CONTENTS

TABLES

17.0 CLIMATE CHANGE AND SUSTAINABILITY

17.1 Introduction

17.1.1 This Chapter of the Preliminary Environmental Information (PEI) Report 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 comprises the construction, operation (including maintenance) and decommissioning of a low carbon Combined Cycle Gas Turbine (CCGT) generating station with an unabated capacity of up to 910MW (gross) electrical output to be located on land in the vicinity of the existing Keadby Power Stations (Keadby 1 and Keadby 2) near Scunthorpe in North Lincolnshire (the Proposed Development Site).

17.1.3 The CCGT unit would be fitted with carbon capture technology that up to 95% of carbon emissions to be captured. Captured carbon will be directed to an offshore carbon store for permanent storage and not released to the atmosphere.

17.1.4 Many of the sustainability issues considered in this chapter refer to other topic specific chapters of this PEI Report; therefore, relevant chapters are referenced herein where appropriate.

17.1.5 In addition to a wider review of sustainability, in accordance with the requirements of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (HMSO, 2017), guidance from the Institute of Environmental Management and Assessment (IEMA) for climate change mitigation (IEMA, 2017) 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.

17.1.6 The assessment of cumulative effects on sustainability associated with the Proposed Development and other committed developments in the vicinity are described in **Chapter 19**: Cumulative and Combined Effects (PEI Report Volume I).

17.1.7 As part of this assessment, the Proposed Development has been considered against a number of key sustainability themes. This includes a consideration of the methods which will be employed to minimise impacts on a number of themes such as ecology, landscape, air quality and water use, 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.

17.2.2 The legislation and policies will be reviewed following public consultation and updated prior to finalisation of the Environmental Statement (ES).

International Legislation

EIA Directive 2014/52/EU

17.2.3 The EIA Directive 2014/52/EU states that as of May 2017, an environmental impact assessment (EIA) (where relevant) must include an assessment of the impact of a project on climate change (mitigation assessment), an assessment of the interaction between environmental impacts and climate change (in-combination assessment), and information on the vulnerability of the project to climate change (Official Journal of the European Union, 2014). This requirement is addressed in Section 17.6.

Kyoto Protocol

17.2.4 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 (Official Journal of the European Union, 2018). This ambition is addressed in Section 17.6 and 17.7.

Paris Agreement

17.2.5 The Paris Agreement is an agreement under the UNFCCC dealing with greenhouse gas 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)

17.2.6 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)

17.2.7 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.

National Legislation

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

17.2.8 The Climate Change Act 2008 (UK Government, 2008) (hereafter referred to as the 'Act') provides a framework to meet its GHG emission reduction goals through legally binding national carbon emission caps within five-year periods. The Act was amended in 2019 to revise the existing 80% reduction target and legislate for a net zero emissions by 2050 (2050 Target Amendment, Order 2019) (UK Government, 2019). The UK has declared its 5th carbon budget up until 2032 (Committee on Climate Change, 2017). As a result of the amended 2050 carbon reduction target to net zero carbon, the Committee on Climate Change announced it will review the current carbon budgets. The results of this review will be published in autumn 2020 along with the 6th carbon budget.

17.2.9 This Act defines 'net zero' carbon as "*the amount of net UK emissions of targeted greenhouse gases for a period adjusted by the amount of carbon united, credited or debited for the year 2050*". This means that by 2050 emissions will have to be avoided completely or offset by removal from the atmosphere and/or traded in carbon units.

17.2.10 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.

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

17.2.11 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.

17.2.12 As the Proposed Development will require some limited working within the UK Marine Area (Section 42, MCAA), a Marine Licence will be sought from the MMO. The MCAA sets out the legislative framework for the application of Marine Plans to relevant planning decisions in the UK Marine Area. Specifically, decisions affected by marine policy documents include 'the determination of any application […] for authorisation

of the doing of any act which affects or might affect the whole or any part of the UK marine area' (Section 58, MCAA).

17.2.13 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 the determination process for the project. In this instance, as prescribed by the MCAA, the published Eastern Marine Plan (EMP) is the appropriate marine policy document (Marine Management Organisation, 2014).

17.2.14 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).

17.2.15 Paragraph 326 goes on to state the following:

'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'*

National Policies and Strategies

Overarching National Policy Statement for Energy (EN-1)

17.2.16 Published by the Department of Energy and Climate Change (2011a), this 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; in relation to climate projections, flood risk and the importance of relevant mitigation.

17.2.17 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.

National Policy Statement for Fossil Fuel Electricity Generating Infrastructure (EN-2)

17.2.18 Published by the Department of Energy and Climate Change (2011b), this 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.

The National Planning Policy Framework

17.2.19 The revised National Planning Policy Framework (Ministry of Housing, Communities and Local Government, 2019a) sets out the Government's planning policies for England and how these are expected to be applied.

17.2.20 Policies of relevance to climate change and sustainability assessment as presented herein include those achieving sustainable development and meeting the challenge of moving to a low carbon economy, climate change, flooding and coastal change. This Framework states that the planning systems should support this transition by supporting low carbon energy and associated infrastructure. This framework has been used to inform this Chapter and the wider submission.

National Planning Policy Guidance on Climate Change

17.2.21 Guidance published by the Ministry of Housing, Communities and Local Government (2019b), this describes how to identify suitable mitigation and climate adaptation measures to incorporate into the planning process. Stating "*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*.". This guidance has been used to develop this Chapter and the wider submission.

Biodiversity Strategy 2020 (2011)

17.2.22 The national biodiversity strategy for England 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. This strategy has been used to develop Section 17.6.

The Clean Growth Strategy

17.2.23 In 2017, the government published The Clean Growth Strategy (UK Government, 2017a). This Strategy details the increased investment and collaboration in carbon capture usage and storage in the UK to drive industrial innovation and its importance in long-term emissions reduction. This strategy has been used to develop this Chapter and the wider submission.

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

17.2.24 The 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.".

17.2.25 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)

17.2.26 '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.

17.2.27 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."

17.2.28 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 this will primarily play a peaking role in the electricity system.

Local Policies and Strategies

North Lincolnshire Carbon Management Strategy

17.2.29 This Strategy (North Lincolnshire Council, 2017) details the local councils 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 that illustrates the potential area of flooding by 2100 with a 1 m sea level rise.

North Lincolnshire Local Development Framework

17.2.30 The North Lincolnshire Local Development Framework (North Lincolnshire Council, 2011) adopted in 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
- Policy CS20 Sustainable waste management

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

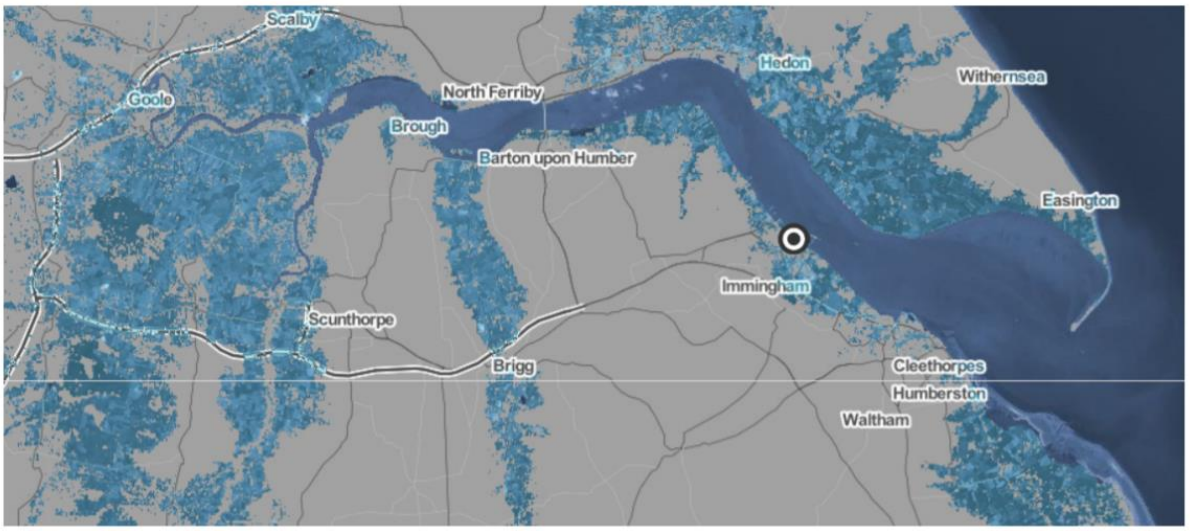

Figure 17.1: Potential Areas of Flooding (2100)

Other Standards and Guidance

Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment

17.2.32 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). This guidance has been used to develop Section 17.5.

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

17.2.33 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). They have been used to develop Section 17.5.

Guidance for the Calculation of Land Carbon Stocks

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

British Standards

17.2.35 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

17.2.36 Guidance on assessing the significance of GHG impacts in EIA, published by IEMA (2017), has been used. This provides a framework for the consideration of greenhouse gas emissions in the EIA process, in line with the 2014 EU Directive. Amongst other things, the guidance sets out how to:

- Identify the greenhouse gas 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).

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

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

17.2.38 The IEMA Guidance for assessing climate change resilience and adaptation (2020) 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.

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

GHG Protocol

17.2.40 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)

17.2.41 This provides the latest estimates of 1990-2015 UK greenhouse gas emissions by source and by end user sector.

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

17.2.43 Carbon dioxide (CO_2) is the main greenhouse gas, accounting for 81% of total UK greenhouse gas 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 An EIA Scoping Report was prepared by AECOM and submitted to the Planning Inspectorate in May 2020; this is provided within **Appendix 1A:** EIA Scoping Report (PEI Report Volume II). The EIA Scoping Report sets out the proposed approach to the EIA and is intended to facilitate discussions regarding the scope of the EIA.

17.3.2 In response to the EIA Scoping Report, the Planning Inspectorate prepared a Scoping Opinion document; this is provided within **Appendix 1B:** EIA Scoping Opinion (PEI Report Volume II). Specific comments raised by the Planning Inspectorate in relation to climate change are listed in Table 17.1.

17.3.3 These comments and how they have been incorporated into this PEI Report are described Table 17.1.

Table 17.1: Comments raised by the Planning Inspectorate in the Scoping Opinion

ID	Subject	Inspectorate Comments	Addressed in PEIR Section
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 17.2 details the scope of the assessment. Emissions associated with decommissioning will be estimated and described in Section 17.6.
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 17.3 details the scope of the ICCI Assessment. Sections 17.5 onwards will summarise the ICCI impacts from the FRA, and any relevant embedded design measures or mitigation measures. **Appendix 12B:** FRA (PEI Report Volume II) may be reviewed for further details.
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 17.3 details the scope of the ICCI Assessment. Sections 17.5 onwards will assess and examine any ICCI impacts from temperature change and low precipitation.

ID	Subject	Inspectorate Comments	Addressed in PEIR Section
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*".
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 17.4 Determination of the Baseline describes the use of UKCP18 as the basis for examining the future baseline for the purposes of the ICCI and CCR assessments.
4.10.6	GHG lifecycle impact assessment	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 – 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.
4.10.7	Methodology	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 defined. The ES and/or accompanying appendices should describe the methodology applied to the assessment and how significant effects	Section 17.3, particularly sub-section Classification and Significance of Effects describes the methodology for the GHG, ICCI and CCR assessments

ID	Subject	Inspectorate Comments	Addressed in PEIR Section
		will be evaluated. Effort should be made to agree the methodology with the relevant consultation bodies.	including how significant effects will be identified.
4.10.8	Guidance	Where relevant, the ES should take into account the following guidance: •IEMA (2017) Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance •IEMA (2015) Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation	Section 17.2- Other Standards and Guidance describes how guidance such as that published by IEMA have been used within this assessment.
4.10.9	CCR Review	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.
4.10.10	Significant effects on climate	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 greenhouse gas emission impact assessment. As part of this assessment, a Sustainability Review has been undertaken to consider the opportunities for enhancement of sustainability related to topics such as Air Quality, Ecology, Water Resources and Geology.

Determination of the Baseline

GHG Emissions Impact Assessment

17.3.4 For the purposes of the GHG emissions impact assessment, the baseline conditions are also defined as 'Do Nothing' scenario where the Proposed Development does not go ahead.

17.3.5 The baseline comprises of existing carbon stocks and sources of GHGs 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, 2018a and b) and principles of the GHG Protocol (WRI & WBCSD, 2004), 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 Bath University 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, 2004) when calculating GHG emissions, the seven Kyoto Protocol GHGs 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).

17.3.10 These gases are broadly referred to in this report under an encompassing definition of 'GHGs', 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 to the Proposed Development (Robin Hood Doncaster Sheffield Airport, approximately 13 miles from 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 (RCPs), to inform differing future emission trends. These RCPs '[…] specify the concentrations of greenhouse gases 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 GHGs 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 is a 'do something' scenario with the delivery of the Proposed Development, which includes the construction, operation and decommissioning of the plant.

Scope of Assessments

GHG Emissions Impact Assessment

17.3.17 The scope of the assessment includes activities that will emit GHGs within the project environment and are detailed in Table 17.2.

17.3.18 As described in **Chapter 1:** Introduction (PEI Report Volume I), the CO_2 export pipeline will not form part of this assessment (or the wider DCO Application) but will be the subject of separate consent applications by third parties.

17.3.19 Whilst appreciating it does not form part of the project for which consent is being sought in this application, **Chapter 19:** Cumulative and Combined Effects (PEI Report Volume I) considers potential cumulative and combined effects that may result from the Proposed Development and Zero Carbon Humber (ZCH) partnership CO_2 pipeline into which the CO_2 captured and compressed within the Proposed Development would be transferred for onward transport and sequestration.

Table 17.2: 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
	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

Lifecycle Stage	Activity	Primary Emission Sources	Scoped In/Out
	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

17.3.20 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 will be assessed in liaison with the technical specialists responsible for preparing other technical chapters of this PEI Report and will be updated in the ES following consultation.

17.3.21 The scope of the ICCI assessment is detailed within Table 17.3.

Table 17.3: 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 12B**: Flood Risk Assessment (PEI Report Volume II). 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 12B**: Flood Risk Assessment (PEI Report Volume II). 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.
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 impacts of sea level rise on receptors may be exacerbated by the Proposed Development.

Climate Variable	Scoped In/Out	Rationale
		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 12B**: Flood Risk Assessment (PEI Report Volume II). 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 temperatures may cause increased risks to habitats and species within the riverine environment. It is anticipated that the volume of expected discharge from the Proposed Development will be less than $1m^3/s$ and discharged intermittently, although this remains to be confirmed. This is likely to be discharged in combination with the $0.016m^3/s$ discharged from Keadby 2. As such it is considered that the Proposed Development will be operating well within the parameters of what was determined to be not significant for Keadby 1, where the existing permit (EPR/YP3133LL) allows a maximum daily flow of $15m^3/s$ (average of 24-hour period). This will require further assessment within the Environmental Statement when the quantity of the discharge has been finalised. On a provisional basis, it is 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 (PEI Report Volume I).
Wind	Out	The Proposed Development is not expected to alter the wind environment and therefore to not 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”.

17.3.22 Construction and operation of the Proposed Development has been assessed on the basis of a 3 year construction followed by commissioning and up to 25 years operation. 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 during the construction assessment will follow a descriptive based approach only.

17.3.23 An assessment of ICCI following the steps shown in Figure 17.2 will be conducted for the Proposed Development that identifies potential climate change impacts and considers their potential consequence and likelihood of occurrence.

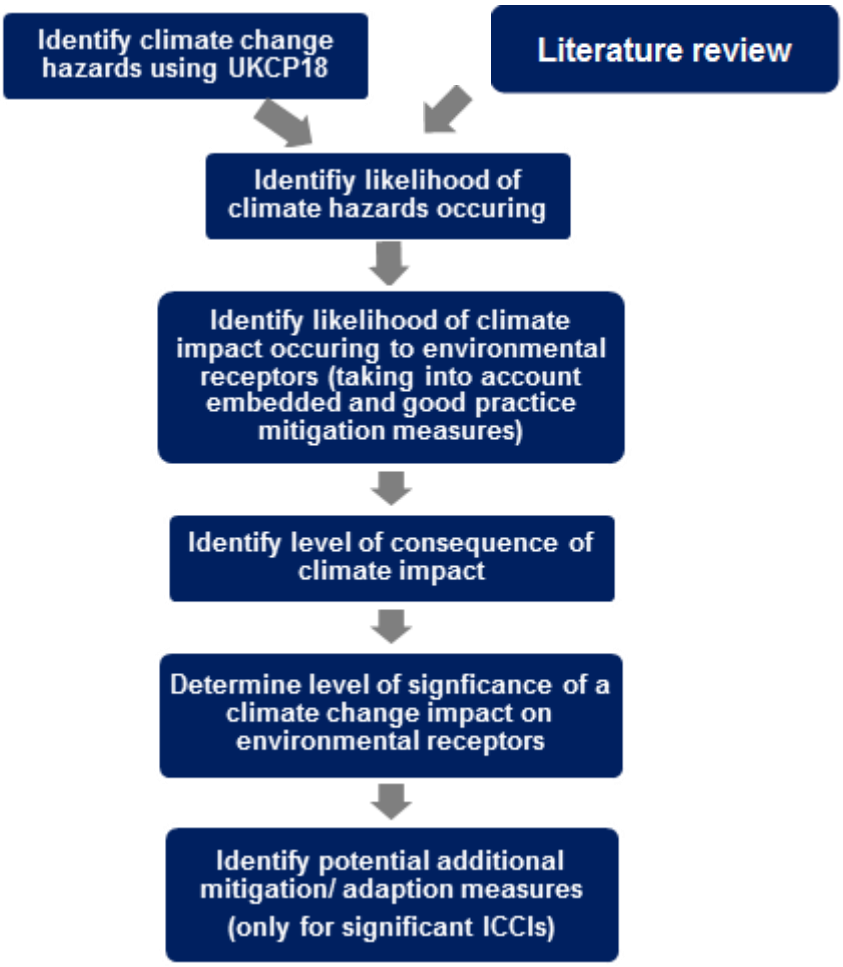

Figure 17.2: ICCI Assessment Methodology

17.3.24 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) will be 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.

17.3.25 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 will be used to identify potential chronic and acute climate hazards that may affect the geographical location of the proposed development.

17.3.26 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 17.4 presents the likelihood levels and definitions used. This is in line with the definitions presented in IPCC Fifth Assessment Report (IPCC, 2014).

Table 17.4: 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

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

17.3.28 Identified climate hazards and the level of likelihood that they will occur is presented further below. The likelihood of an in-combination climate impact occurring is determined based on the likelihood of a climate hazard occurring 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.

17.3.29 In defining the likelihood of an in-combination climate impact occurring, embedded and good practice mitigation measures (primary and tertiary mitigation) are accounted for. Definitions of likelihood are set out in Table 17.5. Table 17.5 is meant 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 17.5: 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

17.3.30 Table 17.6 is then used to determine the overall likelihood of the ICCI.

Table 17.6: ICCI assessment- Level of Likelihood of the ICCI

		Likelihood of climate change hazard occurring (Table 17.4)				
		Very unlikely	Unlikely	Possible	Likely	Very likely
Likelihood of impact occurring (given embedded mitigation measures) (Table 17.5)	Unlikely	Low	Low	Low	Medium	Medium
	Possible	Low	Low	Medium	Medium	Medium
	Likely	Low	Medium	Medium	High	High

17.3.31 Once the likelihood of an in-combination climate impact occurring on a receptor has been identified, the discrete environmental assessment should consider how this will affect the significance of the identified effects.

17.3.32 The ICCI consequence criteria are defined in Table 17.7 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 will assign a level of consequence to an impact based on the criteria description in Table 17.7 and their discipline assessment methodology.

Table 17.7: 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 proposed scheme 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

17.3.33 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).

17.3.34 The scope of the CCR assessment is detailed within Table 17.8.

Table 17.8: Scope of the CCR Assessment

Climate Variable	Scoped In/Out	Rational
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.
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.

17.3.35 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).

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

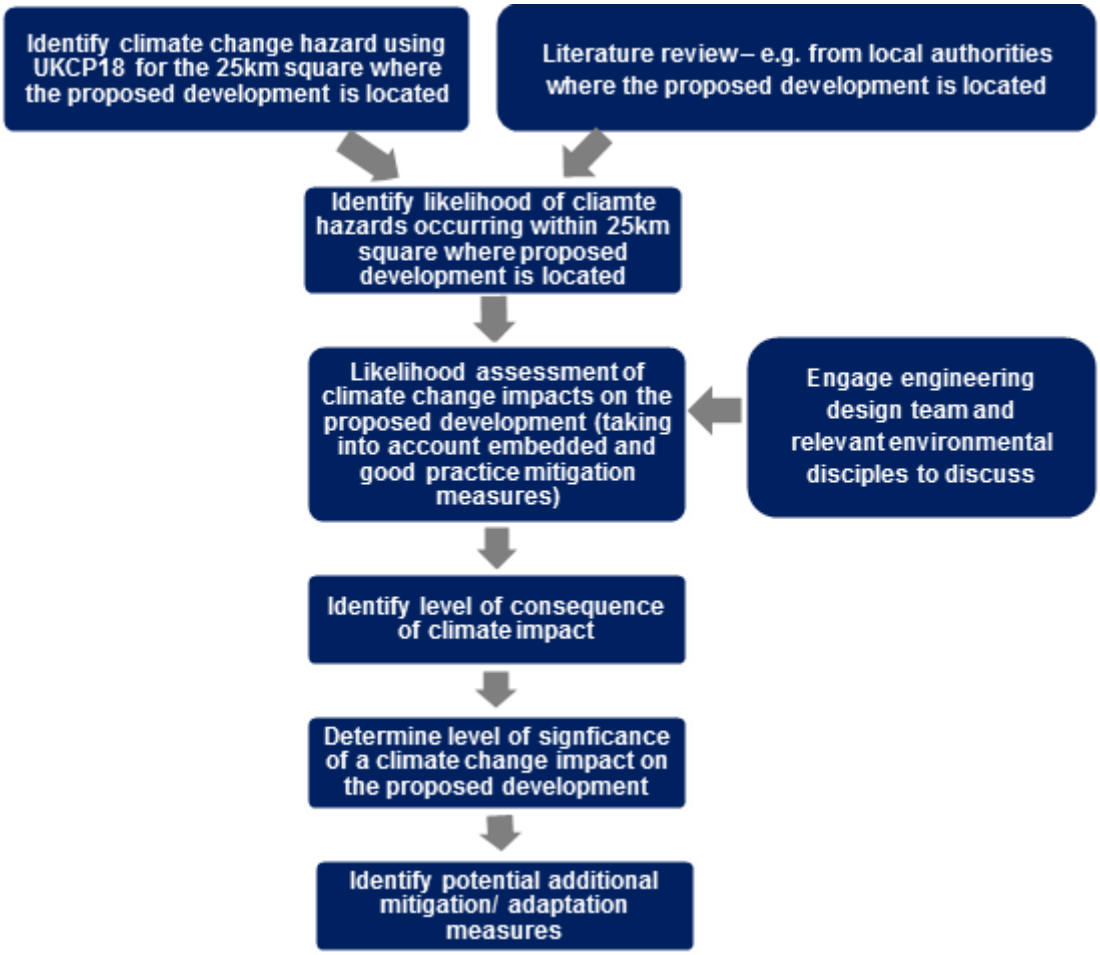

Figure 17.3: CCR Assessment Methodology

17.3.37 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 time frame for operation.

17.3.38 Criteria used to determine the likelihood of an event occurring, based on its probability and frequency of occurrence, are detailed in Table 17.9.

Table 17.9: 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*

17.3.39 The consequence of an impact has been measured using the criteria detailed in Table 17.10.

Table 17.10: 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.

17.3.40 Engagement is 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.

17.3.41 Measures to adapt the Proposed Development are identified where potential climate change consequences are identified as being significant and will be reported in the ES.

Study Area

GHG Emissions Impact Assessment

17.3.42 The GHG Study Area includes all GHG emissions from within the red line boundary area arising during all stages of the construction, operation and decommissioning of the Proposed Development. It will also include emissions arising from offsite activities which are directly related to the onsite activities, such as transport, and treatment of materials and waste disposal.

ICCI Assessment

17.3.43 The Study Areas for the ICCI assessment is the study area defined by each Environmental Discipline in their assessment.

CCR Assessment

17.3.44 The Study Area for the CCR review is the Proposed Development itself.

Sensitive Receptors

GHG Emissions Impact Assessment

17.3.45 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 the global climate. 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

17.3.46 The ICCI assessment considers the sensitive receptors identified by each Environmental discipline in their assessment.

CCR Assessment

17.3.47 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

17.3.48 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 the projects emission impacts.

17.3.49 In GHG accounting, it is considered good practice to contextualise emissions against pre-determined national, sector-based on local carbon budgets (IEMA, 2017). Currently, only national carbon budgets are available in the UK.

17.3.50 Both the Department of Energy and Climate Change (2013) and the PAS 2050 Specification (British Standards Institution, 2011) allow emissions sources of <1% contribution to be excluded from emission inventories, and these inventories to still be 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.

17.3.51 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 to be of high significance. This is summarised in Table 17.11.

Table 17.11: Magnitude Criteria for GHG Emissions

Magnitude	Magnitude Criteria Description
High	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	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

17.3.52 There is currently no published standard definition for receptor sensitivity of GHG emissions. All GHG emissions are classed as being capable of being significant on the basis that all emissions contribute to climate change (IEMA (2017) guidance). 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:

- GHG emission impacts could compromise the UK's ability to reduce its GHG emissions and therefore the ability to meet its future carbon budgets;
- The need to reduce GHG emissions to reduce the risks and impacts of climate change, as broadly identified by the climate science community and by the Paris Agreement which aims to keep global temperature rise this century below two degrees 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); and

- A disruption to global climate is already having diverse and wide-ranging impacts to the environment, society, economic and natural resources. Known effects of climate change include increased frequency and duration of extreme weather events, temperature changes, rainfall and flooding, and sea level rise and ocean acidification. These effects are largely accepted to be negative, profound, global, likely, long-term to permanent, and are transboundary and cumulative from many global actions.

17.3.53 This method to determine the significance of GHG emissions are summarised in Table 17.12.

Table 17.12: Magnitude Criteria for GHG Emissions

		Sensitivity of Receptor
		High
Magnitude of emissions (from Table 17.11)	Low	Minor significance
	High	Major significance

17.3.54 The UK carbon budgets are in place to restrict the volume of GHG emissions the UK can legally emit in a five-year period. The UK is currently in the 3rd carbon budget period, which runs from 2018 to 2022, as detailed in Table 17.13. The current Carbon Budgets reflect the previous 80% reduction target by 2050, rather than the current target of net zero emissions by 2050.

17.3.55 The Committee on Climate Change, the body responsible for setting the UK carbon budgets, is currently reviewing the budgets with consideration of the net zero carbon target and will publish their outcome later in 2020 along with the sixth carbon budget. The carbon budgets are reducing to meet the legislated carbon reduction commitments. This means that any source of emissions contributing to the UK's carbon inventory will have a greater impact on the UK carbon budgets in the future.

17.3.56 Construction of the Proposed Development is likely to intersect the carbon budgeting periods running from 2023 to 2026 (UK 4th Carbon Budget). Commissioning will then follow, and an operational period of 25 years, anticipated to be from circa 2026 to 2051 (intersecting the UK 4th and 5th 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 currently anticipated to commence after 2057.

17.3.57 These timeframes will be updated during the development of the ES.

17.3.58 Although there are no sectoral budgets, the Committee on Climate Change does provide sectoral emissions allocations that underpin the development of the UK Carbon Budgets. The allotted emissions associated with 'grid electricity' using the more conservative 'central' scenario are also detailed in Table 17.13. To further contextualise operational emissions will be compared to these allocations to understand the magnitude of emissions.

Table 17.13: UK Carbon Budgets

UK Carbon Budget	Total Budget ($MtCO_{2e}$)	Total Industry Allocation ($MtCO_{2e}$) for Grid Electricity
3rd (2018-2022)	2,544	398.4
4th (2023-2027)	1,950	270.6
5th (2028-2032)	1,725	171.2

ICCI Assessment

17.3.59 The significance of potential effects is determined by the environmental disciplines using the matrix in Table 17.14. 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 17.14: ICCI Assessment- Significance Criteria

		Likelihood (Table 17.6)		
		Low	Medium	High
Consequence (Table 17.7)	Very Low	Negligible	Negligible	Minor
	Low	Negligible	Minor	**Moderate**
	Medium	Minor	**Moderate**	**Major**
	High	**Moderate**	**Major**	**Major**

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

17.3.61 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.

17.3.62 Where relevant, mitigation measures or mechanisms to reduce the potential significant effects arising from ICCI will be developed in discussion with environmental specialists.

CCR Assessment

17.3.63 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 17.15. 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 17.15: CCR Assessment- Significance Criteria

		Likelihood (Table 17.10)				
		Very unlikely	Unlikely	Possible	Likely	Very likely
Consequence (Table 17.9	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**

17.3.64 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.

17.3.65 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

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 (PEI Report Volume I). The provisional Proposed Development Site is directly within and adjacent to the existing boundary for Keadby 1 Power Station (operational) and Keadby 2 Power Station (under construction). The Proposed Development Site covers approximately 88.13 hectares (ha), of which the Proposed PCC Site is 18.65ha.

17.4.2 As described in **Chapter 14**: Landscape and Visual Amenity (PEI Report Volume I), the Proposed PCC Site is described as currently being used as construction laydown area for the Keadby 2 Power Station, with sparse tree and shrub cover.

17.4.3 Given the limited scope of decommissioning activities, as described within **Chapter 4:** The Proposed Development (PEI Report Volume I), and the general lack of vegetation, for the purposes of determining net changes in GHG emissions through the Proposed Development, the baseline emissions will be considered as zero and all project emissions will be considered as additional. Use of this precautionary principle approach will produce a conservative assessment, as not all activities (and therefore GHG emissions) will be additional activities. This will be reviewed during the production of the final ES, where required.

ICCI and CCR Assessment

17.4.4 The current climatic baseline (1981 to 2010) for the location is listed in Table 17.16

Table 17.16: 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 17.17.

Table 17.17: 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 17.18 to Table 17.20.

Table 17.18: Projected Changes in Temperature Variables (°C), 50% Probability (10% and 90% Probability in Parenthesis)

Climate Variable	Time Period	
	2020 -2039	2030 - 2049
Mean annual air temperature anomaly at 1.5m (°C)	+1.0 (+0.3 to +1.7)	+1.3 (+0.6 to +2.2)
Mean summer air temperature anomaly at 1.5m (°C)	+1.2 (+4 to +2.0)	+1.5 (+0.4 to +2.6)

Climate Variable	Time Period	
	2020 -2039	2030 - 2049
Mean winter air temperature anomaly at 1.5m (°C)	+0.9 (0 to +1.9)	+1.3 (0.1 to +2.5)
Maximum summer air temperature anomaly at 1.5m (°C)	+1.2 (+0.2 to +2.4)	+1.6 (+0.3 to +3.0)
Minimum winter air temperature anomaly at 1.5m (°C)	+0.9 (-0.1 to +1.9)	+1.2 (0 to +2.5)

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

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

17.4.7 Sea level rise may increase up to 16cm by the time operations start (approximately 2026) and up to 31cm by the time operations are completed and decommissioning initiates (not before 2057).

17.4.8 For the purposes of this assessment, a range of time periods are reviewed from the start of operations onward in 10-year increments (under the RCP 8.5, these 10 year increments are 2026, 2036 and 2046). The ranges of projected sea level rise from the 1981-2000 baseline are detailed in Table 17.20.

Table 17.20: 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	2046
Sea level anomaly (m)	+0.12 (+0.10 to +0.16)	+0.18 (+0.14 to +0.23)	+0.25 (+0.19 to +0.31)

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*'. 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 17.21.

Table 17.21: Potential Climate Hazards /and Likelihood of Occurrence (from UKCP18 Projections)

Climate Variable	Potential Hazard	Time Period	
		2020 -2039 Likelihood	2030 - 2049 Likelihood
Mean annual air temperature anomaly at 1.5m (°C)	Increase in mean annual air temperature	Very Likely	Very Likely
Mean summer air temperature anomaly at 1.5m (°C)	Increase in mean summer air temperature	Very Likely	Very Likely
Mean winter air temperature anomaly at 1.5m (°C)	Increase in mean winter air temperature	Very Likely	Very Likely
Maximum summer air temperature anomaly at 1.5m (°C)	Increase in maximum summer air temperature	Very Likely	Very Likely
Minimum winter air temperature anomaly at 1.5m (°C)	Increase in minimum winter air temperatures	Likely	Very Likely
Annual precipitation rate anomaly (%)	Decrease in annual precipitation rate	Likely	Possible
Summer precipitation rate anomaly (%)	Decrease in summer precipitation rate	Possible	Likely
Winter precipitation rate anomaly (%)	Increase in winter precipitation rate	Likely	Likely
Sea level rise (m)	Increase in sea level	Very Likely	Very Likely
Sea temperature rise (°C)	Increase in sea surface temperature	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 17.22. All measures will be finalised and presented during the ES process.

Table 17.22: Embedded Control Measures During Construction

Climate Impact Aspect	Measure Purpose	Measure Description
GHG emissions	Reduce GHG emissions	Developing and implementation of a Construction Environmental Management Plan (CEMP) and the Site Waste Management Plan (SWMP) that controls construction activities through relevant regulations, industry good practice and specific measures described within this PEIR. 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. Content that may be included in the CEMP are: • fuel consumption on site in vehicles, equipment and plant; • minimisation of vehicle and plant idling; • energy consumption from the onsite amenity blocks; • water consumption; • water consumption from the construction process (including dampening down as part of dust mitigation); • transportation of materials to the site; and • waste disposal (by method i.e. landfill, recycling etc.) and transportation from construction activities.
		Specification of construction materials to lower embodied carbon emissions i.e. higher recycled content.
		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 such as public transport (including rail), cycling and car sharing in accordance with policy. This will be outlined in the Construction Workers Travel Plan which will be included in the final ES to accompany the DCO Application and secured through a Requirement in the DCO
		Where possible, avoiding routing connections through habitat. Where impacts cannot be avoided, landscape management and enhancement proposals will be developed to ensure replacement planting and overall biodiversity net gain.

Climate Impact Aspect	Measure Purpose	Measure Description
ICCI	Reduce climatic impacts to local receptors	In case of heavy rainfall, flooding or storms, measures will be taken to prevent spoil material being washed off-site, including bunding to prevent its movement into local watercourses
		To prevent flooding during heavy rainfall and storms, soil drainage qualities will be maintained in accordance with the Defra Construction Code of Practice for Sustainable Use of Soil on Development Sites (Defra, 2009).
		The management of dust and particulates and the application of adequate mitigation measures during construction would be controlled through the CEMP. 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. Air Quality during the construction phase specifically is considered further within **Appendix 8A:** Construction Air Quality Appendix (PEI Report Volume II).
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 outside the 1 in 200 year floodplain extent, as will be described in the CEMP and as is set out **Chapter 12:** Water Resources and Flood Risk (PEI Report Volume I) and **Appendix 12B:** FRA (PEI Report Volume II).
		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. At this preliminary stage, a Flood Risk Assessment has been undertaken and is attached within **Appendix 12B:** FRA (PEI Report Volume II); 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 negative impacts during the operational phase are listed in Table 17.23. All measures will be finalised and presented during the ES process.

Table 17.23: 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. Captured carbon emissions will be compressed and pumped by third party into an offshore geological store and not 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. The GHG assessment within this Chapter has been modelled for high levels of thermal efficiency.
		To reduce emissions associated with operational worker commuting, sustainable forms of travel will be promoted by provision of cycle storage areas.
ICCI	Reduce climatic impacts to local receptors	Process emissions to be managed and regulated in line with the Environment Agency permitting in accordance with the Industrial Emissions Directive.
		Routine maintenance will be planned and scheduled via the maintenance management system with major overhauls occurring approximately once every two years. These maintenance activities will require additional contractors to work on-site. It is intended that major maintenance activities be harmonised around the longest or most constrained outages. For example, it is likely that planned maintenance of the Proposed Development will be scheduled to not coincide with planned maintenance of Keadby 2 Power Station. Through development and adoption of a robust maintenance regime, the Proposed Development 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 local biodiversity, landscaping and biodiversity enhancement will be undertaken.

Climate Impact Aspect	Measure Purpose	Measure Description
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.
		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 12B:** FRA (Section 5 - 6) (PEI Report Volume II); 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 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. During construction, the opportunity would be taken to adopt flood resilient design techniques where possible, including placement of main plant and flood sensitive equipment above the River Trent 1 in 200 year flood level, plus an allowance for climate change. Further details are included within **Appendix 12B:** FRA (PEI Volume II). Storage volume calculations have been undertaken for the critical storm duration of the 100-year return period storm event plus climate change allowance. 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 water are also particularly low by virtue of cooling cells as well as River Water aiding the cooling process. This reduces overall water demand and increases 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 17.24. All measures will be finalized and presented during the ES process.

Table 17.24: Embedded Control Measures During Decommissioning

Climate Impact Aspect	Measure Purpose	Measure Description
GHG emissions	Reduce GHG emissions	The Proposed Development is expected to have a design life of up to 25 years. 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. Prior to removing the plant and equipment, all residues and operating chemicals will be cleaned out from the plant and disposed of in an appropriate manner. 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. Prohibited materials such as asbestos, polychlorinated biphenyls (PCBs), ozone depleting substances and carcinogenic materials will not be allowed within the design of the Proposed Development. Other materials recognised to pose a risk to health, but which are not prohibited, will be subject to a detailed risk assessment. 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 Site and contain guidance on how risks can be removed or mitigated. Decommissioning traffic is expected to be managed under Decommissioning Traffic Management Plan. This would be secured by a requirement imposed on the DCO. Any demolition contractor would have a legal obligation to consider decommissioning and demolition under the CDM Regulations 2015, or the equivalent prevailing legislation at that time.
ICCI	Reduce climatic impacts to local receptors	
CCR	To increase Project resilience to climate hazards	

Climate Impact Aspect	Measure Purpose	Measure Description
		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. Upon completion of the decommissioning programme, including any remediation works that might be required, the Environment Agency will be invited to witness a post-decommissioning inspection by site staff. All records from the decommissioning process will be made available for inspection by the Environment Agency and other relevant statutory bodies, in accordance with the Environmental Permit requirements.

17.6 Likely impacts and effects

17.6.1 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 (PEI Report Volume I). The Rochdale Envelope approach has specifically been used to estimate likely material quantities for the construction of the Proposed Development.

Construction Activities

17.6.2 The Proposed Development Site is described in **Chapter 3:** The Site and Surrounding Area (PEI Report Volume I). The provisional area outlined for The Proposed Development includes some areas of land within the existing Keadby Power Station boundary, where Keadby 1 Power Station operates, and Keadby 2 is being constructed.

17.6.3 The Proposed Development Site covers approximately 88.1ha, of which the Proposed PCC Site is 18.7.

17.6.4 At this stage, a detailed construction programme is not available. Construction activities are expected to take three years for site preparation, main civil works, plant installation and gas and electrical connections, followed by commissioning.

17.6.5 The Proposed PCC Site will include constructing the following key features:

- a single CCGT unit to be fired by natural gas including a Heat Recovery Steam Generator (HRSG) and a condensing steam turbine;
- gas conditioning equipment to enable prior treatment of natural gas before it is used as a fuel source for the CCGT;
- transformers for the import of any electricity required for the Proposed Development as well as for the export of electricity into the National Grid National Electricity Transmission System;
- ancillary equipment (including compressors, pumps, chemical storage, coolers and water treatment) required to safely and efficiently operate the generating station;
- hybrid cooling modules;
- exhaust stack(s) for the discharge of emissions to air from the HRSG, Carbon Capture Plant and auxiliary boiler;
- equipment to facilitate effective treatment of exhaust gases prior to carbon capture, including selective catalytic reduction equipment for the removal of nitrogen oxides (NO_x) from the flue gas; and
- a Post-Combustion Carbon Capture Plant, including absorber column, CO_2 treatment and compression infrastructure.

17.6.6 Other features and buildings to be constructed include:

- water treatment area;
- car park;
- gatehouse;
- cooling tower;
- cooling tower instrument and electrical building;
- clean water treatment building;
- CO_2 stripper area electrical and instrument building;
- absorber area electrical and instrument building;
- Numerous other pumps, tanks, bulk storage areas; and
- Temporary cofferdam(s) to create a safe, dry working area within the Water Connection Corridor.

17.6.7 Further details regarding each component of the Proposed Development are available within **Chapter 4:** The Proposed Development (PEI Report Volume I). A detailed review of the individual components within the Proposed Development Site is proposed within **Chapter 3:** The Site and Surrounding Area (PEI Report Volume I). An Indicative DCO Site Layout is provided within **Figure 3.2** (PEI Report Volume III).

Operational Activities

17.6.8 The Proposed Development will operate as a 910MW power-generating station, a single CCGT fuelled by natural gas.

17.6.9 The CCGT unit will be served by a dedicated and fully integrated CCP. The CCP will be designed to be capable of capturing up to 95% of the CO_2 emitted from the generating station, with an average capture rate of around 90% (subject to completion of studies and commercial agreements). The Proposed PCC Site has been sited in order to connect on site into a CO_2 gathering network including a CO_2 export pipeline that is being designed by Humber Low Carbon to operate independently of the Proposed Development. Further information on this network is provided within **Chapter 4:** The Proposed Development (PEI Report Volume I).

17.6.10 The Proposed Development is expected to operate in a number of different operational modes; these are considered further below with further details available in **Chapter 4:** The Proposed Development (PEI Report Volume I).

Decommissioning Activities

17.6.11 At the end of operation, it is expected 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 and, if necessary, re-permitted in line with the legislative requirements at that time.

17.6.12 At the end of its operating life, the most likely scenario is that the Proposed Development would be shut down and all above ground structures removed from the Site.

Sustainability Review

17.6.13 This section presents the preliminary findings of the Sustainability Review in relation to the construction and operation (including maintenance) of the Proposed Development.

17.6.14 Currently, there is no defined single accepted methodology for the completion of a Sustainability Assessment or Review. Notwithstanding, this review will provide a mechanism for considering the sustainability of the Proposed Development as a whole and for integrating sustainability considerations throughout its lifecycle.

17.6.15 The review summarises the features and attributes of the Proposed Development that would contribute to, or affect each of the sustainability themes, and sets out actions, which would be taken during the design, construction and operation that would further assist in delivering sustainability benefits for the local and wider area.

17.6.16 Measures are outlined, where feasible, that would be considered for implementation to incorporate and improve sustainability within the Proposed Development design and management.

17.6.17 The key topics within the scope of the Sustainability Review are:

- Biodiversity and Nature Conservation;
- Geology, Hydrogeology and Ground Conditions;
- Air Quality;
- Traffic and Transport;
- Noise and Vibration; and
- Water Quality.

17.6.18 The scope of the review includes the construction and operation of the Proposed Development.

17.6.19 The Proposed Development is expected to have a design life of circa 25 years. At the end of this period, it is expected 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, no decommissioning activities are currently anticipated to commence before 2057.

17.6.20 Decommissioning activities would be conducted in accordance with the appropriate guidance and legislation at the time of the Proposed Development's closure. In terms of sustainability, all decommissioning activities will be undertaken in accordance with the waste hierarchy. 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.

17.6.21 A Decommissioning Plan (including Decommissioning Environmental Management Plan (DEMP)) will be produced and agreed with the Environment Agency as part of the Environmental Permitting and site surrender process. The DEMP will consider in detail all potential environmental risks and contain guidance on how risks can be removed, mitigated or managed. This will include details of how surface water drainage should be managed on the Proposed PCC Site during decommissioning and demolition.

17.6.22 The Decommissioning Plan will include an outline programme of works. It is anticipated that it would take up to a year to decommission the Proposed PCC Site, with demolition following thereafter, i.e. taking approximately two years to complete. Further details on decommissioning are provided within **Chapter 4**: The Proposed Development (PEI Report Volume I).

17.6.23 In the light of the control measures applied during the decommissioning phase, including those set out above, decommissioning is not anticipated to present any environmental effects beyond those assessed for the construction phase of the Proposed Development and are not assessed separately in the sustainability review. It is also the case that forecasting methods of enhancing sustainability at a distant future time – i.e. 2057 or after – is technically infeasible. For these reasons, decommissioning is not considered further as part of the Sustainability Review.

17.6.24 The design for the Proposed Development is based on the Best Available Techniques (BAT) for a CCGT with carbon capture which aim to minimise impacts on the surrounding environment including in terms of air quality, emissions, energy and water use. The following sections describe the sustainability impact avoidance measures that have been incorporated into the Proposed Development design, together with mitigation and management actions that are assumed to be taken that contribute to sustainability and mitigate the effects of climate change.

Ecology

17.6.25 Ecology and biodiversity are important considerations in relation to the sustainability of the Proposed Development. A range of impact avoidance measures are set out in **Chapter 11:** Biodiversity and Nature Conservation (PEI Report Volume I). These include compliance with good environmental protection practice during construction to prevent surface and groundwater pollution, dust and noise pollution. It is assumed that such measures would be prepared and implemented by the contractor through a CEMP. Further details on the management of potential effects during the construction phase, including the role of the CEMP, are provided within **Chapter 5:** Construction Programme and Management (PEI Report Volume I).

Ground Conditions and Hydrogeology

17.6.26 **Chapter 13:** Geology, Hydrogeology and Land Contamination (PEI Report Volume I) considers the impact of the Proposed Development on soil and groundwater. Impact avoidance measures are proposed that accord with standard practice in construction and operation Measures to manage potential impacts upon ground conditions and hydrogeology during the construction phase would be implemented via the CEMP. More widely, best practice requirements to enhance sustainability would be adopted, where possible; for example, opportunities for excavated materials to be re-used on site for ground preparation and landscaping will be explored.

Air Quality

17.6.27 **Chapter 8:** Air Quality (PEI Report Volume I) details best practice measures to be applied to manage emissions of dust and particulates by construction activities, construction traffic, as well as air emissions during operation. 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 (PEI Report Volume II).

17.6.28 During operation, emissions to air would comply with the Emissions Limit Values (ELV) specified in the Industrial Emissions Directive (IED), and the European Large Combustion Plant BAT Reference document which was finalised in 2017 and contained tighter emission levels than were included in the IED. There is currently no BRef or BAT guidance document available for carbon capture plant. It is understood that the Environment Agency are currently preparing a BAT review for Post-Combustion Carbon Dioxide Capture using Amine-Based Technologies, which is due to be published in early 2021.

17.6.29 The Proposed Development would be regulated by the Environment Agency through an Environmental Permit. Monitoring strategies for the operational plant will be enshrined within the Environmental Permit and are likely to require continuous monitoring of key pollutant emissions from each stack, with annual reporting of results to the Environment Agency and annual independent validation of the monitoring results. Air Quality during the operational phase is considered further within **Appendix 8B:** Operational Air Quality Appendix (PEI Report Volume II).

Traffic and Transport

17.6.30 **Chapter 10:** Traffic and Transportation (PEI Report Volume I) details good practice measures that are assumed to be implemented to minimise construction traffic impacts (including delivery of materials and removal of waste generated). Traffic movements would be controlled during the construction phase to minimise, as far as reasonably practicable, impacts on the surrounding road network. A Construction Worker Travel Plan (CWTP) would be required from the contractor, which aims to identify measures and establish procedures to encourage construction workers to adopt modes of transport, which reduce reliance on single occupancy private car use. In addition, the contractor would be required to prepare a Construction Traffic Management Plan (CTMP) to identify a number of measures to control the routing

and impact that heavy goods vehicles (HGVs) would have on the local road network during construction.

17.6.31 Based on best practice, a Transport Assessment has also been prepared and is attached within **Appendix 10A:** Transport Assessment (PEI Report Volume II). This considers current conditions at the Proposed Development Site whilst providing calculations for the profile of transport generation through the construction period and the identification of peak development flows. The assessment considers the impacts of the surrounding network and how mitigation measures may serve to improve the sustainability of the Proposed Development from a transport perspective.

Noise and Vibration

17.6.32 Mitigation of noise and vibration during construction and operation are detailed in **Chapter 9:** Noise and Vibration (PEI Report Volume I) and the supporting **Appendix 9A**: Noise Appendix (PEI Report Volume II). Construction mitigation measures include working within construction noise limits through the use of modern plant complying with the applicable UK noise emission requirements. Any noise complaints would be recorded and investigated by the Applicant. The management of noise and vibration and the application of appropriate mitigation measures during construction would be controlled through the CEMP, proposed to be secured through a Requirement of the DCO.

17.6.33 In terms of operation, consideration of potential noise effects and proximity to noise sensitive receptors (NSR) have been considered, with plant being located close to the (existing) Keadby 1 and (under construction) Keadby 2.

17.6.34 The Proposed Development would be operated in accordance with an Environmental Permit, issued and regulated by the Environment Agency. This would require control of operational noise through use of BAT, which would be demonstrated in the Environmental Permit application.

Flood risk, Hydrogeology and Water Resources

17.6.35 **Chapter 12**: Water Resources and Flood Risk (PEI Report Volume I) considers potential design and impact avoidance measures to minimise water environment impacts.

17.6.36 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. At this preliminary stage, a Flood Risk Assessment has been undertaken and is attached within **Appendix 12B:** FRA (PEI Report Volume II); 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.

17.6.37 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 12B:** FRA (Section 5 - 6) (PEI Report Volume II); this presents options for the drainage design that would be developed through the detailed design process. With specific relation to sustainability, this also considers the opportunities for the incorporation of Sustainable 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.

17.6.38 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. During construction, the opportunity would be taken to adopt flood resilient design techniques where possible, including placement of main plant and flood sensitive equipment above the River Trent 1 in 200 year flood level, plus an allowance for climate change. Further details are included within **Appendix 12B:** FRA (PEI Volume II).

GHG Impact Assessment

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

Description of Potential Effects

17.6.40 This Section identifies any likely significant effects that are predicted to occur and then highlights the mitigation and enhancement measures that are proposed to minimise any adverse significant effects.

Construction

17.6.41 In order to assess the magnitude of the impact of the Proposed Development on the climate, GHG emissions associated with construction of the Proposed Development will be calculated in the final ES. However, due to the early concept design at this stage in the project development a calculation of emissions has not been undertaken to date. Embodied emissions from the construction phase are only likely to contribute a small proportion of overall lifetime emissions for this project, with the operational phase making up a large majority of whole life emissions.

17.6.42 Construction emissions will be calculated in the final ES using the activity types detailed in Table 17.25.

Table 17.25: Construction GHG Emissions

Lifecycle stage	Project activity/Emission source
Manufacturing and Fabrication of Project Components	Embodied carbon of material and products
	Materials and product transport
Pre-Construction and Site Clearance/	Electricity usage
	Fuel usage onsite

Lifecycle stage	Project activity/Emission source
	Waste transport
	Waste disposal
	Worker commute
Construction and Commissioning	Electricity usage
	Fuel usage onsite
	Waste transport
	Waste disposal
	Worker commute

Operations

17.6.43 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.
- Treated water will be required for plant cooling and makeup. At this preliminary stage, a number of options are under consideration for the supply of water including abstraction from the either the River Trent or the Stainforth and Keadby Canal. Indicative abstraction volumes for the River Water Abstraction Option and the Canal Water Abstraction Option are 1149 tonnes per hour (t/h) and 1483t/h respectively (noting that these may change depending on the final preferred cooling philosophy). Power associated with any abstraction, any associated GHG emissions, are implicit to the overall assessment for the Proposed PCC Site (being parasitic loads on the CCGT).
- If available, emissions associated with any additional required treated water demand will be included in the ES.
- 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 and wastes are assumed to be transported by a mix of Heavy Goods Vehicles and include a return trip.
- Information regarding maintenance schedules is not currently available, however it is assumed that the plant will be unavailable for 14 days per year for annual maintenance.
- 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. If further transport data becomes available for specific materials, this information would be included in the ES.

- Fuels and oils required onsite, other than natural gas, which may include but is not limited to diesel required for generators in emergencies and start-up of the turbines, lubricating oils and acetylene. In this stage of the design process, information regarding the annual volume requirements of these are not available, and other fuels may also be required. These will be minor sources of GHG emissions.
- CO_2 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. If data is available, emissions associated with purging generators will be included in the ES.
- Nitrogen will be used to purge natural gas systems 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 the purging would be a minor source of GHG emissions. If data is available, emissions associated with purging natural gas systems will be included in the ES.
- Electrical circuit breakers and other switchgear frequently use sulphur hexafluoride (SF_6) as an arc quencher and noise suppressant. This gas has a very high global warming potential, and if any data on its use and potential leakage rates become available it will allow the climate impact to be included in the ES.
- Emissions associated with some waste disposal and treatment have been included. Information regarding likely wastes and volumes are not available at this stage in the design process, therefore only estimates of sewage and municipal wastes have been included. Other types of waste are likely to be generated.
- Using current estimates of 50 operational staff, calculations of GHG emissions associated with the commute of workers have been carried out. This is on the assumptions that 100% of workers will travel by car with an occupancy of 1 person per vehicle. It is assumed that all workers will travel a maximum of 50km each way (based on the findings of **Chapter 16:** Socioeconomics (PEI Report Volume I) this is regarded as precautionary but will be reviewed, where required, in the ES). All transits include a two-way journey.
- An additional 50 staff will be required onsite during the 14-day maintenance every year using the same car occupancy rates and location distribution.
- Materials required for operations are likely to include sodium hypochlorite, hydrochloric or sulphuric acid, sodium hydroxide, carbohydrazide, trisodium phosphate, ammonia, amines, urea, cleaning chemicals, inert firefighting gases, carbon dioxide, hydrogen and mains water. The annual volumes needed of these materials are not available at this stage of the design process, and other materials may also be required. These will be sources of GHG emissions.
- The source of materials required for normal operations of the Proposed Development are not available at this stage of the design. All transits will include a two-way journey.
- The carbon capture system is designed to remove carbon dioxide from the flue gases. The overall effectiveness of the carbon capture system varies depending

on the operating mode applied (see para 17.6.47 below) and has been calculated based on preliminary material balance flow data provided for each mode.

- The material balance flow data for each operating mode includes preliminary information on final stack emissions of carbon dioxide (CO_2).
- For each operating mode, a preliminary gross power plant electricity output figure has been combined with the expected electricity demand of the carbon capture and compression plant 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.
- Cooling and process water is all assumed to be sourced from existing surface water abstraction sources.

17.6.44 All assumptions and data for different operating modes will be updated as more information becomes available, and an updated GHG calculation for the operations phase of the Proposed Development will be presented in the ES.

Operational Modes

17.6.45 It is anticipated that on commissioning, the Proposed Development will 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 ZCH partnership network. Operating in baseload mode could involve up to 20 start-up/ shutdown cycles per year.

17.6.46 After a period of baseload operation, it is expected 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 100 start-up/ shutdown cycles per year.

17.6.47 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.

17.6.48 Operational Modes are discussed further within **Chapter 4:** The Proposed Development (PEI Report Volume I). The four operating modes used to form the basis of this preliminary 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 Proposed PCC Site 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
- **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 (PEI Report Volume I), there are a number of technical and engineering factors which will influence the carbon capture rate

17.6.49 Material flow and electrical output data has been provided for four possible operating modes as follows (Table 17.26).

17.6.50 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 changes in these periods and the low frequency of start-up and shut-down, they are considered to be negligible for the purposes of this assessment. This will be re-reviewed during the production of the ES, where required.

Table 17.26: 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	Minimum Flow	Summer/Winter	Ref. 95% carbon capture
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 atmosphere (tonnes CO2e	210,048	59,088	187,168	105,312
Lifetime GHG emissions to atmosphere (tonnes CO_2e)	5,251,200	1,477,200	4,679,200	2,632,800

Operating mode	Reference	Minimum Flow	Summer/Winter	Ref. 95% carbon capture
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

17.6.51 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 5,251,200 tCO_2e over 25 years.

17.6.52 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 2,775 tCO_2e per year, for total annual operational emissions of 212,823 tCO_2e and lifetime operational emissions of 5,320,566 tCO_2e. These emissions are detailed in Table 17.27.

Table 17.27: 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	5,251,200	98.70%
	Waste disposal	61,155	1.15%
	Worker commute	8,120	<1%
	Materials	11	<1%
	Materials transport	80	<1%
TOTAL		**5,320,566**	100.00%
Annualised operational emissions (based on 25-year life)		**212,823**	

GHG Avoidance

17.6.53 The emissions from consumption of natural gas detailed above are for the reference case, with the carbon capture plant running as designed.

17.6.54 Unabated emissions for the reference case would be substantially higher, for total annual plant emissions of 2,252,378 tCO_2e and lifetime emissions of 56,309,456 tCO_2e. The carbon capture plant, in the reference case operating mode, reduces the overall emissions of greenhouse gases by 90.7%.

17.6.55 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).

17.6.56 Table 17.28 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.

17.6.57 Table 17.28 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 slightly better than that of the typical combined-cycle gas-powered power plant (354 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 233 tCO_2e per GWh.

Table 17.28: 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)
Combined Cycle Gas Turbine (UKUK Parliament, 2015)	354
All fuels, grid average (including nuclear and renewables) (BEIS, 2020)	233
Proposed Development (unabated-without carbon capture technology)	352.3
Proposed Development (abated-with carbon capture technology)	35.9

17.6.58 The UK electricity grid is in the process of being decarbonised as the UK transitions toward net zero by 2050. BEIS (2019) provides grid intensity projections to 2100, with intensities falling to 28 tonnes per GWh in 2050 and remaining flat thereafter.

17.6.59 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. The projected average grid intensity is based on an anticipated mix of electricity generation sources including fossil fuel, nuclear and renewable energy.

17.6.60 **Figure 17.4** shows the comparison between projected decarbonisation of the UK national grid from 2027 to 2052 and the emissions intensity for the Reference case of the Proposed Development calculated from the emissions and electrical data provided. 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.

17.6.61 If the rate of carbon capture is increased from 90% to 95%, then the overall carbon intensity of the Proposed Development could be as low as 18 tonnes CO_2e/GWh, at which level it will outperform grid projections for the entire design life of the development. The potential carbon capture rate will be reviewed in the ES.

17.6.62 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.

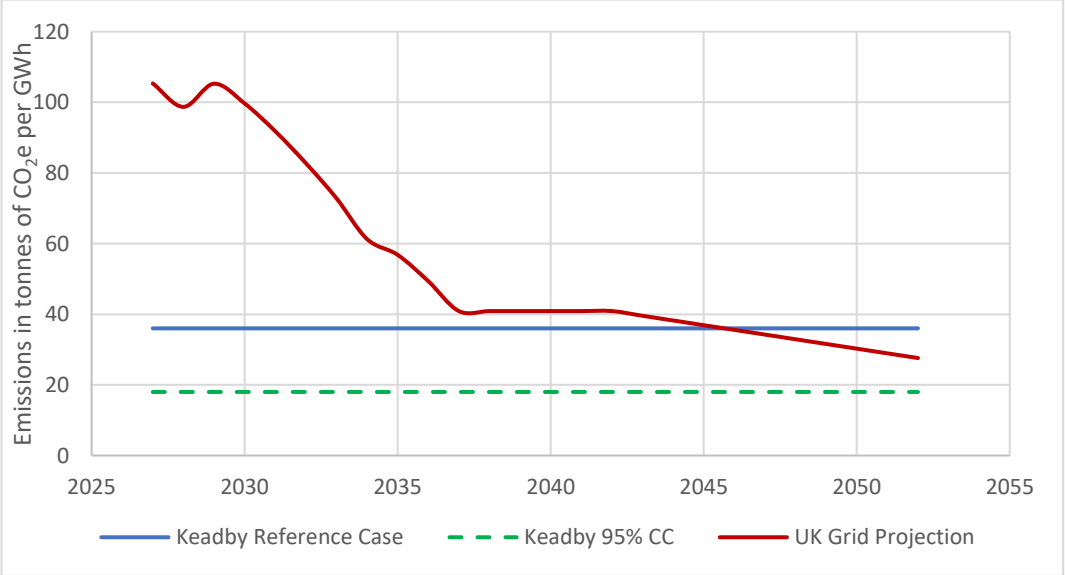

Figure 17.4:Projected UK Grid Intensity vs Proposed Development (Reference case)

Decommissioning

17.6.63 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 project activities will be calculated and be based on the assumptions listed below:

- demolition and excavation of all buildings and infrastructure, as required;
- disposal and treatment of all wastes; and
- assumed to be returned to an industrial brownfield site under hardstanding with no change in land use.

17.6.64 These assumptions will be updated and a GHG calculation for the decommissioning phase of the Proposed Development will be presented in the ES.

17.6.65 At this stage of the design, details regarding these activities have not been developed, however they are expected to be commensurate with emissions generated during the construction stage.

Summary of GHG Impacts

17.6.66 The receptor for the GHG assessment is the global climate and the UKs carbon budgets are used as a proxy to assess the impacts to this receptor.

17.6.67 Emissions associated with the Proposed Development have been examined for their significance against the UK Carbon Budgets. These emissions are detailed in Table 17.29.

17.6.68 This assumes one year of operations occurring during the 4th carbon budget and five years during the 5th carbon budget. The percentage contribution of emissions from the Proposed Development to the respective carbon budgets are 0.011%, and 0.06%, respectively. This assessment will be refined and updated to include construction data and further operational data during the ES.

17.6.69 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 and the Proposed Development supports the UK transition towards the net zero target.

Table 17.29: Proposed Development GHG Emissions Compared to the UK Carbon Budget

UK Carbon Budget	Total Budget ($MtCO_2e$)	Potential Project Emissions ($MtCO_2e$)	Percentage Contribution of Emissions
3rd (2018-2022)	2,544	-	-
4th (2023-2027)	1,950	0.21 (one year of operations)	0.011%
5th (2028-2032)	1,725	1.05 (five years operations)	0.06%

ICCI Assessment

Construction Phase

17.6.1 No potential impacts or effects during construction of the Proposed Development have been identified. This will be finalised with any updates during the ES.

Operational Phase

17.6.2 No potential impacts or effects during operation of the Proposed Development have been identified. This will be finalised with any updates during the ES.

Decommissioning Phase

17.6.3 No potential impacts or effects during decommissioning of the Proposed Development have been identified. This will be finalised with any updates during the ES.

CCR Assessment

Construction Phase

17.6.4 At this stage, likelihood and consequences during construction have been preliminarily assessed for their significance. This assessment will be updated for the ES.

17.6.5 Potential climate change impacts on the Proposed Development and the adaptation methods to increase the resilience of the Proposed Development are detailed in Table 17.30.

Operational Phase

17.6.6 At this stage, likelihood and consequences during operations have been preliminarily assessed for their significance. This assessment will be updated for the ES.

17.6.7 Potential climate change impacts on the Proposed Development and the adaptation methods to increase the resilience of the Proposed Development are detailed in Table 17.31.

Decommissioning Phase

17.6.8 At this stage, likelihood and consequences during decommissioning have been preliminarily assessed for their significance. This assessment will be updated for the ES.

17.6.9 Potential climate change impacts on the Proposed Development and the relevant adaptation methods to help increase the resilience of the Proposed Development are detailed in Table 17.32.

Table 17.30: Construction- Potential Climate Change Impacts and Relevant Embedded Adaptation/Resilience Measures

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
Built assets, materials, staff facilities and access routes to sites	Increased frequency and severity of extreme weather events (such as heavy and/or prolonged precipitation, storm events and heatwaves)	Likely	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.	Unlikely	Low Minor- not significant	The potential risks to the Proposed Development arising from flood risk and climate change, including increased sea levels and storm events, is considered within **Appendix 12B:** FRA (PEI Report Volume II). This includes a consideration of any required mitigation to ensure resilience for the lifetime of the project. A high-level risk assessment of severe weather impacts on the process will be produced by the main contractor to inform mitigations. Any receptors and/or construction/decommissioning-related operations and activities potentially sensitive to severe	Low Minor- not significant

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
	Increasing summer temperatures, increased humidity and increasing frequency of hot days and heatwaves	Very likely	Overheating of electrical equipment Damage to materials	Very unlikely	Very low Negligible – not significant	weather events should be considered in the assessment. Climate change projections should be considered in the risk assessments (which may be different during construction and decommissioning). The FRA will inform the adoption of any adaptation / mitigation measures that need to be incorporated into the final design.	Very low Negligible- not significant
	Increased winter rainfall	Likely	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).	Possible	Low Minor- not significant	The contractors will use a short to medium range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium term programme management, environmental control and impact mitigation measures. The contractors will register with the Environment Agency's (EA) flood	Low
	Sea level rise	Very likely		Very unlikely	Low Negligible – not significant		Low Negligible – not significant

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
						warning service in areas of flood risk.	
Workers on site	Increasing summer temperatures, increased humidity and increasing frequency of hot days and heatwaves	Very likely	Increased heat stress/ heat exhaustion for workers.	Unlikely	Medium Minor- not significant	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.	Low Minor- not significant

Table 17.31: Operation- Potential Climate Change Impacts and Relevant Embedded Adaptation/Resilience Measures

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
Built terrestrial assets, staff facilities and access routes to sites Staff, contractors and visitors	Increased frequency and severity of extreme weather events (such as heavy and/or prolonged precipitation, storm events and heatwaves)	Likely	Damage to utilities and roofs due to high winds or intense rainfall Damage to drainage systems, gutters and downpipes due to flooding from intense rainfall Flooding from drainage systems during intense or prolonged rainfall. Land loss, destabilisation and flooding	Possible	Low Minor- not significant	Initial capture of surface water run-off will be provided by appropriate sustainable drainage system (SuDS) methods. A range of different potential SuDS solutions are considered further within Appendix 12B (Section 5 – 6): Conceptual Drainage Strategy (PEI Report Volume II). The Flood Risk Assessment (FRA) will inform the any adaptation measures that need to be incorporated into the final design and operations management.	Low Minor- not significant

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
			from erosion and storm surge				
	Increased winter rainfall	Likely	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	Possible	Low Minor- not significant	The Flood Risk Assessment (FRA) which include the Drainage Strategy will inform the any adaptation measures that need to be incorporated into the final design and operations management.	Low Minor- not significant
	Sea level rise	Very likely		Unlikely	Low Minor- not significant		Low Minor- not significant

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
			frost penetration Damage to infrastructure through storm surge and river flooding				
	Decreased summer precipitation	Likely	Water shortages Drying out of pavement structures Deterioration of structures due to decrease in soil moisture levels	Unlikely	Low Minor- not significant	Consideration of abstraction of water from the River Trent, or from the Stainforth and Keadby Canal, to reduce use of mains water.	Low Minor- not significant
	Increased summer and winter temperatures	Very likely	Impacts on the thermal comfort of building users	Possible	Low Minor- not significant	A cooling water and return network for heat rejections from the CCGT and CCP. Cooling achieved through the use of hybrid wet/dry cooling towers	Low Minor- not significant

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
			Increase in ambient temperature of buildings, leading to higher air conditioning requirements and impacts on the thermal comfort of building users Overheating of electrical equipment Heat damage, deformation, cracking and thermal expansion of building surfaces and pavements			abstracted from the River Trent or from the Stainforth and Keadby Canal. Supplemented by additional pre-cooling by dry 'fin-fan' cooler during summer.	

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
Marine assets	Increased frequency and severity of extreme weather events	Likely	Physical damage to marine assets Reduced function of marine assets	Unlikely	Medium Minor- not significant	Adaptation and resilience measures for this asset have yet to be determined at this stage of the design. This will be updated during the ES.	To be determined
	Sea level rise	Very likely		Unlikely	Medium Minor- not significant		To be determined

Table 17.32: Decommissioning- Potential Climate Change Impacts and Relevant Embedded Adaptation/Resilience Measures

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
Built assets, materials, staff facilities and access routes to sites	Increased frequency and severity of extreme weather events (such as heavy and/or prolonged precipitation, storm events and heatwaves)	Likely	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.	Unlikely	Low Minor- not significant	A high-level risk assessment of severe weather impacts on the process will be produced by the main contractor to inform mitigations. Any receptors and/or construction/decommissioning-related operations and activities potentially sensitive to severe weather events should be considered in the assessment. Climate change projections should be considered in the risk assessments (which may be different during construction and decommissioning) The Flood Risk Assessment (FRA) will inform any adaptation measures that need to be incorporated into the final design.	Low Minor- not significant
	Increasing summer temperatures,	Very likely	Overheating of electrical equipment	Unlikely	Very low Negligible – not significant		Very low Negligible- not significant

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
	increased humidity and increasing frequency of hot days and heatwaves		Damage to materials				
	Increased winter rainfall	Likely	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).	Possible	Low Minor- not significant	The contractors will use a short to medium range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium term programme management, environmental control and impact mitigation measures. The contractors will register with the Environment Agency's (EA) flood warning service in areas of flood risk.	Minor- not significant
	Sea level rise	Very likely		Unlikely	Low Negligible – not significant		Minor- not significant
Workers on site	Increasing summer temperatures, increased	Very likely	Increased heat stress/ heat	Unlikely	Medium Minor- not significant	Prevention measures covered in the CEMP and health and safety plans e.g. temporary buildings such as site offices will be	Low Minor- not significant

Proposed Development Asset	Potential climate change hazard	Likelihood of climate hazard occurring (from UKCP Projections)	Potential impacts on the Proposed Development	Likelihood of climate impact occurring (Table 17.9)	Consequence and significance of inherent risk (Table 17.10 and Table 17.15)	Embedded Adaptation / Resilience measures (included within inherent risk)	Consequence and significance of residual risk
	humidity and increasing frequency of hot days and heatwaves		exhaustion for workers.			designed with measures to control summertime overheating	

17.7 Mitigation and enhancement measures

17.7.1 A combination of best practice, legal requirements, design refinement and anticipated conditions within the DCO will enable the Proposed Development to be constructed – and operated – in a sustainable manner. Further opportunities for enhancing the sustainability credentials of the Proposed Development will be explored in the ES.

17.7.2 The management of GHG emissions and the application of mitigation measures during construction will be secured through the CEMP. The use of the carbon capture plant will control GHG emissions during plant operation.

17.7.3 As no ICCI impacts have been identified, no further mitigation or enhancement measures have been proposed. This will be re-evaluated following finalised of any updates during the ES.

17.7.4 The management of impacts and the application of mitigation/adaption measures during construction will be enforced through the CEMP. The management of impacts and the application of mitigation/adaption measures during operation will be developed for inclusion in the ES.

17.8 Monitoring

17.8.1 No additional monitoring is recommended, other than that detailed within the CEMP.

17.9 Limitations or difficulties

GHG Impact Assessment

17.9.1 The current GHG assessment is limited to the availability of data and information. The inclusions and exclusions of data have been detailed in Section 17.6 and will be updated and refined in the ES as appropriate.

ICCI and CCR Assessment

17.9.2 While modelled climate change projections represent anticipated changes to average weather conditions, they cannot predict the frequency and severity of acute events such as 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 is included in this assessment.

17.9.3 The ICCI and CCR assessment is limited to the availability of data and information at this stage of the assessment. The full assessment results will be detailed in the ES.

17.10 Summary of likely significant residual effects

17.10.1 A summary of the current estimate of GHG emissions produced during the lifespan of the Proposed Development has been detailed in Section 17.6.

17.10.2 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' magnitude and therefore are of **Minor adverse** significance.

17.10.3 Existing design measures incorporated into the design of the Proposed Development provide measures that reduce the likelihood of an ICCI occurring or increase the resilience to future climate change hazards.

17.10.4 Using climate projections, a number of changes to climate variables have been identified as at least 'likely' and 'very likely' during the lifespan of the Proposed Development. These changes include increases in temperatures, reductions in summer rainfall, increases in winter rainfall, extreme weather events, sea level and sea temperature rise.

17.10.5 At this stage of planning, no significant ICCI or CCR impacts have been identified. This will be re-assessed during the ES stage.

17.10.6 Appropriate mitigation measures to limit or potentially remove the effects described above have been outlined, and these will be refined in the next stage of the EIA assessment. The significance of the effects will be formally assessed using the guidance set out in Section 17.3. The final mitigation measures set out in the ES are intended to minimise as far as practicable all identified effects to receptors within the constraints of the Proposed Development and in accordance with all applicable legislation.

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