sources	Scoped In/Out
	Disposal and transportation of operational waste	GHG emissions from recycling/ disposal of process waste and domestic waste GHG emissions from fuel consumption for transportation of raw materials and waste	In
	Provision and treatment of water	GHG emissions from the supply of potable water, and the disposal and treatment of wastewater	In
	Building/infrastructure maintenance	GHG emissions from maintenance of buildings and infrastructure/assets in the operational stage	In
Decommissioning	Raw material extraction and manufacturing of products/materials Transport of products/materials to site	Embodied GHG emissions. GHG emissions from fuel consumption for transportation of materials.	In
	On-site decommissioning activity Transport of decommissioning workers	Energy (electricity, fuel, etc.) consumption from plant and vehicles, generators on site, and workers commuting. GHG emissions from fuel consumption for transportation of workers	In
	Transportation and disposal of waste	GHG emissions from energy use and from fuel consumption for transportation of waste	In
	Provision and treatment of water	GHG emissions from the supply of potable water, and the disposal and treatment of wastewater	In

ICCI Assessment

17.3.19 The scope of the ICCI assessment includes climatic variables that have the potential to increase the impact to surrounding receptors. The ICCI assessment considers the existing and projected future climate conditions for the geographical location and assessment timeframe. It identifies the extent to which identified receptors in the surrounding environment are potentially vulnerable to and affected by these factors. The receptors for the ICCI assessment are those that will be impacted by the Proposed Development. These impacts have been assessed in liaison with the technical specialists responsible for preparing other technical chapters of this ES.

17.3.20 The scope of the ICCI assessment is detailed within Table 17.4.

Table 17.4: Scope of the ICCI Assessment

Climate Variable	Scoped In/Out	Rationale
Extreme weather event	In	An increase in the likelihood and severity of extreme weather events could lead to damage to ecosystem stability. In combination with sea level rise, the likelihood and severity of acute coastal impacts such as erosion, loss of habitats, destabilisation and damage to infrastructure. These impacts may be exacerbated by the Proposed Development. The primary topic of interest for this potential climate variable is Water Environment and Flood Risk. ICCI impacts associated with extreme weather events and flood risk are assessed within **Appendix 12A**: Flood Risk Assessment (ES Volume II - **Application Document Ref. 6.3**). A summary of key conclusions is provided within this Chapter.
Precipitation change leading to flash flooding	In	Climate change may lead to an increase in substantial precipitation that may cause flooding and erosion. The combination of the Proposed Development and climate change may cause increased risk of impacts. The primary topic of interest for this potential climate variable is Water Environment and Flood Risk. ICCI impacts associated with extreme weather events and flood risk are assessed within **Appendix 12A**: Flood Risk Assessment (ES Volume II - **Application Document Ref. 6.3**). A summary of key conclusions is provided within this Chapter.
Precipitation change leading to droughts	In	Climate change may lead to drought events. The combination of the Proposed Development, its water requirements and climate change may cause increased risk of impacts.

Climate Variable	Scoped In/Out	Rationale
Temperature and Humidity	In	Fluctuating levels of temperature may lead to: • Increase in likelihood and severity of heat waves which might have a negative impact on biodiversity and health; and • Increase in likelihood and severity of freezes which might have a negative impact on biodiversity and health.
Sea level rise	In	The Proposed Development Site is located in an area that is susceptible to sea level rise. The primary topic of interest for this potential climate variable is Water Environment and Flood Risk. ICCI impacts associated with sea level rise have been considered within **Appendix 12A**: Flood Risk Assessment (ES Volume II - **Application Document Ref. 6.3**). A summary of key conclusions is provided within this Chapter.
Sea water temperature	In	The Proposed Development will produce thermal discharges which may be directed to the (tidal) River Trent via the outfall. The combination of this with increasing sea/ estuarine temperatures could potentially cause increased risks to habitats and species within the riverine environment if not appropriately managed. However, it is anticipated that the rate of expected discharge from the Proposed Development will be less than $1m^3/s$ and discharged intermittently. This is likely to be discharged in combination with the $0.016m^3/s$ discharged from Keadby 2 Power Station. The existing Keadby 1 Power Station permit (EPR/YP3133LL) allows a maximum daily flow of $15m^3/s$ (average of 24-hour period). Consequently, it is considered that the Proposed Development will be operating well within the existing consented parameters of Keadby 1 Power Station. It is therefore considered that there will be negligible impact in EIA terms to the temperature status of the River Trent, and the discharge would not prevent a barrier to migratory routes for fish. Further information on this climate variable is available within **Chapter 12:** Water Environment and Flood Risk (ES Volume I - **Application Document Ref. 6.2**).

Climate Variable	Scoped In/Out	Rationale
Wind	Out	The Proposed Development is not expected to alter the wind environment and therefore not to have any additional impact upon receptors identified by other environmental disciplines. Section 17.4 summarises the current and likely future climate environment within the vicinity of the Proposed Development Site. Peer-reviewed evidence is provided describing "*no compelling trends in storminess when considering maximum gust speeds over the last five decades*".

17.3.21 Construction and operation of the Proposed Development has been assessed on the basis of an initial 6 months enabling works phase, followed by a 3 year construction for the Main Works phase and subsequent commissioning, with circa 25 years of operations prior to decommissioning. As the construction phase would be much shorter in duration than the operational phase, and would be undertaken within the next ten years, future climate change is less relevant to the assessment of construction impacts and effects. Accordingly, the ICCI assessment for the construction phase follows a descriptive based approach only.

17.3.22 An assessment of ICCI following the steps shown in Figure 17.2, below, has been conducted for the Proposed Development that identifies potential climate change impacts and considers their potential consequence and likelihood of occurrence.

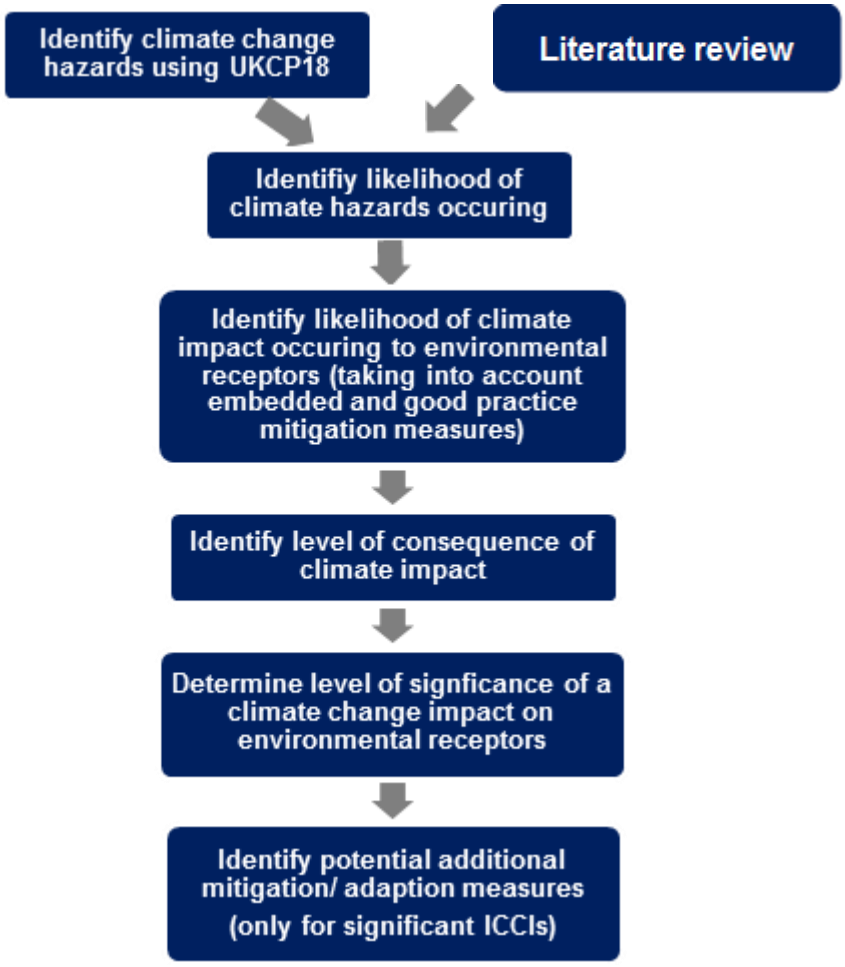

Figure 17.2: ICCI Assessment Methodology

17.3.23 The likelihood of an in-combination impact occurring (a change in the impact significance level to surrounding receptors when the impacts from the Proposed Development are considered in-combination with climate change)

has been determined based on the assessed likelihood of a climate hazard occurring, combined with the sensitivity of the receptor as defined by the relevant environmental disciplines, using professional judgement.

17.3.24 Information on historic observations on climate change such as the UK Climate Change Risk Assessment (UK Government, 2017b) along with climate change projection data from UKCP18 has been used to identify potential chronic and acute climate hazards that may affect the geographical location of the Proposed Development.

17.3.25 The likelihood of each potential climate change hazard occurring has then been assessed. Likelihood is categorised into five levels depending on the probability of the hazard occurring. Table 17.5 presents the likelihood levels and definitions used. This is in line with the definitions presented in IPCC Fifth Assessment Report (IPCC, 2014).

Table 17.5: ICCI Assessment - Level of Likelihood of the Climate Hazard Occurring

Level of Likelihood	Definition of Likelihood
Very likely	90-100% probability that the hazard will occur
Likely	66-90% probability that the hazard will occur
Possible, about as likely as not	33-66% probability that the hazard will occur
Unlikely	0-33% probability that the hazard will occur

17.3.26 There is some amount of overlap in the criteria provided to allow for uncertainty and the qualitative approach of the assessment.

17.3.27 Identified climate hazards and the level of likelihood that they will occur is presented further below. The likelihood of an ICCI occurring is determined based on the likelihood of a climate hazard occurring (Table 17.5) combined with the sensitivity of the receptor as defined by the relevant environmental disciplines, using professional judgement. Consideration is given to any increase in the impact of the Proposed Development.

17.3.28 In defining the likelihood of an ICCI occurring, embedded and good practice mitigation measures (primary and tertiary mitigation) are accounted for. Definitions of likelihood are set out in Table 17.6 to support ICCI assessment but where it does not fit with discipline specific criteria to assess effects then expert judgement is used to qualitatively assess whether the likelihood of the impact occurring is very likely – very unlikely.

Table 17.6: ICCI Assessment – Level of Likelihood of the Climate Impact Occurring

Level of likelihood of climate impact occurring	Definition of likelihood
Likely	66-100% probability that the impact will occur during the life of the project
Possible, about as likely as not	33-66% probability that the impact will occur during the life of the project
Unlikely	0-33% probability that the impact will occur during the life of the project

17.3.29 Table 17.7 is then used to determine the overall likelihood of the ICCI.

Table 17.7: ICCI assessment- Level of Likelihood of the ICCI

Likelihood of impact occurring (given embedded mitigation measures) (Table 17.6)	Likelihood of climate change hazard occurring (Table 17.5)				
	Very unlikely	Unlikely	Possible	Likely	Very likely
Unlikely	Low	Low	Low	Medium	Medium
Possible	Low	Low	Medium	Medium	Medium
Likely	Low	Medium	Medium	High	High

17.3.30 Once the likelihood of an ICCI occurring on a receptor has been identified, the environmental assessment considers how this will affect the significance of the identified effects.

17.3.31 The ICCI consequence criteria are defined in and are based on the change to the significance of the effect already identified by the environmental discipline. To assess the consequence of an ICCI impact, each discipline has assigned a level of consequence to an impact based on the criteria description in and their discipline assessment methodology.

Table 17.8: ICCI assessment – Level of Consequence of the Climate Impact Occurring

Consequence	Consequence criteria
High	The climate change parameter in-combination with the effect of the Proposed Development causes the significance of the effect of the development on the resource/ receptor, as defined by the topic, to increase from negligible, minor or moderate to major.
Medium	The climate change parameter in-combination with the effect of the Proposed Development causes the effect defined by the topic to increase from negligible or minor to moderate.
Low	The climate change parameter in-combination with the effect of the Proposed Development, causes the significance of effect defined by the topic to increase from negligible to minor.
Very low	The climate change parameter in-combination with the effect of the Proposed Development does not alter the significance of the effect defined by the topic.

CCR Assessment

17.3.32 The scope of the CCR assessment includes climatic variables that have the potential to impact the Proposed Development itself. The CCR assessment includes both slow and rapid onset climate hazards as per the UKCP18 dataset (The Met Office, 2020b).

17.3.33 The scope of the CCR assessment is detailed within Table 17.9, below.

Table 17.9: Scope of the CCR Assessment

Climate Variable	Scoped In/Out	Rationale
Extreme weather event	In	The Proposed Development may be vulnerable to extreme weather events such as storm damage, coastal erosion and storm surge to structures and assets.
Precipitation	In	The Proposed Development may be vulnerable to changes in precipitation, for example, pressure on water supply during periods of reduced rainfall, and damage to structures and drainage systems during periods of heavy precipitation.

Climate Variable	Scoped In/Out	Rationale
Temperature	In	Increased temperatures may increase cooling requirements of the proposed scheme and could impact on structural integrity of buildings and materials.
Sea level rise	In	The Site is located in an area that is susceptible to sea level rise.
Sea temperature	Out	The Proposed Development is not likely to be affected by the small increase in sea temperature during its operational life.
Wind	Out	The impacts of wind on receptors in the surrounding environment are likely to be no worse relative to baseline conditions.

17.3.34 The identification and assessment of climate change resilience within EIA is an area of emerging practice. There is no single prescribed format for undertaking such assessments; therefore, the approach adopted to undertaking and reporting the assessment has drawn on good practice from other similar developments and studies and is aligned with existing guidance such as that of IEMA (IEMA, 2020).

17.3.35 The methodology for the CCR assessment is summarised in Figure 17.3

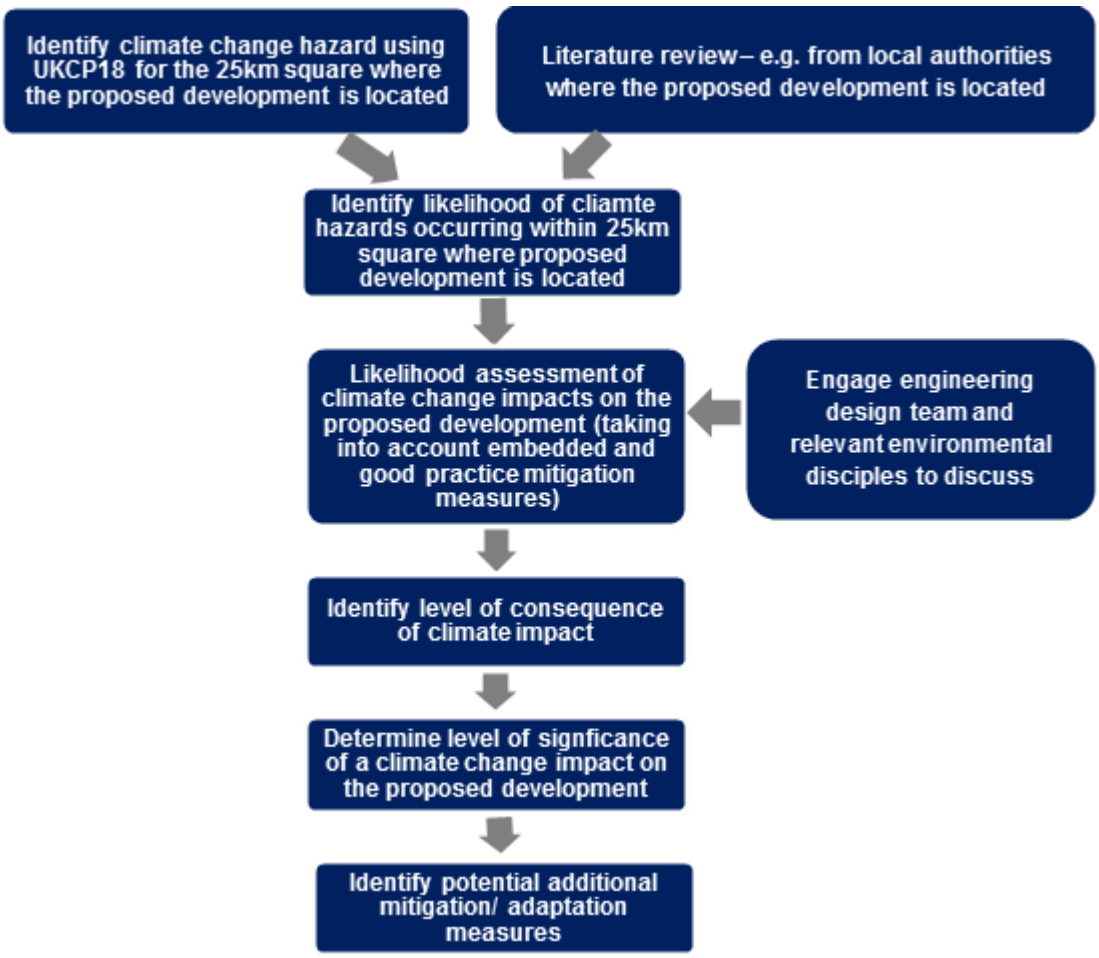

Figure 17.3: CCR Assessment Methodology

17.3.36 For the operational phase of the Proposed Development, once potential impacts have been identified, the likelihood and consequence of each impact occurring to each receptor (where relevant) are assessed for the selected future timeframe for operation.

17.3.37 Criteria used to determine the likelihood of an event occurring, based on its probability and frequency of occurrence, are detailed in Table 17.10.

Table 17.10: CCR Assessment - Description of Likelihood for Climate Change Hazard

Level of Likelihood	Definition of Likelihood
Very likely	90-100% probability that the hazard will occur
Likely	66-90% probability that the hazard will occur
Possible, about as likely as not	33-66% probability that the hazard will occur
Unlikely	0-33% probability that the hazard will occur
Very unlikely	0-10% probability that the hazard will occur

**The event is defined as the climate event (such as heatwave) and the hazard (such as overheated electrical equipment) occurring in combination*

17.3.38 The consequence of an impact has been measured using the criteria detailed in Table 17.11.

Table 17.11: CCR Assessment - Description of Likelihood for Climate Change Hazard

Consequence of Impact	Description
Very high	Permanent damage to structures/assets; Complete loss of operation/service; Complete/partial renewal of infrastructure; Serious health effects, possible loss of life; Extreme financial impact; and Exceptional environmental damage.
High	Extensive infrastructure damage and complete loss of service; Some infrastructure renewal; Major health impacts; Major financial loss; and Considerable environmental impacts.
Medium	Partial infrastructure damage and some loss of service; Moderate financial impact; Adverse effects on health; and Adverse impact on the environment.
Low	Localised infrastructure disruption and minor loss of service; No permanent damage, minor restoration work required; and Small financial losses and/or slight adverse health or environmental effects.
Very low	No damage to infrastructure; No impacts on health or the environment; and No adverse financial impact.

17.3.39 Engagement has been undertaken with relevant environmental disciplines and the engineering design team to discuss the CCR assessment and identify mitigation measures for incorporation into the design of the Proposed Development.

17.3.40 Measures to adapt the Proposed Development to climate change hazards are detailed in Section 17.5, and the assessment of effects is detailed in Section 17.6.

Study Area

GHG Emissions Impact Assessment

17.3.41 The GHG study area includes all GHG emissions from within the Proposed Development Site boundary arising during all stages of the construction, operation and decommissioning of the Proposed Development. It also includes emissions arising from off-site activities which are directly related to the on-site activities, such as transport, and treatment of materials and waste disposal.

ICCI Assessment

17.3.42 The study area for the ICCI assessment is the study area defined by each of the topic chapter of the ES (**Chapters 8-18** (ES Volume I – **Application Document Ref. 6.2**)). This assessment aims to determine the influence of climate change and project-related impacts to the identified receptors in each of the assessments in those chapters.

CCR Assessment

17.3.43 The study area for the CCR review is the Proposed Development itself.

Sensitive Receptors

GHG Emissions Impact Assessment

17.3.44 The identified receptor for GHG emissions is the global climate as the effects are not geographically constrained which means all developments have the potential to result in a cumulative effect on GHG emissions. Therefore, for the purpose of the GHG emissions impact assessment, the global climate will be used as the sensitive receptor. The UK's relevant five-year carbon budget will be used as a proxy for the global climate.

ICCI Assessment

17.3.45 The ICCI assessment considers the sensitive receptors identified by each Environmental discipline in their assessment, as defined in **Chapters 8 to 18** (ES Volume I – **Application Document Ref. 6.2**). The ICCI assessment is undertaken by individual technical disciplines in regard to the identified sensitive receptors in each assessment.

CCR Assessment

17.3.46 Sensitive receptors include workers, occupiers, users and associated infrastructure and include:

- construction phase receptors (i.e. workforce, plant and machinery);

- the Proposed Development assets and their operation, maintenance and refurbishment (i.e. pavements, structures, earthworks and drainage, technology assets, etc.); and
- end-users (i.e. staff and commercial operators etc.).

Classification and Significance of Effects

GHG Emissions Impact Assessment

17.3.47 IEMA (2017) guidance states that there are currently no agreed methods to evaluate levels of GHG significance and that professional judgement is required to contextualise a project's emission impacts.

17.3.48 In GHG accounting, it is considered good practice to contextualise emissions against pre-determined carbon budgets (IEMA, 2017). In the absence of sector-based or local emissions budgets, the UK carbon budgets can be used to contextualise the level of significance .

17.3.49 When considering the scope and boundary for inclusion of GHG emissions it is standard accounting practice to exclude minor sources as these are not material. Both the Department of Energy and Climate Change (2013) and the PAS 2050 Specification (BSI, 2011) allow emissions sources that contribute or remove less than 1% to the total inventory to be excluded as immaterial. Inventories that exclude these minor sources are still considered complete for verification purposes. This exclusion of emission sources that are <1% of a given emissions inventory is on the basis of a '*de minimis*' (relatively minimal) contribution.

17.3.50 On this basis, where GHG emissions from the Proposed Development are equal to or more than ±1% of the relevant annual UK Carbon Budgets, the impact of the Proposed Development on the climate is considered of high significance. This is summarised in Table 17.12.

Table 17.12: Magnitude Criteria for GHG Emissions

Magnitude	Magnitude Criteria Description
High Increase	Estimated GHG emissions from the Proposed Development equate to equal to or more than 1% of total emissions across the relevant 5-year UK Carbon Budget period in which they arise
Low Increase	Estimated GHG emissions from the Proposed Development equate to less than 1% of total emissions across the relevant 5-year UK Carbon Budget period in which they arise
Low Reduction	Estimated GHG emissions equate to a reduction of less than 1% of total emissions across the relevant five-year UK Carbon Budget period in which they arise

Magnitude	Magnitude Criteria Description
High Reduction	Estimated GHG emissions equate to a reduction of equal to or more than 1% of total emissions across the relevant five-year UK Carbon Budget period in which they arise

17.3.51 There is currently no published standard definition for receptor sensitivity of GHG emissions. As per IEMA (2017) guidance, all GHG emissions are classed as having the potential to be significant as all emissions contribute to climate change (IEMA (2017). The global climate has been identified as the receptor for the purposes of the GHG assessment. The sensitivity of the climate to GHG emissions is considered to be 'high'. The rationale supporting this includes:

- any additional GHG emission impacts could compromise the UK's ability to reduce its GHG emissions and therefore the ability to meet its future carbon budgets; and
- the importance of meeting the Paris Agreement goal of limiting global average temperature increase to well below 2ºC above pre-industrial levels, (Framework Convention on Climate Change (FCCC/CP/2015/10Add.1), UNFCCC, 2016). Additionally, a recent report by the IPCC highlighted the importance of limiting global warming below 1.5°C (IPCC, 2018).

17.3.52 This method to determine the significance of GHG emissions are summarised in Table 17.13.

Table 17.13: Significance Criteria for GHG Emissions

Magnitude of emissions (from Table 17.12, above)		Sensitivity of Receptor
		High
	Low Increase	Minor adverse significance
	High Increase	Major adverse significance
	Low Reduction	Minor beneficial significance
	High Reduction	Major beneficial significance

UK Carbon Budgets

17.3.53 The UK carbon budgets are in place to restrict the volume of GHG emissions the UK can legally emit in a five-year period (UK Government, 2021). The UK is currently in the 3rd carbon budget period, which runs from 2018 to 2022, as detailed in Table 17.14. The 3rd to the 5th carbon budgets reflect the earlier UK target (80% reduction target by 2050). The 6th carbon budget, currently under consideration by the UK Government, is the first budget to reflect the amended Net Zero target. As the Proposed Development will likely be active

past 2050, the assessment also compares the emissions against Net Zero in 2050.

17.3.54 Construction of the Proposed Development is likely to intersect the carbon budget periods running from 2023 to 2026 (UK 4th Carbon Budget). Commissioning will then follow, and an operational period of circa 25 years, anticipated to be from circa 2026 to 2051 (intersecting the UK 4th, 5th and 6th Carbon Budgets and beyond), intersecting the net zero target of 2050. At the end of this operational period, it is anticipated that the Proposed Development will have some residual life remaining and an investment decision would then be made based on the market conditions prevailing at that time. If the operating life were to be extended, the Proposed Development would be upgraded in line with the legislative requirements at that time. On this basis, decommissioning activities are not currently anticipated to commence before 2051.

17.3.55 Although there are no sectoral budgets, the CCC does provide sectoral emissions allocations that underpin the development of each UK Carbon Budgets. The allotted emissions associated with 'electricity supply' for the 6th UK Carbon Budget, using the more conservative 'Widespread Innovation' scenario are also detailed in Table 17.14. To further contextualise, operational emissions will be compared to these allocations to understand the magnitude of emissions.

Table 17.14: UK Carbon Budgets

UK Carbon Budget	Total Budget ($MtCO_{2e}$)	Total Industry Allocation ($MtCO_{2e}$) for Electricity Supply
3rd (2018-2022)	2,544	144.3*
4th (2023-2027)	1,950	178.3
5th (2028-2032)	1,725	80.3
6th (2033-2037)**	965	27.4

**Partial allocation including three years only (2020 to 2022)*

*** Published by the Climate Change Committee in November 2020 for the consideration of Government Ministers*

ICCI Assessment

17.3.56 The significance of potential effects is determined by the environmental disciplines using the matrix in Table 17.15. As a general rule, where an effect has been identified as moderate or major, this has been deemed significant. However, professional judgement is also applied where appropriate.

Table 17.15: ICCI Assessment- Significance Criteria

		Likelihood (Table 17.7)		
		Low	Medium	High
Consequence (Table 17.8)	Very Low	Negligible	Negligible	Minor
	Low	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Major

17.3.57 Where an ICCI is determined to be significant then appropriate additional mitigation measures (secondary mitigation) is identified.

17.3.58 Professional judgement is used to describe whether with additional mitigation in place, the ICCI remains significant or the residual effect has been reduced to not significant.

17.3.59 Where relevant, mitigation measures or mechanisms to reduce the potential significant effects arising from ICCI have been developed in discussion with environmental specialists.

CCR Assessment

17.3.60 The identification of likely significant effects on receptors has been undertaken using professional judgement by combining the measure of likelihood with the predicted consequence of impact, as shown in Table 17.16. As a rule, where an effect has been identified as moderate or major, this has been deemed significant. However, professional judgement is also applied where appropriate.

Table 17.16: CCR Assessment- Significance Criteria

		Likelihood (Table 17.10)				
		Very unlikely	**Unlikely**	**Possible**	**Likely**	**Very likely**
Consequence (Table 17.8)	**Very Low**	Negligible	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Minor	Minor	Minor	Minor
	Medium	Negligible	Minor	Moderate	Moderate	Moderate
	High	Negligible	Minor	Moderate	Major	Major
	Very high	Negligible	Minor	Moderate	Major	Major

17.3.61 The assessment of potential impacts and the Proposed Development's vulnerability takes into account the mitigation measures that have been designed into the Proposed Development as discussed in Section 17.5. The assessment also identifies and accounts for existing climate change

resilience measures either already in place or in development for infrastructure and assets, for example, mitigation measures for potential flooding impacts on the Proposed Development.

Rochdale Envelope

17.3.62 A focused use of the Rochdale Envelope approach has been adopted to present a worst-case assessment of potential environmental effects of the different parameters of the Proposed Development that cannot yet be fixed. The parameters included within the Rochdale Envelope are described in **Chapter 4**: The Proposed Development (ES Volume I – **Application Document Ref. 6.2**). The Rochdale Envelope approach has specifically been used to estimate likely material quantities for the construction of the Proposed Development and also to inform the CCR and ICCI impacts and effects in relation to the findings of the Flood Risk Assessment (**Appendix 12A** (ES Volume II – **Application Document Ref. 6.3**)).

17.4 Baseline Conditions

GHG Emissions Impact Assessment

17.4.1 The Proposed Development Site is described in **Chapter 3:** The Site and Surrounding Area (ES Volume I - **Application Document Ref. 6.2**). The Proposed Development Site is adjacent to the existing boundary for Keadby 1 Power Station (operational) and Keadby 2 Power Station (under construction). The Proposed Development Site covers approximately 69.4 hectares (ha), of which the Proposed PCC Site is 18.7ha.

17.4.2 As described in **Chapter 3**: The Site and Surrounding Area (ES Volume I - **Application Document Ref. 6.2**), the Proposed PCC Site includes the northern areas of Keadby Common where the CCGT and CCP are proposed (referred to as the 'Main Site') occupied by improved grassland, with a drain on each boundary (four drains in total). The Proposed PCC Site is bisected by overhead electricity transmission lines associated with the existing National Grid 400kV Substation to the east of the Proposed PCC Site. In the vicinity of the overhead lines a swathe of unmanaged semi-improved grassland and pockets of scattered scrub occur within the Proposed PCC Site. To the south of these areas, existing land within the Proposed PCC Site comprises extensive hardstanding areas associated with the Keadby 2 Power Station laydown and construction site.

17.4.3 For the purposes of determining net changes in GHG emissions as a consequence of the Proposed Development, the baseline emissions are considered to be zero and all project emissions are considered as additional. Use of this precautionary principle approach provides a conservative assessment, as not all activities (and therefore GHG emissions) will be additional activities given the nature of existing land-use on-Site.

ICCI and CCR Assessment

17.4.4 The current climatic baseline (1981 to 2010) for the location is listed in Table 17.17

Table 17.17: Historic Climate Data

Climatic Variable	Month	Value
Average annual maximum daily temperature (°C)	-	14.1
Warmest month on average (°C)	July	21.9
Coldest month on average (°C)	January and February	1
Mean annual rainfall levels (mm)	-	574.5
Wettest month on average (mm)	June	63
Driest month on average (mm)	February	32.2

17.4.5 The Met Office historic 10-year averages for the 'East and North East England' region identify gradual warming (although not uniformly so) between 1970 and 2019, with increased rainfall also. Information on mean maximum annual temperatures and mean annual rainfall is summarised in Table 17.18.

Table 17.18: Historic 10-year Averages for Temperature and Rainfall for the East and North-East England

Climate Period	Climatic Variable	
	Mean Maximum annual temperatures	Mean Annual Rainfall (mm)
1970-1979	12.0	698.2
1980-1989	12.0	748.2
1990-1999	12.7	720.2
2000-2009	13.2	824.9
2010-2019	13.1	796.2

17.4.6 Projected variables are presented in Table 17.19 to Table 17.21.

Table 17.19: Projected Changes in Temperature Variables (°C), 50% Probability (10% and 90% Probability in Parenthesis)

Climate Variable	Time Period		
	2020 - 2039	2030 - 2049	2050-2069
Mean annual air temperature anomaly at 1.5m (°C)	+1.0 (+0.3 to +1.7)	+1.3 (+0.6 to +2.2)	+2.2 (+1.0 to +3.4)
Mean summer air temperature anomaly at 1.5m (°C)	+1.2 (+4 to +2.0)	+1.5 (+0.4 to +2.6)	+2.6 (+0.9 to +4.3)
Mean winter air temperature anomaly at 1.5m (°C)	+0.9 (0 to +1.9)	+1.3 (0.1 to +2.5)	+2.0 (+0.5 to +3.6)
Maximum summer air temperature anomaly at 1.5m (°C)	+1.2 (+0.2 to +2.4)	+1.6 (+0.3 to +3.0)	+2.9 (+0.8 to +5.1)
Minimum winter air temperature anomaly at 1.5m (°C)	+0.9 (-0.1 to +1.9)	+1.2 (0 to +2.5)	+2.0 (+0.5 to +3.6

Table 17.20: Projected Changes in Precipitation Variables (%), 50% Probability (10% and 90% Probability in Parenthesis)

Climate Variable	Time Period		
	2020 -2039	2030 - 2049	2050-2069
Annual precipitation rate anomaly (%)	+1.7 (-3.0 to +6.7)	-0.3 (-4.8 to +4.6)	-1.0 (-7.2 to +5.3)
Summer precipitation rate anomaly (%)	-4.9 (-24.4 to +15.4)	-8.8 (-29.5 to +12.0)	-19.4 (-46.0 to +8.3)
Winter precipitation rate anomaly (%)	+3.7 (-5.3 to +13.6)	+4.7 (-4.6 to +14.6)	+9.5 (-4.8 to +24.8)

17.4.7 Sea level rise may increase up to 16cm by the time operations start (approximately 2026) and up to 37cm by the end of the 25 year operational life, which would be the earliest date that decommissioning activities may commence (i.e. 2051).

17.4.8 For the purposes of this assessment, a range of time periods are reviewed over this period from the earliest start of commercial operations (2026) through to the latter stages of operation/ potential decommissioning (2051). The ranges of projected sea level rise from the 1981-2000 baseline are detailed in Table 17.21.

Table 17.21: Projected 50% Probability of Sea Level Rise Under RCP 8.5 Relative to the 1981-2000 Baseline Period (10% And 90% Probability in Parenthesis)

Climate Variable	Time Period		
	2026	2036	2051
Sea level anomaly (m)	+0.12 (+0.10 to +0.16)	+0.18 (+0.14 to +0.23)	+0.29 (+0.22 to +0.37)

17.4.9 Sea temperature change projections are more variable, but under RCP 8.5 a rise in global sea surface temperature of 1.5°C by 2050 is predicted, and 3.2°C by 2100, relative to 1870–1899 temperatures. In UK waters, mean annual sea temperatures have risen by 0.8°C since 1870, and have shown a consistent warming trend from the 1970s onwards (Genner *et al*., 2017). According to Lowe *et al*., (2009), the seas around the UK are projected to be 1.5 – 4 ºC warmer by 2100.

17.4.10 The 2019 State of the UK Climate report (Kendon *et al*., 2020) states that there are "*no compelling trends in storminess when considering maximum gust speeds over the last five decades*", therefore an increase in storm intensity is currently considered unlikely. Using the climate variable likelihood data for future baselines and the definitions for likelihood, the likelihood of occurrence of potential climate hazards are detailed in Table 17.22.

Table 17.22: Potential Climate Hazards/and Likelihood of Occurrence (from UKCP18 Projections)

Climate Variable	Potential Hazard	Time Period		
		2020 - 2039 Likelihood	2030 - 2049 Likelihood	2050- 2069 Likelihood
Mean annual air temperature anomaly at 1.5m (°C)	Increase in mean annual air temperature	Very Likely	Very Likely	Very likely

Climate Variable	Potential Hazard	Time Period		
		2020 - 2039 Likelihood	2030 - 2049 Likelihood	2050- 2069 Likelihood
Mean summer air temperature anomaly at 1.5m (°C)	Increase in mean summer air temperature	Very Likely	Very Likely	Very likely
Mean winter air temperature anomaly at 1.5m (°C)	Increase in mean winter air temperature	Very Likely	Very Likely	Very likely
Maximum summer air temperature anomaly at 1.5m (°C)	Increase in maximum summer air temperature	Very Likely	Very Likely	Very likely
Minimum winter air temperature anomaly at 1.5m (°C)	Increase in minimum winter air temperatures	Likely	Very Likely	Very likely
Annual precipitation rate anomaly (%)	Decrease in annual precipitation rate	Likely	Possible	Possible
Summer precipitation rate anomaly (%)	Decrease in summer precipitation rate	Possible	Likely	Likely
Winter precipitation rate anomaly (%)	Increase in winter precipitation rate	Likely	Likely	Likely
Sea level rise (m)	Increase in sea level	Very Likely	Very Likely	Very likely
Sea temperature rise (°C)	Increase in sea surface temperature	Very Likely	Very Likely	Very likely

17.5 Development Design and Impact Avoidance

Construction Phase

17.5.1 Embedded control measures that have been developed through the design processes to reduce the likelihood or consequence of negative impacts during the construction phase are listed in Table 17.23.

Table 17.23: Embedded Control Measures During Construction

Climate Impact Aspect	Measure Purpose	Measure Description
GHG emissions	Reduce GHG emissions	Aspects of GHG emissions will be managed through the final Construction Environmental Management Plan (CEMP) and related plans including the Site Waste Management Plan (SWMP) and Soil Resources Plan that controls construction activities to minimise any impact on the environment through relevant regulations, industry good practice and specific measures described within this ES. The appointed contractor(s) will be required to develop and implement a CEMP to measure, monitor and report energy and water consumption and GHG emissions during construction. A Framework CEMP (**Application Document Ref. 7.1**) has been developed, and includes proposed measures to reduce GHG emissions through: • fuel consumption on site in vehicles, equipment and plant through minimisation of idling, and switching off when not being used. Preference of lower carbon fuels such as HVO fuel, biodiesel or electric powered plant instead of traditional fossil fuels; • water consumption in the on-site amenity blocks and construction activities (including dampening down as part of dust mitigation); • minimisation of the impacts of transportation of materials to the site through implementation of the Construction Traffic Management Plan (CTMP) – a Framework CTMP is provided as **Application Document Ref. 7.2** and secured through a requirement in the draft DCO (**Application Document Ref. 2.1**); and • setting minimum rates for material recycling and re-use, as described in the Site Waste Management Plan, a framework of which is included in the Framework CEMP (**Application Document Ref. 7.1**).
		Consideration in specifying construction materials to options for lower embodied carbon emissions i.e. higher recycled content, where this is reasonably practicable.

Climate Impact Aspect	Measure Purpose	Measure Description
		Construction staff are anticipated to travel to the Proposed Development via the existing trunk road and local networks. The Applicant will seek to maximise sustainable transport options as outlined in the Construction Workers' Travel Plan (**Application Document Ref. 7.3**) and secured through a requirement in the draft DCO (**Application Document Ref. 2.1**).
		Design development has already avoided the most sensitive habitat for temporary laydown, as described in **Chapter 6**: Consideration of Alternatives (ES Volume I – **Application Document Ref. 6.2)**. Where habitat loss cannot be avoided, a landscape management and enhancement plan (LBMEP) has been developed to ensure replacement habitat creation and overall biodiversity net gain (**Application Document Ref. 5.10**).
		Reducing construction works by re-using, replacing or upgrading the existing water connection infrastructure on-Site, and using techniques such as the 'sliplining' trenchless construction where practicable.
ICCI	Reduce climatic impacts to local receptors	It is proposed that the selected contractor would be encouraged to be a member of the Considerate Constructors Scheme (CCS) which is an initiative open to all contractors undertaking building work. This would assist in reducing pollution and nuisance from the Proposed Development. The Framework CEMP (**Application Document Ref. 7.1**) incorporates measures to prevent an increase in flood risk during the construction works. Examples of such measures include adequate containment of storage areas, to ensure that material does not wash away and cause pollution and damage to infrastructure during adverse weather, including heavy rainfall, flooding or storms. In accordance with best practice, measures will be taken to prevent materials being moved off-site, including siting maintaining standoffs from watercourses, bunding to prevent release of materials into local watercourses, and use of enclosures/ seeding to stabilise material stockpiles.

Climate Impact Aspect	Measure Purpose	Measure Description
		As outlined in the Framework CEMP (**Application Document Ref. 7.1**) storage of soils will be undertaken in accordance with the Defra Construction Code of Practice for Sustainable Use of Soil on Development Sites (Defra, 2009). This will help to prevent the impacts of flooding during heavy rainfall and storms.
		The management of dust and particulates and the application of adequate mitigation measures during construction would be controlled through the CEMP. Air Quality during the construction phase specifically is considered further within **Appendix 8A:** Construction Air Quality Appendix (ES Volume II - **Application Document Ref. 6.3**).
CCR	To increase Project resilience to climate hazards	In case of heavy rainfall, flooding or storms, laydown areas for topsoil and other construction materials will be stored a minimum of 20 m from watercourses on flat lying land, as described in the Framework CEMP (**Application Document Ref. 7.1**) and as is set out **Chapter 12:** Water Environment and Flood Risk (ES Volume I - **Application Document Ref. 6.2**) and **Appendix 12A:** FRA (ES Volume II - **Application Document Ref. 6.3**).
		The Contractor will monitor weather forecasts and plan works accordingly, protecting workers and resources from any extreme weather conditions such as high temperatures. Any receptors, construction-related operations and activities potentially sensitive to severe weather events will be considered in the assessment. Climate change projections will be considered in the risk assessments.
		The contractors will monitor weather forecasts and register with the Environment Agency's (EA) flood warning service, protecting workers and resources from any extreme weather conditions such as storms, flooding or heatwaves.
		Laydown and welfare areas will be laid will permeable membranes to protect the working areas from high rainfall and flooding events or sea level rise.

Climate Impact Aspect	Measure Purpose	Measure Description
		The construction contractor would be required to protect ground and surface water using a range of best practice construction methods, including pollution plans, storage of materials, staff awareness training and plans for appropriate water discharge. Such measures would be implemented through a CEMP. The contractor would also be required to produce a Flood Risk Management Action Plan/Method Statement, which would provide details of the response to an impending flood. A Flood Risk Assessment has been undertaken and is attached within **Appendix 12A** (ES Volume II - **Application Document Ref. 6.3**); this provides further details on the sustainability of the project from a flood risk perspective, and any required mitigation measures to help reduce flood risk.

Operational Phase

17.5.2 Embedded control measures that have been developed through the design processes to reduce the likelihood or consequence of adverse impacts during the operational phase are listed in Table 17.24.

Table 17.24: Embedded Control Measures During Operations

Climate Impact Aspect	Measure Purpose	Measure Description
GHG emissions	Reduce GHG emissions	The purpose of this Proposed Development is to provide low carbon energy through carbon capture and offshore carbon storage. By overall design, the Proposed Development offers the opportunity to reduce the carbon emissions emitted from the generating station and aid decarbonisation of the grid electricity supplied to the national grid. A carbon capture plant (CCP) fitted to the generating station will use a chemical process to absorb and capture at least 90% of the carbon dioxide in the flue gases. Captured CO_2 will be compressed and then pumped by a third party into an offshore geological store instead of being released to the atmosphere.
		The Environmental Permit application will present a number of measures that the Proposed Development would include in order to improve energy efficiency and to reduce overall GHG emissions. The design of the Proposed Development will be based on European Best Available Technique (BAT) reference documents ('BRefs') for CCGT plants and the emerging Environment Agency BAT Guidance for carbon capture plants. The GHG assessment within this Chapter has been based on high levels of thermal efficiency within the CCGT as an H-Class unit is proposed to be used.
		To reduce emissions associated with operational worker commuting, sustainable forms of travel will be promoted including provision of cycle storage areas.
		Process emissions to be managed and regulated through an Environmental Permit by the Environment Agency in accordance with the Industrial Emissions Directive and Energy Efficiency Directive.
ICCI		To reduce the impacts to local biodiversity, landscaping and biodiversity enhancement will be undertaken as outlined in the LBMEP (**Application Document Ref. 5.10**)

Climate Impact Aspect	Measure Purpose	Measure Description
	Reduce climatic impacts to local receptors	Through development and adoption of a robust maintenance regime, the Proposed Development, where possible will be operating at optimal performance levels for the duration of it's lifetime, thus minimising any potential adverse climatic impacts from unanticipated performance issues. To reduce the impacts to groundwater quality in times of extreme rainfall, any contaminated soils encountered during construction will be removed, remediated or mitigated to acceptable levels.
		To reduce the likelihood of impacts to the Keadby Common Drain through overflow from untreated attenuation ponds in times of extreme rainfall, the conceptual drainage strategy presented in Section 5.0 of **Appendix 12A**: Flood Risk Assessment (ES Volume II - **Application Document Ref. 6.3**) has determined appropriate storage volumes to account for climate change projections
CCR	To increase Project resilience to climate hazards	An allowance for increased rainfall intensity due to climate change of 40% has been accounted for in the design storm event. This is in line with the upper end estimation of potential peak rainfall intensity increase due to climate change anticipated for the 2080s.
		All buildings will be designed to UK standards and specifications. Detailed design of buildings will include consideration of heating and cooling requirements.
		During operation, the Applicant's Environmental Management System (EMS) would include impact avoidance measures, such as pollution plans and containment measures, whilst the Proposed PCC Site would be operated in accordance with the Environmental Permit. At this preliminary stage, a Conceptual Drainage Strategy has been prepared and is attached in **Appendix 12A:** FRA (Section 5 - 6) (ES Volume II - **Application Document Ref. 6.3**); this presents options for the drainage design that would be developed through the detailed design process. This strategy also considers the opportunities for the incorporation of Sustainable

Climate Impact Aspect	Measure Purpose	Measure Description
		Drainage Systems (SuDS) into the design for the Proposed Development. As part of the Conceptual Drainage Strategy, high rainfall events of the kind that are projected to become more frequent with climate change are also considered. Flood risk in association with climate change has been considered and flood resilience measures would be incorporated into the design to minimise the potential for damage and reduce recovery time. Further details are included within **Appendix 12A** (ES Volume II - **Application Document Ref. 6.3**). Storage volume calculations have been undertaken for the critical storm duration of the 100-year return period storm event plus climate change allowance. The FRA informs the adaptation measures that need to be incorporated into the final design and operations management.
		Flood Resistance and Resilience Measures to be implemented, include: • the main development platform to be raised to the breach level (2.2m AOD) +400mm freeboard i.e. 2.6m AOD, aligned with the consented levels of the Keadby 2 Power Station development platform and within this area, critical operational infrastructure associated with the CCGT (defined in paragraph 6.3.11 of **Appendix 12A** (ES Volume I – **Application Document Ref. 6.3**)) will have a further clearance of 1.0m, therefore providing a level of resilience of no less than 3.6m AOD. This is a minimum level that will be achieved for critical operational infrastructure, but further clearance will be provided up to 4.4m AOD (i.e. the CFL + 300mm freeboard) where reasonably practicable to do so; ii) consideration of a range of additional flood resilience measures described in paragraphs 6.3.13 – 6.3.14 for incorporation at detailed design; • Flood Emergency Response plan to be developed in consultation with the Environment Agency; • make use of Environment Agency flood warnings and alerts;

Climate Impact Aspect	Measure Purpose	Measure Description
		• define emergency access and egress route; • provision of adequate facilities to provide a place of safe refuge including welfare facilities for employees occupying the Proposed PCC Site in the extremely rare and unlikely event that the Trent tidal defences were to breach; and • ensure maintenance of the drainage system will be incorporated in general site management and remains the responsibility of the operator.
		The power plant is designed to operate over a large range of ambient conditions including winter and summer extreme values. Temperature changes would therefore not have a noticeable impact.
		Detailed design of buildings within the Proposed PCC Site to consider water efficiency in line with Building Regulations.
		Under the preferred cooling method, to reduce the water requirements, steam will be extracted and re-used in the HRSG. When compared against other forms of cooling, such as direct or 'once-through' cooling, the volumes of abstracted water are considerably lower when using hybrid cooling. This reduces overall water demand and increase the resilience of the Proposed Development to climate change during periods of drought.

Decommissioning Phase

17.5.3 Embedded control measures that have been developed through the design processes to reduce the likelihood or consequence of negative impacts during the decommissioning phase are listed in Table 17.25.

Table 17.25: Embedded Control Measures During Decommissioning

Climate Impact Aspect	Measure Purpose	Measure Description
GHG emissions	Reduce GHG emissions	At the end of its operating life, it is anticipated that all above-ground equipment associated with the Proposed Development will be decommissioned and removed from the Proposed Development Site. The bulk of the plant and equipment will have some limited residual value as scrap or recyclable materials, and the demolition contractor will be encouraged to use materials that could be recycled. Materials and waste produced during decommissioning and demolition will be stored in segregated areas to maximise reuse and recycling. All materials that cannot be reused or recycled will be removed from the Proposed Development Site and transferred to suitably permitted waste recovery/ disposal facilities. It is anticipated that a large proportion of the materials resulting from demolition will be recycled and a record will be kept in order to demonstrate that the maximum level of recycling and reuse has been achieved. A Decommissioning Plan (including Decommissioning Environmental Management Plan) would be produced and agreed with the Environment Agency as part of the Environmental Permitting and site surrender process. The Decommissioning Environmental Management Plan would consider in detail all potential environmental risks on the Proposed Development Site and contain guidance on how risks can be removed or mitigated. Decommissioning activities will be conducted in accordance with the appropriate guidance and legislation at the time of the Proposed Development's closure. All decommissioning activities will be undertaken in accordance with the waste hierarchy.
ICCI	Reduce climatic impacts to local receptors	
CCR	To increase Project resilience to climate hazards	

17.6 Likely Impacts and Effects

GHG Impact Assessment

17.6.1 This Section presents findings of the GHG impact assessment for the construction and commissioning, operation and decommissioning of the Proposed Development.

Construction

17.6.2 In order to assess the magnitude of the climate change impacts as a result of GHG emissions associated with the construction of the Proposed Development, the GHG emissions that have been associated with the project activities are calculated based on the assumptions listed below:

- the construction programme will commence with an enabling works phase for the A18/ Mabey Bridge replacement (circa 6 months) followed by a main works phase, anticipated to take three years, with activities occurring 6 days per week (07:00 and 19:00 Monday to Friday (except bank holidays) and 08:00 and 13:00 on Saturdays);
- numbers of construction workers and vehicle traffic have been estimated from **Appendix 10A**: Transport Assessment (ES Volume II – **Application Document Ref. 6.3**);
- materials transport has been included in this estimate and is based upon the use of ladened HGV travelling a one-way distance of 50km, and includes a return trip;
- the embodied carbon from these materials have been based upon a similar sized energy development. This excludes fit-out materials and other infrastructure of these buildings. Separately, the materials for the car park have been estimated through total area, and assumed depths of layers;
- additional construction materials included in this estimate include mains water for domestic, sanitation and industrial uses. It is assumed that each person on-site uses 72 litres of water per day, half of the average daily water use in England and Wales (Water UK et al, 2020). Other construction water uses such as wheel-washing or dust suppression have been estimated conservatively with an industry benchmark (Strategic Forum Water Subgroup, 2011);
- waste transport and disposal is included in this estimate. Construction waste volume estimates have been based upon building floor areas for the indicative Proposed Development layout (**Chapter 4**: Proposed Development (ES Volume I – **Application Document Ref. 6.2**) and waste types published by Construction Resources and Waste Platform (CRWP, 2009). Water volumes from domestic and sanitation uses are assumed to all be treated;

- fuel-usage on-Site has been included in this estimate. Using construction benchmarks, an approximate volume of emissions has been calculated (Glenigan, 2018);
- uses of grid electricity for temporary welfare and office facilities has been included in this estimate. Usage has been conservatively estimated on continuous use during construction hours using CIBSE Energy Benchmarks (2008) and is based upon peak workers for each year needing 0.5 m^2 of welfare space per person'; and
- pre-construction site clearance activities have been included in the estimate.

17.6.3 As detailed in Table 17.26, using the listed inclusions and exclusions, the total construction-related GHG emissions from the Proposed Development are calculated to be 80,275 tCO_{2e} with the majority (80%) of emissions associated with the embodied carbon of construction materials. Assuming that emission-related activities are similar during the 42 month construction period, annual emissions are expected to be approximately 22,936 tCO_{2e}.

Table 17.26: Construction GHG Emissions

Lifecycle stage	Project activity/Emission source	Emissions (tCO_{2e}) over 42 month construction period
Manufacturing and Fabrication of Project Components	Embodied carbon of material and products	64,161
	Materials and product transport	3,527
Construction and Commissioning	Electricity usage	162
	Fuel usage onsite	4,077
	Waste disposal and transport	78
	Worker commute	7,811
	Other materials	459
TOTAL		80,275
Annual estimation		22,936

Operation

17.6.4 In order to assess the magnitude of the climate change impacts through GHG emissions associated with operating the Proposed Development, the GHG emissions that would be associated with its operation are calculated based on the assumptions listed below:

- The Proposed Development is expected to be available and manned 24 hours a day, 7 days per week for 25 years, running approximately 8,000 hours per year.
- Use of grid electricity has been partially included in this estimate. The majority of electricity consumption will arise from the use of pumps, compressors and cooling towers. During plant operation, this equipment will be a parasitic load and source power straight from the CCGT plant. Other consumption including for buildings and maintenance is not included in this estimate as it is expected not to be material in comparison to energy consumption for this plant equipment.
- Treated water will be required for plant cooling and makeup. At this stage, two options are under consideration for the supply of water - abstraction from the either the Stainforth and Keadby Canal or the River Trent. Indicative abstraction volumes from the Canal Water Abstraction Option are 1,119 tonnes per hour (t/h) and for the River Water Abstraction Option are 1483 t/h. Power associated with any abstraction, and therefore the associated GHG emissions, are implicit to the overall assessment for the Proposed PCC Site (being parasitic loads on the CCGT).
- Fuels and oils required on-Site, other than natural gas, may include but are not limited to diesel required for the emergency diesel generator, lubricating oils and acetylene. One tonne of diesel per annum has been included within this estimate, and volumes of other fuels and oils are assumed to be a minor fraction.
- The majority of emissions from this category will arise from the CCGT plant's use of natural gas. The carbon capture system is designed to remove carbon dioxide from the flue gases. The carbon capture abatement technology is capable of capturing over 90% of the carbon dioxide produced by the CCGT plant. The overall effectiveness of the carbon capture system varies depending on the operating mode applied and has been calculated based on material balance flow data provided for each mode, assuming at least 90% capture rates are achieved.
- The most beneficial abated CCGT mode (Reference scenario with enhanced carbon capture performance) will produce an average of 779 MW electrical output (minus any parasitic load), with a carbon intensity of approximately 18.23 tonnes CO_2 per GWh. It is assumed that the carbon capture storage system and sequestration technology is operational and functioning as expected.
- Carbon dioxide will be used to purge generators of hydrogen during periods of downtime, the volumes of gas required, and the frequency of this activity is not known at this stage of the design but would be a minor source of GHG emissions.
- Electrical circuit breakers and other switchgear historically used sulphur hexafluoride (SF_6) as an arc quencher and noise suppressant. This gas

has a very high global warming potential, but suppliers are increasingly producing SF_6-free equipment, or sealed-for-life units with extremely low leakage rates. For the purposes of this assessment it is assumed that leakage rates will be negligible.

- Emissions associated with some waste disposal and treatment have been included. Operational wastes included in this calculation include sewage, municipal wastes and hazardous waste from the reclaimer package, acid wash purge from absorber, reflux purge from stripper reflux, reclaimer sludge, and ammonium sulphate effluent.
- Worker commuting has been included based upon up to 50 operational staff. This assumes that 100% of workers will travel by car with an occupancy of 1 person per vehicle. Using current estimates of likely distribution of worker staff, it is assumed that all workers will live within 25km of the Proposed Development Site (based on the findings of **Chapter 16:** Socioeconomics (ES Volume I - **Application Document Ref. 6.2**) this is regarded as precautionary). All transits include a two-way journey.
- It is assumed that an additional circa 50 staff will be required on-site during the maintenance activities every year using the same car occupancy rates and location distribution.
- It is assumed that each person on-site uses 72 litres of water per day, half of the average daily water use in England and Wales (Water UK, 2020); of which 60 litres per person per day is returned as sewage.
- Materials required for operations are likely to include bulk solvent, sodium hydroxide and sulphuric acid, ammonia/ urea, triethylene glycol, hydrogen, biocides, antiscalants, sulphuric acid, sodium hydroxide, phosphoric acid, polyelectrolyte, molasses, cleaning chemicals, inert firefighting gases, carbon dioxide and mains water. Available volumes included in this estimate include sodium hydroxide, sulphuric acid, fresh solvent, and hydrogen.
- The material balance flow data for each operating mode includes information on final stack emissions of carbon dioxide (CO_2). For each operating mode, a gross power plant electricity output figure has been combined with the expected electricity demand of the CCP and other ancillary equipment to give a net power plant electricity output in megawatts. Combining the final stack emissions per operating hour with the net electricity output of the power station with carbon capture plant gives an average emissions factor in tonnes CO_2e/GWh for each operating mode. These emissions factor have be compared with the current (2020) UK average emissions factor, and with UK government estimates of projected emissions factors for each of the years in the plant's operating lifetime.

- It has been assumed that materials required for operations (fuels and oils other than natural gas, chemical and parts) are generally available on average within 80km of the Proposed Development Site including a return trip.

Operational Modes

17.6.5 It is anticipated that on commissioning, the Proposed Development will initially operate in baseload mode i.e. generation that generally runs continuously throughout the year so that the plant is operated at stable power output levels. Continuous and stable CO_2 production and export is preferred during this period to minimise changes to injection rates into the CO_2 collection system of the Humber Low Carbon pipeline network. Operating in baseload mode could involve up to 20 start-up/ shutdown cycles per year.

17.6.6 After a period of baseload operation, it is assumed that the CCGT plant will operate in dispatchable mode, i.e. being able to export power to match the anticipated intermittency of renewable power in the future power market. Operating in dispatchable mode could involve up to 200 start-up/ shutdown cycles per year or more.

17.6.7 In the event that the CCP is not available, for example due to issues downstream in the ZCH partnership export pipeline, it could be necessary to operate the Proposed Development for a short period of time in in unabated mode, with exhaust gases from the CCGT being routed via the HRSG stack.

17.6.8 Operational Modes are discussed further within **Chapter 4:** The Proposed Development (ES Volume I - **Application Document Ref. 6.2**). The plant is expected to operate in dispatchable mode following a period of stable operation. The effect of start-up on short term CO_2 emissions will not be fully understood until the detailed design has been completed and commissioning undertaken. However, when the plant is not operating the CO_2 emissions will also cease. It is therefore considered that the worst case assessment for annual carbon emissions would be the plant running all year round with an average capture rate of 90%. On this basis, the four operating modes used to form the basis of this assessment are summarised below:

- **reference scenario**: The Proposed PCC Site will operate for up to c. 8,000 hours per year at 100% full load on the CCGT and 90% carbon capture rate;
- **minimum flow scenario:** The Proposed PCC Site will operate for up to c. 8000 hours per year at 40% load on the CCGT and 90% carbon capture rate;
- **combined summer/ winter scenario**: As noted earlier, there are some differences in the operation of the generating station depending on seasonal variations. In order to consider this within the assessment, a combined summer/ winter scenario was included. Under this scenario, the

Proposed PCC Site will operate for up to c. 4000 hours in each mode each year. The CCGT will be under 100% load with 90% carbon capture running 4,000 hours in each mode each year; and

- **reference scenario with enhanced carbon capture performance**: The Proposed PCC Site will operate for up to c. 8000 hours per year at 100% CCGT load with 95% carbon capture. As described in **Chapter 4:** The Proposed Development (ES Volume I - **Application Document Ref. 6.2**), there are a number of technical and engineering factors which will influence the carbon capture rate.

17.6.9 Material flow and electrical output data has been provided for four possible operating modes as follows (Table 17.27).

17.6.10 It is generally the case that there is a linear relationship between operating hours and direct operational plant GHG emissions for each mode, so for a reduced number of operating hours the total annual emissions can be adjusted accordingly. The only minor changes to a linear relationship are associated with start-up and shut-down cycles; given the limited duration of start-up activities and the expected relatively low number of start-ups and shut-downs each year, coupled with the cessation of CO2 emissions when the plant is not operating, they are considered to not give rise to any increase in carbon emissions from those presented in this assessment.

Table 17.27: Direct operational GHG Emissions from the abated power plant running in four different operating modes; plant runs for 8,000 hours/year in each case

Operating mode	Reference case (90% carbon capture)	Minimum Flow Scenario	Combined Summer/ Winter Scenario	Ref. enhanced (95%) carbon capture scenario
Annual Operating Hours	8,000	8,000	8,000	8,000
Hourly unabated GHG emissions from power plant (kg CO_2e)	281,547	133,454	270,056	281,547
Hourly GHG emissions to atmosphere (kg CO_2e)	26,256	7,386	23,396	13,164
Annual GHG emissions to	210,048	59,088	187,168	105,312

Operating mode	Reference case (90% carbon capture)	Minimum Flow Scenario	Combined Summer/ Winter Scenario	Ref. enhanced (95%) carbon capture scenario
atmosphere (tonnes CO_2e)				
Lifetime GHG emissions to atmosphere (tonnes CO_2e)	5,251,200	1,477,200	4,679,200	2,632,800
Gross output from power plant (MW)	783.625	323.449	827.619	779
Electrical load from capture, compression and ancillary plant (MW)	-52.504	-30.873	-51.073	-53.839
Net output from abated power plant (MW)	731.121	292.576	776.546	725.161
Annual output from abated plant (GWh)	5,848.968	2,340.608	6,212.368	5,801.288
Average lifetime emissions factor (tonnes CO_2e/GWh)	35.91	25.24	30.13	18.23

17.6.11 The Reference case operating mode results in the highest direct annual operational emissions figure of 210,048 tonnes CO_2e (tCO_2e) per year, for a lifetime total emissions figure of 5,251,170 tCO_2e over 25 years.

17.6.12 Additional indirect operational emissions from sources including worker transport, waste generation and transport, consumption of water and disposal of wastewater have been calculated to be 26,649 tCO_2e per year, for a grand total annual operational emissions of 236,695 tCO_2e and lifetime operational emissions of 5,917,384 tCO_2e. These emissions are detailed in Table 17.28.

17.6.13 The change in annual GHG emission estimates since the PEI Report is due to the refinement of assumptions regarding worst-case operational material volumes.

Table 17.28: Operational GHG emissions (using Reference case emissions)

Lifecycle stage	Project activity/Emission source	Emissions (tCO_2e) over 25-year design life	Percentage of total
Operations	Consumption of natural gas	5,251,170	88.7%
	Waste disposal	197,521	3.3%
	Worker commute	8,120	<1%
	Materials	392,495	6.6%
	Materials transport	68,000	1.1%
	Other fuel use	79	<1%
TOTAL		**5,917,384**	100.00%
Annualised operational emissions (based on 25-year life)		**236,695**	

GHG Avoidance

17.6.14 The GHG avoidance of the Proposed Development is centred on the carbon capture technology proposed for onward transfer to the Humber Low Carbon pipeline and offshore sequestration, once operational. The emissions from consumption of natural gas detailed above are for the reference case, with the carbon capture plant running as designed.

17.6.15 Unabated emissions for the reference case (i.e. without carbon capture) would be substantially higher, for total annual plant emissions of 2,252,378 tCO_2e and lifetime emissions of 56,309,456 tCO_2e. With carbon capture, in the reference case, up to 90.7% of these emissions will be captured, geo-sequestered and not released into the atmosphere.

The benefits of the Proposed Development will be to supply low-carbon electricity to the UK electricity supply grid and therefore displace higher carbon intensity grid electricity (or other power generation sources).

17.6.16 Table 17.29 presents the carbon intensity of national averages for electricity generation in the UK in 2018. The table details the carbon intensity associated with the combustion of the primary fuel source only.

17.6.17 Table 17.29 compares the carbon intensity of the Proposed Development (both with and without the carbon capture technology). Unabated, the carbon intensity of the Proposed Development (352.3 tCO_2e/GWh) is lower than the average for gas-fired power generation (371 tCO_2 per GWh). Using the carbon capture technology, the abated plant (Reference case) will result in a carbon intensity of 35.9 tCO_2e per GWh, which is significantly less than the grid average emissions in 2020 of 198 tCO_2e per GWh.

Table 17.29: Carbon Intensities of UK Electricity Grid Generation Sources in 2020

Generation source by fuel type	Emissions (tonnes of CO_2 per GWh of Electricity generated)
Gas (UK Government, 2020b)	371
All fossil fuels (BEIS, 2020b)	446
All fuels, grid average (including nuclear and renewables) (BEIS, 2020)	198
Proposed Development (unabated- without carbon capture technology)	352.3
Proposed Development (abated- with carbon capture technology)	35.9

17.6.18 The UK electricity grid is in the process of being decarbonised as the UK transitions toward Net Zero by 2050. BEIS (2020) provides grid intensity projections to 2100, at which point the UK grid average is expected to emit 28 tCO_2 for every GWh generated.

17.6.19 Figure 17.4 presents the GHG intensity of energy generation from the Proposed Development (35.9 tCO_2 per GWh) alongside projected average grid intensity. Forecast average grid intensity is based on an anticipated mix of electricity generation sources including fossil fuel, nuclear and renewable energy. Average GHG intensity presented in this figure is based on BEIS emission intensity factors (2020).

17.6.20 Figure 17.4 shows the comparison between projected decarbonisation of the UK national grid from 2027 to 2052 (BEIS, 2019) and the emissions intensity for the Reference case of the Proposed Development. The figure shows that the carbon intensity of the Proposed Development is significantly lower than the current UK grid average and is not set to exceed the projected intensity of the grid until 2046, recognizing that the reduction in grid intensity is only achieved through the implementation of low carbon projects such as the Proposed Development.

17.6.21 If the rate of carbon capture is increased from 90% to 95% (as per the reference scenario with enhanced carbon capture performance), then the overall carbon intensity of the Proposed Development could be as low as 18 tonnes CO_2e/GWh, at which level it would outperform grid projections for the entire design life of the Proposed Development.

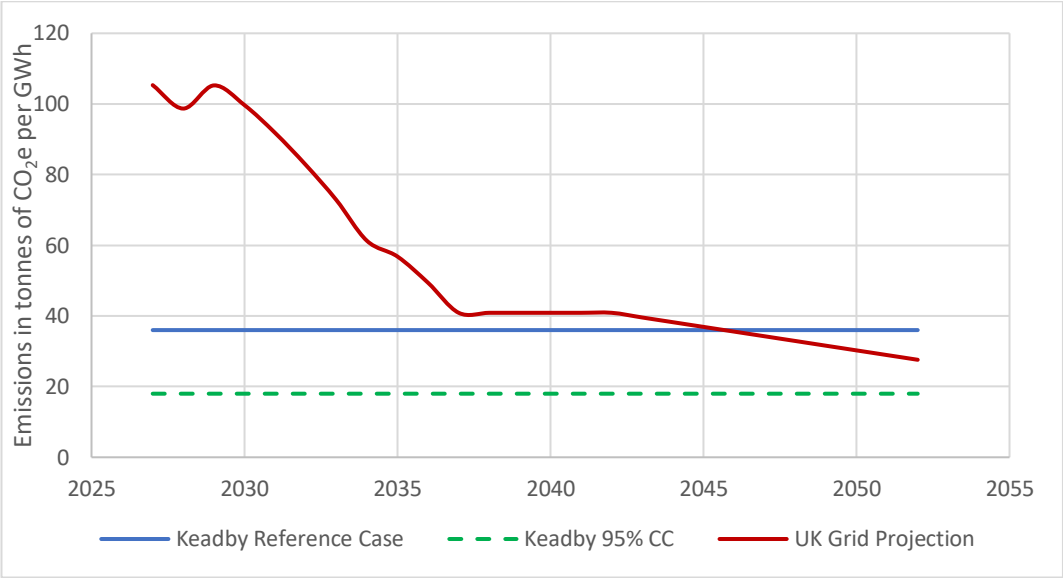

Figure 17.4:Projected UK Grid Intensity vs Proposed Development (Reference case)

Decommissioning

17.6.22 In order to assess the magnitude of the climate change impacts through GHG emissions associated with decommissioning of the Proposed Development, the GHG emissions that would be associated with the Proposed Development decommissioning activities could include those associated with:

- demolition and excavation of all buildings and infrastructure, as required;
- disposal and treatment of all wastes; and
- return of the Proposed Development Site to an industrial brownfield use under hardstanding (i.e. no change in land use).

17.6.23 At this stage of the design, details regarding these activities have not been developed, however they are assumed to be commensurate with emissions generated during the construction stage (e.g. of the approximate magnitude of 70,688 tCO_2e).

Summary of GHG Impacts

17.6.24 The receptor for the GHG assessment is the global climate and the UK's carbon budgets are used as a proxy to assess the impacts to this receptor.

17.6.25 Emissions associated with the Proposed Development have been examined for their significance against the UK Carbon Budgets. These emissions are detailed in Table 17.30.

17.6.26 This assumes 42 months of construction, and one year of operation occurring during the 4th carbon budget and five years during each of the 5th and 6th

carbon budgets. The percentage contribution of emissions from the Proposed Development to the respective carbon budgets are 0.02%, 0.07% and 0.12%, respectively.

17.6.27 The magnitude of impact of the Proposed Development is therefore considered 'low' against the current UK carbon budgets whilst the significance of effects is considered as 'minor adverse'. As such, the operations of the Proposed Development are not expected to affect the UK in meeting its current Carbon Budgets except that the Proposed Development supports the UK transition towards the net zero target.

Table 17.30: Proposed Development GHG Emissions Compared to the UK Carbon Budget

UK Carbon Budget	**Total Budget ($MtCO_2e$)**	Estimated Project Emissions ($MtCO_2e$)	**Percentage Contribution of Emissions**
3rd (2018-2022)	2,544	-	-
4th (2023-2027)	1,950	0.32 (42 months of construction, one year of operations)	0.02%
5th (2028-2032)	1,725	1.18 (five years' operations)	0.07%
6th 2033-2037	965[2]	1.18 (five years' operations)	0.12%

17.6.28 The receptor for the GHG assessment is the global climate but using the corresponding UK Carbon Budgets as a proxy. Total GHG emissions associated with the Proposed Development do not exceed 1% of the corresponding UK carbon budget limits. Therefore, the GHG emissions are considered as having a 'Low increase' magnitude (Table 17.12) and therefore classified as minor adverse significance (Table 17.13).

ICCI Assessment

Construction Phase

17.6.1 Potential construction-based ICCI to receptors, their likelihood, consequence and significance are detailed in Table 17.31.

[2] This figure is provisional. The draft advice on the 6th Carbon Budget from the Climate Change Committee remains subject to consultation and has not yet been transposed into legislation.

Table 17.31: Potential ICCI during Construction and Relevant Embedded Measures

Climate Hazard Type	Climate hazard Protection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of an Impact Occurring to this Receptor	Likelihood of an ICCI Impact Occurring	Consequence of Impact Occurring	ICCI Significance Level	Significant	Additional Mitigation
Increase to winter rainfall	Unlikely	Groundwater	Medium	Surface flooding Mixing with shallow contaminants if present. This would increase the likelihood of potential impact on groundwater quality.	Dewatering	Unlikely	Low	Low	Negligible	No	None
Increase in annual temperature	Very Likely	Human health	Medium	Increase in dust generation which may increase potential exposure to dusts/contaminants.	Detailed in Framework CEMP including reduce dust emissions through the effective transportation and storage of materials.	Unlikely	Medium	Low	Minor	No	None

Operational Phase

17.6.2 Potential operation-based ICCI to receptors, their likelihood, consequence and significance are detailed in Table 17.32.

Table 17.32: Potential ICCI during Operation and Relevant Embedded Measures

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of an impact occurring to this receptor	Likelihood of an ICCI impact occurring	Consequence of impact occurring	ICCI Significance Level	Significant	Additional mitigation measures
Increase to winter rainfall	Unlikely	Groundwater	Low	Surface flooding Mixing with shallow contaminants if present. This would increase the likelihood of potential impact on groundwater quality	Any unacceptable levels of contamination would be remediated/ mitigated during construction. Maintenance and operation of the Proposed Development will be in accordance with environmental legislation and good practice.	Unlikely	Low	Low	Negligible	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of an impact occurring to this receptor	Likelihood of an ICCI impact occurring	Consequence of impact occurring	ICCI Significance Level	Significant	Additional mitigation measures
Decrease in annual rainfall	Possible	Cultural Heritage (Archaeology - peat deposits)	Low	A decrease in rainfall may affect local hydrology and could dry out waterlogged peat deposits leading to the loss of this palaeo-environmental resource	Any palaeo-environmental resources determined and mitigated during construction Peat deposits left in situ following construction will be sensitive to the ICCI, but information held within the peat will have been appropriately sampled, investigated and recorded.	Possible	Medium	Very Low	Negligible	No	None
Decrease in summer rainfall	Likely	Cultural Heritage (Archaeology - peat deposits)	Low			Likely	High	Very Low	Minor	No	None
Increase to winter rainfall	Unlikely	Cultural Heritage (Archaeology - peat deposits)	Low	An increase in rainfall may affect local hydrology and could make buried peat deposit more waterlogged, affecting preservation of archaeological		Unlikely	Low	Very Low	Negligible	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of an impact occurring to this receptor	Likelihood of an ICCI impact occurring	Consequence of impact occurring	ICCI Significance Level	Significant	Additional mitigation measures
				remains within this palaeo-environmental resource							
Increase to winter rainfall	Unlikely	Flood Risk (Site workers, infrastructure and downstream receptors)	High	Increased precipitation can impact i) the frequency and duration of flooding from all sources (e.g. tidal, fluvial, surface water, artificial sources, groundwater and drainage infrastructure)	Design of the drainage infrastructure will accommodate for the influence of climate change on expected flows with appropriate storage for anticipated flows (e.g. in attenuation pond in the surface water	Unlikely	Low	High	Moderate	No	None
Increase in storm intensity	Unlikely	Flood Risk (Site workers, infrastructure	High	Increased intensity of precipitation can		Unlikely	Low	High	Moderate	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of an impact occurring to this receptor	Likelihood of an ICCI impact occurring	Consequence of impact occurring	ICCI Significance Level	Significant	Additional mitigation measures
		and downstream receptors)		impact i) the frequency and duration of flooding (e.g. fluvial, surface water, artificial sources, groundwater and drainage infrastructure), if capacity of river channels or drainage infrastructure is exceeded.	drainage system).						
Increase to heat waves	Possible	Cultural Heritage (Archaeology - peat deposits)	Low	Dryer conditions may affect local hydrology and could dry out waterlogged peat	Any palaeo-environmental resources determined and	Possible	Medium	Very Low	Negligible	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of an impact occurring to this receptor	Likelihood of an ICCI impact occurring	Consequence of impact occurring	ICCI Significance Level	Significant	Additional mitigation measures
Increase droughts	Possible	Cultural Heritage (Archaeology - peat deposits)	Low	deposits leading to the loss of archaeological remains within this palaeo-environmental resource	mitigated during construction Peat deposits left in situ following construction will be sensitive to the ICCI, but information held within the peat will have been appropriately sampled, investigated and recorded.	Possible	Medium	Very Low	Negligible	No	None
Sea level rise	Very Likely	Cultural Heritage (Built heritage)	Medium	Sea level rise may lead to localised flooding impacting built heritage assets	No embedded mitigation	Likely	High	Very Low	Minor	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of an impact occurring to this receptor	Likelihood of an ICCI impact occurring	Consequence of impact occurring	ICCI Significance Level	Significant	Additional mitigation measures
				located on or adjacent to the River Trent, the canal network and the warping drains throughout the wider landscape surrounding the Site							
Increase to winter rainfall	Unlikely	Keadby Common Drain (Drain 1)	Medium	Increased precipitation can impact peak discharge rates for surface water runoff, which can impact receiving waterbodies (receptors) if the capacity of the provided	The conceptual drainage has taken into account future climate change. The final strategy will also determine appropriate storage volumes based	Unlikely	Low	Medium	Minor	No	None
Increase in storm intensity	Unlikely	Keadby Common Drain (Drain 1)	Medium			Unlikely	Low	Medium	Minor	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of an impact occurring to this receptor	Likelihood of an ICCI impact occurring	Consequence of impact occurring	ICCI Significance Level	Significant	Additional mitigation measures
				attenuation treatment train is exceeded (i.e. attenuation ponds have a certain capacity which may be exceeded in extreme events). If the treatment train is bypassed due to overcapacity, there is potential for Keadby Common Drain to receive untreated water.	on the final layout, to account for climate change projections.						

Decommissioning Phase

17.6.3 Potential decommissioning-based ICCI to receptors, their likelihood, consequence and significance are detailed in Table 17.33.

Table 17.33: Potential ICCI during Decommissioning and Relevant Embedded Measures

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of An Impact Occurring to This Receptor	Likelihood of An ICCI Impact	Consequence of Impact Occurring	ICCI Significance Level	Significant	Additional Mitigation Measures
Increase to winter rainfall	Unlikely	Flood Risk (Site workers, infrastructure and downstream receptors)	High	Increased precipitation can impact i) the frequency and duration of flooding from all sources (e.g. tidal, fluvial, surface water, artificial sources, groundwater and drainage infrastructure)	The impact of climate change on expected flows will be accommodated in the design of drainage infrastructure to ensure appropriate storage for anticipated flows (e.g. in attenuation pond in the surface water drainage system). Flood Emergency Response Plan to be active.	Unlikely	Low	High	Moderate	No	None
Increase in storm intensity	Unlikely	Flood Risk (Site workers, infrastructure and downstream receptors)	High	Increased intensity of precipitation can impact i) the frequency and duration of flooding (e.g. fluvial, surface water, artificial sources,		Unlikely	Low	High	Moderate	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Receptor Sensitivity to Climate Hazard	Description of Potential ICCI	Embedded Design Measures	Likelihood of An Impact Occurring to This Receptor	Likelihood of An ICCI Impact	Consequence of Impact Occurring	ICCI Significance Level	Significant	Additional Mitigation Measures
				groundwater and drainage infrastructure), if capacity of river channels or drainage infrastructure is exceeded.							

CCR Assessment

Construction Phase

17.6.4 Potential climate risks to the construction phase, the likelihood, consequence and significance are detailed in Table 17.34.

Operational Phase

17.6.5 Potential climate risks to the operational phase, the likelihood, consequence and significance are detailed in Table 17.35.

Decommissioning Phase

17.6.6 Potential climate risks to the construction phase, the likelihood, consequence and significance are detailed in Table 17.36.

Table 17.34: Construction- Potential Climate Change Impacts and Relevant Embedded Adaptation/Resilience Measures

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significant	Additional Mitigation or Monitoring
Increase in annual temperature	Very Likely	All receptors	See - Increase in summer temperature	See- Increase in summer temperature	Very Unlikely	Very Low	Negligible	No	None
Increase in summer temperature	Very Likely	Plant and vehicles, physical structures, materials, and access routes to sites	Overheating of electrical equipment Damage to materials	Detailed in CEMP. The Contractor will monitor weather forecasts and plan works accordingly, protecting workers and resources from any extreme weather conditions.	Very Unlikely	Very Low	Negligible	No	None
Increase in winter temperature	Very Likely	All receptors	All receptors	None considered	Very Unlikely	Very Low	Negligible	No	None
Decrease in annual rainfall	Possible	All receptors	All receptors	See- Decrease in summer rainfall	Very Unlikely	Very Low	Negligible	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significant	Additional Mitigation or Monitoring
Decrease in summer rainfall	Likely	All receptors	All receptors	None considered	Very Unlikely	Very Low	Negligible	No	None
Increase to winter rainfall	Likely	Plant and vehicles, physical structures, materials, and access routes to sites	Viability of and access to sites (such as heavy rain resulting in surface water flooding of local roads, sources of power supply or inundation of sites).	Detailed in CEMP. The contractors will monitor weather forecasts and receive Environment Agency's (EA) flood alerts and plan works accordingly, protecting workers and resources from any extreme weather conditions such as storms, flooding.	Possible	Low	Minor	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significant	Additional Mitigation or Monitoring
Increase in heat waves	Possible	Plant and vehicles, physical structures, materials, and access routes to sites	Overheating of electrical equipment Damage to materials	The Contractor will monitor weather forecasts and plan works accordingly, protecting workers and resources from any extreme weather.	Very Unlikely	Low	Negligible	No	None
		Staff, visitors on-site	Increased heat stress/ heat exhaustion for workers.	Prevention measures covered in the CEMP and health and safety plans e.g. temporary buildings such as site offices will be designed with measures to control summertime overheating.	Unlikely	Medium	Minor	No	None
Increase droughts	Possible	All receptors	None considered	None considered	Very Unlikely	Very Low	Negligible	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significant	Additional Mitigation or Monitoring
Increase in storm intensity	Unlikely	Plant and vehicles, physical structures, materials, and access routes to sites	Damage to structures/materials/equipment and resulting in delays to programme and associated costs and/or unacceptable safety risks. May include high winds increasing dust (and other debris), storm surge and coastal erosion.	The Contractor will monitor weather forecasts and receive Environment Agency flood warnings and alerts and plan works accordingly, protecting workers and resources from any extreme weather conditions.	Unlikely	Low	Minor	No	None
Sea level rise	Very Likely	Plant and vehicles, physical structures, materials, and access routes to sites	Viability of and access to sites (such as heavy rain resulting in surface water flooding of local roads, sources of power supply or inundation of sites).	See increase to winter rainfall.	Possible	Low	Minor	No	None

Table 17.35: Operation- Potential Climate Change Impacts and Relevant Embedded Adaptation/Resilience Measures

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significance	Additional Mitigation or Monitoring
Increase in annual temperature	Very Likely	All receptors	See- Increase in summer temperature	See- Increase in summer temperature	Very Unlikely	Very Low	Negligible	No	None
Increase in summer temperature	Very Likely	All receptors (infrastructure, buildings, staff and workers)	Thermal comfort of building users. Increase in air conditioning requirements. Overheating of electrical equipment. Heat damage, deformation, cracking and thermal expansion of building surfaces and pavements	All buildings will be designed to UK standards and specifications. Detailed design of buildings will include consideration of cooling requirements.	Unlikely	Low	Minor	No	None
		Function of facility	Reduced efficiency of CCGT	The power plant is designed to operate over a large range of ambient conditions and the plant efficiency.	Unlikely	Medium	Minor	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significance	Additional Mitigation or Monitoring
				Temperature changes would not have a noticeable impact.					
Increase in winter temperature	Very Likely	All receptors	None considered	None considered	Very Unlikely	Very Low	Negligible	No	None
Increase in annual rainfall	Possible	All receptors	See- Decrease in summer rainfall	See- Decrease in summer rainfall	Very Unlikely	Very Low	Negligible	No	None
Decrease in summer rainfall	Likely	All receptors (infrastructure, buildings, staff and workers)	Water shortages. Drying out of pavement structures. Deterioration of structures or foundations due to decrease in soil moisture levels. Insufficient water for plant cooling	Consideration of alternative sources of water e.g. from the River Trent, or from the Stainforth and Keadby Canal, to reduce use of mains water. Detailed building design to consider	Unlikely	Medium	Minor	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significance	Additional Mitigation or Monitoring
				water efficiency fixtures.					
Increase to winter rainfall	Likely	All receptors (infrastructure, buildings, staff and workers)	Surface water flooding and standing waters. Deterioration of structures or foundations due to increase in soil moisture levels. Damage to building surfaces/ exposed utilities from increased drying/wetting and increase frost penetration. Damage to infrastructure through storm surge and river flooding. Deterioration of structures or foundations due to increase in soil moisture levels. Damage to building surfaces/ exposed utilities from	• Initial capture of surface water run-off through appropriate sustainable drainage system (SuDS) methods detailed in **Appendix 12A** (Section 5): Conceptual Drainage Strategy (ES Volume II – **Application Document Ref. 6.3**) • The Flood Risk Assessment (FRA) includes a number of adaptation measures that would be considered in the detailed design and	Possible	Low	Minor	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significance	Additional Mitigation or Monitoring
			increased drying/wetting and increase frost penetration	operations management.					
Increase to heat waves	Possible	All receptors (infrastructure, buildings, staff and workers)	See- Increase in summer temperature	See- Increase in summer temperature	Unlikely	Low	Minor	No	None
		Function of facility	See- Increase in summer temperature	See- Increase in summer temperature	Unlikely	Medium	Minor	No	None
Increase droughts	Possible	All receptors	See- Decrease in summer rainfall	See- Decrease in summer rainfall	Unlikely	Medium	Minor	No	None
Increase in storm intensity	Unlikely	Marine assets	Physical damage to marine assets Reduced function of marine assets	Any marine assets will be designed to UK standards and specifications	Unlikely	Medium	Minor	No	None
		Built terrestrial assets, staff facilities and access	See- Increase in winter rainfall	See- Increase in winter rainfall	Unlikely	Very High	Minor	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significance	Additional Mitigation or Monitoring
Sea level rise	Very Likely	Built terrestrial assets, staff facilities and access routes to sites Staff, contractors and visitors	Surface water flooding and standing waters Deterioration of structures or foundations due to increase in soil moisture levels Damage to building surfaces/ exposed utilities from increased drying/wetting and increase frost penetration Damage to infrastructure through storm surge and river flooding Deterioration of structures or foundations due to increase in soil moisture levels Damage to building surfaces/ exposed utilities from increased	See increase to winter rainfall and the design and impact avoidance measures proposed in **Appendix 12A** (Section 5): Conceptual Drainage Strategy (ES Volume II – **Application Document Ref. 6.3**) Flood Resistance and Resilience Measures to be implemented as described in Table 17-24 to protect critical operational infrastructure for the residual risk of a breach event and provide a safe place of refuge.	Unlikely	Low	Minor	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significance	Additional Mitigation or Monitoring
			drying/wetting and increase frost penetration						
		Marine assets	Physical damage to marine assets Reduced function of marine assets	Detailed design of any marine assets to consider sea level rise	Unlikely	Medium	Minor	No	None

Table 17.36: Decommissioning- Potential Climate Change Impacts and Relevant Embedded Adaptation/Resilience Measures

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significant	Additional Mitigation or Monitoring
Increase in annual temperature	Very Likely	All receptors	See- Increase in summer temperature	See- Increase in summer temperature	Very Unlikely	Very Low	Negligible	No	None
Increase in summer temperature	Very Likely	Staff, visitors on-site	Increased heat stress/ heat exhaustion for workers.	Prevention measures covered in the DEMP and health and safety plans and likely to be similar to CEMP.	Unlikely	Medium	Minor	No	None
		Built assets, materials, staff facilities and access routes to sites	Damage to structures/materials/equipment and resulting in delays to programme and associated costs and/or unacceptable safety risks.		Unlikely	Low	Minor	No	None
Increase in winter temperature	Very Likely	All receptors	None considered	None considered	Very Unlikely	Very Low	Negligible	No	None
Increase in annual rainfall	Possible	All receptors	See- Decrease in summer rainfall	See- Decrease in summer rainfall	Very Unlikely	Very Low	Negligible	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significant	Additional Mitigation or Monitoring
Decrease in summer rainfall	Likely	All receptors	None considered	None considered	Very Unlikely	Very Low	Negligible	No	None
Increase to winter rainfall	Likely	Built assets, materials, staff facilities and access routes to sites	Viability of and access to sites (such as heavy rain resulting in surface water flooding of local roads, sources of power supply or inundation of sites).	Prevention measures covered in the DEMP and health and safety plans and likely to be similar to CEMP.	Possible	Low	Minor	No	None
Increase to heat waves	Possible	Staff, visitors on-site	Increased heat stress/ heat exhaustion for workers.	See increase in summer temperature	Unlikely	Medium	Minor	No	None
		Built assets, materials, staff facilities and access routes to sites	Damage to structures/materials/equipment and resulting in delays to programme and associated costs and/or unacceptable safety risks.		Unlikely	Low	Minor	No	None
Increase droughts	Possible	All receptors	None considered	None considered	Very Unlikely	Very Low	Negligible	No	None

Climate Hazard Type	Climate Hazard Projection	Sensitive Receptor	Description of Potential Impact	Embedded Design Measures	Likelihood of Impact Occurring	Consequence of Impact Occurring	Resilience Risk Level	Significant	Additional Mitigation or Monitoring
Increase in storm intensity	Unlikely	Built assets, materials, staff facilities and access routes to sites	Damage to structures/materials/equipment and resulting in delays to programme and associated costs and/or unacceptable safety risks.	Prevention measures covered in the DEMP and health and safety plans and likely to be similar to CEMP.	Unlikely	Low	Minor	No	None
Sea level rise	Very Likely	Built assets, materials, staff facilities and access routes to sites	Viability of and access to sites (such as heavy rain resulting in surface water flooding of local roads, sources of power supply or inundation of sites).	Prevention measures covered in the DEMP and health and safety plans and likely to be similar to CEMP.	Unlikely	Low	Minor	No	None

17.7 Mitigation, Monitoring and Enhancement measures

17.7.1 The management of impacts and the application of mitigation/ adaption measures during construction will be secured through the CEMP.

17.7.2 The use of the carbon capture plant will control GHG emissions during plant operation.

17.7.3 As no significant ICCI impacts or CCR risks have been identified, no further mitigation or enhancement measures have been proposed.

17.7.4 No additional monitoring is recommended, other than that detailed within the CEMP during construction, and that which will be required under the Environmental Permit during the operational stage of the Proposed Development.

17.8 Limitations or Difficulties

GHG Impact Assessment

17.8.1 It must be noted that the most recent UK government projections of future grid carbon intensity were published in March 2019, prior to the UK's 2050 Net-Zero commitment. All such projections are subject to considerable uncertainty.

17.8.2 There is limited information on CO2 emissions during start-up of the CCP and this will not be quantifiable until after the detailed design stage and verified through plant commissioning. A conservative assessment has been undertaken whereby it is assumed that the plant will operate for 8,000 hours per year at 90% capture efficiency; this is envisaged to lead to higher emissions than a dispatchable plant operating at lower load factors with start-up emissions.

ICCI and CCR Assessment

17.8.3 The CCR assessment of construction impacts assumes that the measures outlined within the Development Design and Impact Avoidance Section of this Chapter would be incorporated into the design of the Proposed Development. These measures are considered standard best practice that are usually applied across construction sites in the UK. No additional mitigation has been identified as necessary for any stage of the Proposed Development.

17.8.4 While modelled climate change projections represent anticipated changes to average weather conditions, they do not capture the full range of possible future severe weather events (i.e. droughts, heatwaves and prolonged heavy rainfall). Therefore, the ICCI and CCR assessment is based upon UKCP18 predictions for general changes in climate conditions, and only a high-level

assessment of acute events such as a breach in the tidal Trent flood defences is included in this assessment.

17.8.5 The ICCI and CCR assessment is limited to the availability of data and information at the date this assessment was prepared.

17.9 Summary of Likely Significant Residual Effects

17.9.1 No significant residual effects for GHG emissions, ICCI or CCR impacts have been identified.

17.10 References

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