Table of Contents

21. Climate Change 21-1
21.1 Introduction 21-1
21.2 Legislation and Planning Policy Context 21-1
21.3 Greenhouse Gas Assessment 21-7
21.5 Climate Change Resilience Review 21-35
21.6 Residual Effects 21-48
21.7 References 21-49

Diagrams

Diagram 21-1: Tees Valley GHG Emissions Baseline and Reduction Targets (Taken from Tees Valley Unlimited, 2010) 21-5
Diagram 21-2: Forecast UK Grid Intensity vs Proposed Development 21-23
Diagram 21-3: ICCI Assessment Methodology 21-30
Diagram 21-4: CCR Assessment Methodology 21-38

Tables

Table 21-1: Comments raised by the Planning Inspectorate in the Scoping Opinion 21-7
Table 21-2: Scope of Potential GHG Emission Sources from the Construction Stage 21-11
Table 21-3: Scope of Potential GHG Emissions Sources from the Operational Stage 21-12
Table 21-4: Scope of Potential GHG Emissions Sources from the Decommissioning Stage 21-12
Table 21-5: Magnitude Criteria for GHG Impact Assessment 21-13
Table 21-6: Significance of Effects Matrix for GHG Emissions Impact Assessment 21-14
Table 21-7: Current UK Carbon Budgets 21-15
Table 21-8: Construction GHG Emissions 21-17
Table 21-9: Operational GHG Emissions from Turbine Operations, Scenario 1 Assuming Baseload Operations with No Dispatch Modes 21-19
Table 21-10: Operational GHG Emissions from Turbine Operations, Scenario 2 Assuming 40 Start-Up/Shut Down Dispatch Mode from Years 5 To 25 21-20
Table 21-11: Operational GHG Emissions from Turbine Operations, Scenario 3 Assuming 80 Start-Up/Shut Down Dispatch Mode from Years 5 To 25 21-20
Table 21-12: Operational GHG emissions (using Scenario 1 plant emissions) 21-21
Table 21-13: Carbon Intensities of UK Electricity Grid Generation Sources in 2018 21-22

Table 21-15: Proposed Development GHG Emissions Compared to the UK Carbon Budget 21-24
Table 21-16: Historic Climate Data 21-25
Table 21-17: Historic 10-year Averages for Temperature and Rainfall for the East and North East England 21-25
Table 21-18: Projected Changes in Temperature Variables (°C), 50% Probability (10% and 90% Probability in Parenthesis) 21-27
Table 21-19: Projected Changes in Precipitation Variables (%), 50% Probability (10% and 90% Probability in Parenthesis) 21-27
Table 21-20: Projected 50% Probability of Sea Level Rise Under RCP 8.5 Relative to the 1981-2000 Baseline Period (10% And 90% Probability In Parenthesis) 21-27
Table 21-21: Potential Climate Hazards and Likelihood of Occurrence (from UKCP18 Projections) 21-28
Table 21-22: Scope of the ICCI Assessment 21-29
Table 21-23: ICCI Assessment - Level of Likelihood of the Climate Hazard Occurring 21-31
Table 21-24: ICCI Assessment – Level of Likelihood of the Climate Impact Occurring 21-32
Table 21-25: Level of Likelihood of the ICCI 21-32
Table 21-26: ICCI assessment – Level of Likelihood of the Climate Impact Occurring 21-33
Table 21-27: ICCI Assessment – Significance Criteria 21-33
Table 21-28: Scope of the CCR Review 21-37
Table 21-29: Description of Likelihood for Climate Change Hazard 21-38
Table 21-30: Measure of Consequence for Climate Change Resilience 21-39
Table 21-31: Significance Criteria for Climate Change Resilience Assessment 21-40
Table 21-32: Potential Climate Change Impacts and Relevant Embedded Adaptation/Resilience Measures 21-42

21. Climate Change

21.1 Introduction

21.1.1 This chapter of the Preliminary Environmental Information (PEI) Report assesses the potential impacts of the construction and operation of the Proposed Development on the climate and the potential impact of projected future climate change on the Proposed Development and surrounding environment.

21.1.2 The Proposed Development includes the construction, operation and decommissioning of a power station consisting of up to three CCGT units fitted with post combustion carbon capture technology that allows capture of up to 95% of carbon emissions.

21.1.3 Captured carbon will be directed to an offshore carbon store and not released to the atmosphere.

21.1.4 A carbon gathering network is included within the Proposed Development. This is being developed to facilitate neighbouring facilities to be able to capture and store their carbon emissions. However, these future industrial connection options and corresponding additional carbon reduction benefits do not form part of the Proposed Development and have not therefore been included in this assessment in order to present a conservative assessment.

21.1.5 In accordance with the requirements of the *Town and Country Planning and Infrastructure Planning (Environmental Impact Assessment) (Amendment) Regulations 2018*, guidance from the Institute of Environmental Management and Assessment (IEMA) for climate change mitigation (IEMA, 2017) and adaptation (IEMA, 2015) has been applied. This chapter addresses three separate 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 impacts (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) review** – 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.

21.2 Legislation and Planning Policy Context

21.2.1 This Section identifies and describes legislation, policy, and guidance of relevance to the assessment of the potential climate impacts associated with the construction and operation of the Proposed Development.

21.2.2 Legislation, policy and other relevant guidance has been considered on an international, national and local level. The following is considered to be relevant to the climate assessment as it has influenced the sensitivity of receptors and requirements for mitigation or the scope and/or methodology of the assessment.

21.2.3 This Section will be updated with any new or additional relevant legislation and policies following public consultation prior to finalisation of the Environmental Statement (ES).

International

EIA Directive 2014/52/EU

21.2.4 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.

Kyoto Protocol

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

Paris Agreement

21.2.6 At the Conference of the Parties (CoP) 21 in 2015, an agreement (the “Paris Agreement”) was reached under the UNFCCC United Nations Framework Convention on climate change. This came into force, in November 2016 and pledges long-term temperature goals to keep the increase in global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the increase to 1.5°C. Parties to the agreement also aim to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of the century.

Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment

21.2.7 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).

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

21.2.8 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).

National

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

21.2.9 *The Climate Change Act 2008* originally sets a legally binding target for the UK to reduce its greenhouse gas emissions from 1990 levels by at least 80% by 2050. This target is supported by a system of legally binding five-year 'carbon budgets' and an independent body to monitor progress, the Committee on Climate Change. The UK carbon budgets restrict the amount of GHG emissions the UK can legally emit in a defined five-year period. The UK has declared its 5th carbon budget up until 2032 and currently reflect the 80% reduction targets only.

21.2.10 The Act was amended in 2019 to revise the existing 80% reduction target and legislate for a net zero emissions by 2050 (through the Climate Change Act 2008 (2050 Target Amendment) Order 2019).

21.2.11 In 2020, the 6th carbon budget is due to be published by the Committee on Climate Change in late 2020 and will reflect the amended trajectory net zero target.

Overarching National Policy Statement for Energy (EN-1)

21.2.12 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.

21.2.13 This Framework 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)

21.2.14 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.

The National Planning Policy Framework

21.2.15 The revised National Planning Policy Framework (NPPF) (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.

21.2.16 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.

21.2.17 This Framework states that the planning systems should support this transition by supporting low carbon energy and associated infrastructure.

National Planning Policy Guidance on Climate Change

21.2.18 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.”

Biodiversity 2020 (2011)

21.2.19 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.

The Clean Growth Strategy

21.2.20 In 2017, the government published The Clean Growth Strategy (HM Government, updated 2018). 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.

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

21.2.21 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.’

21.2.22 Within this Action Plan, Teesside was identified as a key location for CCUS due to its heavy industry and chemical manufacturing.

Local

North and South Tees Industrial Development Framework

21.2.23 This Framework discusses the need to promote carbon capture and storage networks as an important opportunity for both the North and South Tees, and for the UK to meet its climate change reduction targets (Parsons Brinckerhoff Ltd & Genecon, 2009).

Tees Valley Climate Change Partnership

21.2.24 This Partnership published the Tees Valley Climate Change Strategy (Tees Valley Unlimited, 2010). The Partnership represents five local neighbouring local authorities and details its strategy for emissions reductions, climate change adaptation and resilience communities.

21.2.25 The combined Tees Valley GHG baseline was calculated as 7,125,000 tonnes of CO_2e as shown in Diagram 21-1.

21.2.26 Diagram 21-1 also illustrates the Partnership's total emission reductions that would be needed to meet the previous UK Government target of an 80% reduction in emissions by 2050 compared to that in 1990. Tees Valley calculated that their emissions would need to be under 2,000,000 tonnes of CO_2e by 2050 to meet the previous UK target. As set out above, the Climate Change Act (2050 Target Amendment) Order 2019 revised that 80% reduction target to a net zero target (Paragraph 21.2.10). The Tees Valley Climate Change Partnership has yet to recalculate their emissions reduction target in light of the revised net zero target. These targets have now been revised to be net zero by 2050 (Paragraph 21.2.9).

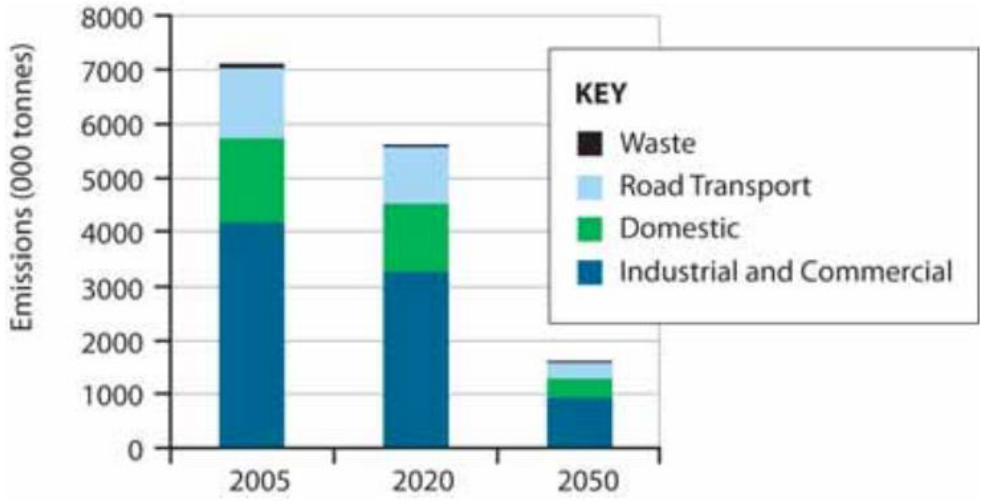

Diagram 21-1: Tees Valley GHG Emissions Baseline and Reduction Targets (Taken from Tees Valley Unlimited, 2010)

Redcar and Cleveland Borough Council

21.2.27 Redcar and Cleveland Borough Council declared a climate emergency in March 2019 and have declared intent to be carbon neutral by 2030 (Redcar and Cleveland Borough Council, 2019). This notably includes the support of a carbon capture storage and utilisation network for industry stating "[to achieve carbon neutrality by 2030] *This must include protecting our manufacturing industry and associated jobs by facilitating an industrial Carbon Capture Storage and Utilisation (CCSU) network in our Borough*".

21.2.28 The Council has adopted the Tees Valley Climate Change Strategy (Tees Valley Unlimited, 2010), which is reported upon in more detail above.

21.2.29 The Council is also a member of UK100, a network of community leaders committed to "*100% clean energy production by 2050*".

21.2.30 The Council's Strategic Flood Risk Assessment (JBA Consulting, 2016) is used as guidance for new developments to help avoid increased flooding risks from projections for sea level rise and increased rainfall. As the Council are defined as Lead Local Flood Authority and a Local Planning Authority,

Strategic Flood Risk Assessments are required to developed as a base for new Local Plans and Sustainability Appraisals. This is described in more detail in Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I).

21.2.31 The Council's Local Plan (RCBC, 2018) describes the need of new developments to be *"sustainable in design and construction, incorporating best practice in resource management, energy efficiency and climate change adaptation*" (RCBC, 2018, pg. 42) with particular climate change adaptation measures to be incorporated in flood and water management design.

Stockton-on-Tees Borough Council

21.2.32 Stockton-on-Tees adopted the Tees Valley Climate Change Strategy in 2010, which is reported upon in more detail above.

21.2.33 In 2016, the Council published its Climate Change Strategy and Action Plan, active until 2021 (STBC, 2016). The Strategy details its low carbon vision for the area and the industrial sector being a priority area for emission reductions.

21.2.34 The Council's Local Plan (Stockton-on-Tees Borough Council, 2019) describes the significant local opportunities to move towards a low carbon economy with carbon capture and storage

Other Guidance

IEMA Environmental Impact Assessment Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance (2017)

21.2.35 In the absence of any widely accepted guidance on assessing the significance of the impact effect of GHG emissions, EIA Guidance published by IEMA in 2017 has been followed. This provides a framework for the consideration of greenhouse gas emissions in the EIA process, in line with the 2014 EU Directive (EU Directive 2014/52/EU, which is reported in more detail above). 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).

IEMA Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation (2017)

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

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

21.3 Greenhouse Gas Assessment

Assessment Methodology

Consultation

21.3.1 An EIA Scoping Report was prepared by AECOM and submitted to the Planning Inspectorate in February 2019. The EIA Scoping Report sets out the proposed approach to the EIA and is intended to facilitate discussions regarding the scope of the EIA.

21.3.2 In response to the EIA Scoping Report, the Planning Inspectorate prepared a Scoping Opinion document. Specific comments raised by the Planning Inspectorate in relation to climate change are listed in Table 21-1.

21.3.3 These comments have been incorporated into this PEI Report.

Table 21-1: Comments raised by the Planning Inspectorate in the Scoping Opinion

ID	Subject	Inspectorates Comments	Addressed in PEIR Section
4.2.1	Assessment of climate change impacts from construction and decommissioning	The focus of paragraphs 6.25 - 6.27 of the Scoping Report is on operational impacts; it is not clear whether an assessment of climate change impacts from construction and decommissioning is proposed. The ES should explain how climate change impacts from construction and decommissioning of the Proposed Development (for example, greenhouse gas (GHG) emissions) have been considered and assess any likely significant effects.	Section 21.3 - Determining Construction Effect, Determining Operational Effect, and Determining Decommissioning Effect detail that GHG emissions from the full lifecycle of the Proposed Development are proposed to be assessed. Section 21.3 - Classification and Significance of Effect details the method in which significance will be determined.

ID	Subject	Inspectorates Comments	Addressed in PEIR Section
4.2.2	GHG emissions	The ES should quantify the GHG emissions relating to the Proposed Development. The calculation methods used should be explained. The ES should state any assumptions made in calculating the predicted GHG emissions, any limitations to the calculations and any uncertainties this presents for the assessment of GHG emissions. Should the DCO allow for the generating station component of the Proposed Development to operate independently of the carbon capture and storage elements, a worst-case assessment of likely significant effects should be undertaken.	Section 21.3 - Determining Construction Effect, Determining Operational Effect, and Determining Decommissioning Effect Details the GHG calculations methodology. 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 rather than in the PEI Report due to the early stage of design. The preliminary basis for calculation Construction emissions is provided in Section 21.3. Similarly, at this stage of the design, details regarding Decommissioning activities have not been developed, however they are expected to be commensurate with emissions generated during the construction stage. The methodology for determining decommissioning GHG emissions is the same as for pre-construction and construction, and operational emissions. Table 21-4 summarises the key anticipated emissions sources and whether they have been scoped in or out of the final assessment. Operational GHG emissions are assessed within Section 21.3 this will also be updated for the final ES.
4.2.3	Sensitive receptors	The sensitive receptors for the purposes of the climate change assessment should be set out and justified in the ES. The susceptibility or resilience of the identified receptors to climate change must be considered as well as the value of the receptor.	Section 21.3 – Sensitive Receptors; this section details the overarching sensitive receptors that will be included in the final ES. The susceptibility or resilience of the identified receptors to climate change will be determined by the environmental disciplines and detailed in the final ES. Section 21.3 Likely Impacts and Effects details the sensitive receptors considered and their susceptibility or resilience.

ID	Subject	Inspectorates Comments	Addressed in PEIR Section
4.2.4	Significance criteria	The Scoping Report does not set out how a significant effect would be determined for the purposes of the climate change assessment. This should be clearly set out in the ES. Any use of professional judgement to assess significance should be fully justified within the ES.	Section 21.3 - Classification and Significance of ICCI Effect details the methodology in which significance criteria is determined.
4.2.5	Climate change risks and adaptation	The ES should describe any potential impacts from changes in rainfall, flood risk, temperature, humidity and wind speed (including resilience to such impacts) with reference to the UKCP18 and the anticipated lifespan of the Proposed Development. If significant effects are likely, these should be assessed.	Section 21.5 – Climate Change Resilience Review details potential climate change impacts and considers their potential consequence and likelihood of occurrence. Potential impacts from climate change associated with flood risk specifically are addressed within Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I) and Appendix 9A: Flood Risk Assessment (PEI Report, Volume III). The assessment has been informed by UKCP18 (see Section 21.5).

Baseline Environment

21.3.4 The baseline environment for the GHG assessment is a ‘business as usual’ scenario where the Proposed Development is not undertaken. The baseline comprises existing carbon stock and sources of GHG emissions within the boundary of the existing Site.

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

21.3.6 It is assumed that there are no activities on Site and that the area is fully under hardstanding.

Project Environment

21.3.7 The alternative environment is a ‘do something’ scenario with the delivery of the Proposed Development, which includes the construction and operation of the plant.

Study Area

21.3.8 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.

Sensitive Receptors

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

Determining Construction Effects

21.3.10 Construction activities of the Proposed Development will involve earthworks and construction of up to three CCGT units with associated carbon capture trains, a CO_2 Gathering Network and Compressor station, an offshore CO_2 Export Pipeline, and associated land-based connection infrastructure. The Proposed Development also includes demolition of any existing site infrastructure and any necessary land remediation prior to development. Construction activities are described in more detail within Chapter 5: Construction Programme and Management (PEI Report, Vol I).

21.3.11 The potential effects of the Proposed Development to the global climate during construction are calculated in line with the GHG Protocol (WRI & WBCSD, 2004) and the GHG 'hot spots' (i.e. sources and activities likely to generate the largest amount of GHG emissions) are identified, as shown in Table 21-2. This has enabled priority areas for mitigation to be identified. This approach is consistent with the principles set out in BS EN 15804 (British Standards Institution, 2012), PAS 2080 (Carbon Trust, 2016) and IEMA guidance (IEMA, 2017).

21.3.12 This lifecycle approach considers emissions from different lifecycle stages of the Proposed Development as a whole: production stage, construction stage operation stage and eventual decommissioning.

21.3.13 Where activity data have allowed, expected GHG emissions arising from the construction and operational activities, and embodied carbon in materials of the Proposed Development, have been quantified using a calculation-based methodology as per the following equation as stated in the Defra emissions factors guidance (Defra, 2019):

Activity data x GHG emissions factor = GHG emissions value

21.3.14 In line with 'The GHG Protocol' (WRI & WBCSD, 2004), when defining potential impacts (or 'hot spots'), 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).

21.3.15 These GHGs are broadly referred to in this PEI Report under an encompassing definition of 'GHG emissions,' with the unit of tCO_2e (tonnes CO_2 equivalent) or $MtCO_2e$ (megatonnes of CO_2 equivalent).

21.3.16 Where data are not available, a qualitative approach to addressing GHG impacts has been followed, in line with the IEMA Guidance (2017).

21.3.17 Table 21-2 summarises the key anticipated GHG emissions sources associated with the Proposed Development and whether they have been scoped into the final assessment.

Table 21-2: Scope of Potential GHG Emission Sources from the Construction Stage

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
Production stage	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
Construction process stage	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

Determining Operational Effects

21.3.18 The methodology for determining operational GHG emissions is the same as for pre-construction and construction emissions. Table 21-3 summarises the key anticipated emissions sources and whether they have been scoped in or out of the final assessment.

Table 21-3: Scope of Potential GHG Emissions Sources from the Operational Stage

Lifecycle stage	Activity	Primary emissions sources	Scoped In/Out
Operation stage	Operation of the Proposed Development	GHG emissions from electricity generation when not captured by the carbon capture plant and energy use in buildings. GHG emissions from operation of the Compressor Station.	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
	Building/infrastructure maintenance	GHG emissions from maintenance of buildings and infrastructure/assets in the operational stage	In

Determining Decommissioning Effects

21.3.19 The methodology for determining decommissioning GHG emissions is the same as for pre-construction and construction, and operational emissions. Table 21-4 summarises the key anticipated emissions sources and whether they have been scoped in or out of the final assessment.

Table 21-4: Scope of Potential GHG Emissions Sources from the Decommissioning Stage

Lifecycle stage	Activity	Primary emissions sources	Scoped In/Out
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

Classification and Significance of Effects

21.3.20 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.

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

21.3.22 When considering the scope and boundary for inclusion of GHG emissions is standard accounting practice to exclude minor sources as not material. Both the Department of Energy and Climate Change (2013) and the PAS 2050 Specification (British Standards Institution, 2011) for example allow emissions sources of <1% contribution to be excluded from emission inventories, and these inventories to still be considered complete for verification purposes.

21.3.23 On this basis where GHG emissions from the Proposed Development are equal to or more than, 1% of the relevant annual UK Carbon Budgets the impact of the Proposed Development on the climate is considered of high significance. This is summarised in Table 21-5.

21.3.24 IEMA guidance (2017) states that the application of the standard EIA significance criteria is not considered to be appropriate for climate change mitigation assessments. The magnitude of the impact is therefore either low or high. It is therefore considered that any emissions arising from the Proposed Development have the potential to be considered significant using this methodology.

Table 21-5: Magnitude Criteria for GHG Impact Assessment

Magnitude	Magnitude criteria
High	Estimated GHG emissions equate to equal to or more than 1% of total emissions across the relevant five-year National Carbon Budget period in which they arise
Low	Estimated GHG emissions equate to less than 1% of total emissions across the relevant five-year National Carbon Budget period in which they arise

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

- any additional GHG impacts could compromise the UK's ability to reduce its GHG emissions and therefore the ability to meet its future carbon budgets; and

- the importance of meeting the Paris Agreement goal of limiting global average temperature increase to well below 2°C above pre-industrial levels (Paragraph 21.2.6).

21.3.26 This method to determine the significance of GHG emissions are summarised in

21.3.27 Table 21-6.

Table 21-6: Significance of Effects Matrix for GHG Emissions Impact Assessment

		Sensitivity of Receptor
		High
Magnitude of GHG emissions (Table 21-5)	**High**	Major adverse significance
	Low	Minor adverse significance

UK Carbon Budgets

21.3.28 The UK carbon budgets are in place to restrict the amount of greenhouse emissions the UK can legally emit in a five-year period (Committee on Climate Change, 2017).The UK is currently in the 3rd carbon budget period, which runs from 2018 to 2022, as detailed in Table 21-7. The current Carbon Budgets reflect the previous 80% reduction target by 2050, rather than the current target of net zero emissions by 2050. As the Proposed Development will be operating past 2050, we have therefore also compared the emissions against net zero in 2050.

21.3.29 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 2050 net zero commitment. 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. The 6th UK carbon budget will also be used if available during the ES assessment.

21.3.30 The appropriate UK national carbon budgets that span the construction programme of the Proposed Development, taking account of the ongoing construction works (2022-2026) are the 3rd and 4th carbon budgets (2018-2022 and 2023-2027, respectively).

21.3.31 The operational phase of the Proposed Development (fully operational by 2026) has been compared to all the appropriate and available carbon budgets within the design life of the Proposed Development: the 4th and 5th carbon budgets (2023-2027 and 2028-2032, respectively). Although the Proposed Development will be operational beyond this time, the budgets have only been set to 2032, so this budget is used for the remaining lifetime. However, future budgets will be lower. As noted above (Paragraph 21.3.29), future carbon budgets have not yet been published however it is understood that these will reflect the new net zero by 2050 carbon reduction target.

Table 21-7: Current UK Carbon Budgets

UK Carbon Budget	Total Budget ($MtCO_2e$)
3rd (2018-2022)	2,544
4th (2023-2027)	1,950
5th (2028-2032)	1,725

International Finance Corporation

21.3.32 In the context of impact assessment, the UK carbon budgets are used as a measure of GHG emissions significance for UK projects, however, as the published budgets do not cover the life span of the Proposed Development or show the Budget limits towards net zero, a secondary measure of magnitude, based on IFC International Finance Corporation (IFC) reporting standards is used.

21.3.33 Under IFC lending criteria, where a project funded by the IFC exceeds annual GHG emissions of 25,000 tCO2e, the emissions impact is deemed sufficiently substantial as to require the project operator to report annual emissions performance. Therefore, a secondary measure of 25,000 tCO2e per year will also be used to determine if the Proposed Development is deemed as a large project.

Development Design and Impact Avoidance

Construction

21.3.34 Aspects of GHG emissions will be managed through the Construction Environmental Management Plan (CEMP) that controls construction activities to minimise any impact on the environment 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;
- 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.

21.3.35 Other measures to mitigate GHG emissions during construction include:

- specification of construction materials to lower embodied carbon emissions i.e. higher recycled content.

21.3.36 All measures will be finalised and presented in the final ES assessment.

Operation

21.3.37 The purpose of this Proposed Development is to provide low carbon electricity through the use of a high efficiency gas-fired power station with carbon capture and off-shore carbon storage. By overall design, the Proposed Development also offers the opportunity to reduce the carbon emissions emitted from other industrial operators in the area and aid decarbonisation of the grid electricity supplied to the national grid. Captured carbon emissions will be compressed and pumped into an offshore geological store and not released to the atmosphere.

21.3.38 Embedded measures incorporated in the operational design are described in other chapters of this PEIR, in particular Chapter 8: Air Quality (PEI Report, Volume I). They are based upon regulations, industry best practice such Best Available Techniques and their Associated Emission Levels.

21.3.39 All measures will be finalised and presented in the final ES assessment.

Decommissioning

21.3.40 At the stage of this PEI Report, no specific additional mitigation has been identified as necessary for the decommissioning phase of the Proposed Development. All measures will be finalised and presented in the final ES assessment.

Likely Impacts and Effects

Rochdale Envelope

21.3.41 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: Proposed Development of this PEI Report. The Rochdale Envelope approach has specifically been used to estimate likely material quantities for the construction of the Proposed Development.

Description of Potential Effects

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

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 rather than in the PEI Report due to the early stage of design. Construction emissions will be calculated using the activity types detailed in
21.3.43 Table 21-8.

Table 21-8: Construction GHG Emissions

Lifecycle stage	Project activity/Emission source
Product	Embodied carbon of material and products
	Materials and product transport
Pre-Construction Demolition and Site Remediation	Electricity usage (including the Compressor Station)
	Fuel usage onsite
	Waste transport
	Waste disposal
	Worker commute
Construction and Commissioning	Electricity usage
	Fuel usage onsite
	Waste transport
	Waste disposal
	Worker commute

Operations

21.3.44 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 the project activities 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. On closure of the CCGT, the CO Gathering Network and Compressor Station would remain active for any other future users;
- treated water will be required for plant cooling and makeup. The annual volumes needed are not available at this stage of the design process. Provision of water will result in GHG emissions. If available, emissions associated with treated water usage 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;
- it is assumed that suitable licensed waste facilities for municipal wastes are within 30 km of the Site. Other wastes are likely to need to be transported further to specialist facilities and that these are available within 180 km of the Site;
- 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 offline 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 80 km of the Site;
- fuels and oils required onsite, other than natural gas, include 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 sources of GHG emissions;
- CO_2 will be used to purge hydrogen from plant 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 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 would be a source of GHG emissions. If data is available, emissions associated with purging natural gas systems will 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 required operational staff, calculations of GHG emissions associated with the commute of workers has been undertaken. This is on the assumptions that 100% of workers will travel by car with an occupancy of 1 person per vehicle. Using current estimates of likely distribution of worker staff, it is assumed that 80% of workers will live within 12 km of the Site, and the remaining 20% will live within 35 km of the Site. All transits include a two-way journey;
- an additional 100 staff will be required onsite during the 14-day maintenance every year using the same car occupancy rates and location distribution;
- 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 capture carbon dioxide. The final technology selection for the capture plant has not yet been made but worst-case emission parameters have been developed based on different equipment and these have been used in the assessment of GHG emissions. It is assumed that the carbon capture storage system and sequestration technology is operational and functioning as expected;
- the continuous use (bar maintenance time) of an 80 MW HP Compressor Station that will be operational for up to 40 years and is assumed to be

using grid electricity. No other uses of electricity have been calculated at this stage, but will be re-assessed at the ES stage;

- each of the up to three abated CCGT units will produce an average of 700 MW electrical output with a worst-case carbon footprint of 339.7 kg CO_2 per MWh;
- the carbon capture abatement technology is capturing 95% of the carbon dioxide produced by the CCGT plant; and
- cooling and process water is all assumed to be sourced either from existing surface water abstraction sources, or through treating effluent from the adjacent Northumbrian Water wastewater treatment works.

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

21.3.46 At this stage in the design, there are three possible plant operating scenarios that differ with how they operate after the first 5 years of operation. The scenarios assume the following:

- In all scenarios, Year 1 of operation assumes the three abated units are working at an 80% capacity;
- In all scenarios, years 2 to 4 assume that the three abated units are working at baseload;
- From years 5 to 25 it is assumed that the plant will continue under baseload (Scenario 1,Table 21-9); or a 40 start-up/shut downs per year option (Scenario 2, Table 21-10); or a 80 start-up/shutdowns per year (Scenario 3,Table 21-11).

21.3.47 In summary, Scenario 1 assumes that the plant will be working continuously under a baseload, with the exception of downtime through maintenance. Scenarios 2 and 3 assume that after the fifth year of operation, the plant will be operating on demand when the grid requires a dispatchable generator and the plant is shut down and restarted either 40 times (Scenario 2) or 80 times in a year (Scenario 3).

Table 21-9: Operational GHG Emissions from Turbine Operations, Scenario 1 Assuming Baseload Operations with No Dispatch Modes

Years of Operation	Year 1	Years 2-4	Years 5-25	Operational Life Total
Annual Operating Hours	8,424	8,424	8,424	210,600
Annual generation Capacity (MW)	1,680	2,100	2,100	52,080
Total MWh per annum	14,152,320	17,690,400	17,690,400	438,721,920
Total CO_2 Produced (tonnes ‘000)	4,808	6,009	6,009	149,034
Total CO_2 Uncaptured (tonnes ‘000)	240	300	300	7,452

Table 21-10: Operational GHG Emissions from Turbine Operations, Scenario 2 Assuming 40 Start-Up/Shut Down Dispatch Mode from Years 5 To 25

Years of Operation	Year 1	Years 2-4	Years 5-25	Operational Life Total
Annual Operating Hours	8,424	8,424	5,688	153,144
Annual generation Capacity (MW)	1,680	2,100	2,100	52,080
Total MWh per annum	14,152,320	17,690,400	11,944,800	318,064,320
Total CO_2 Produced (tonnes '000)	4,808	6,009	4,058	108,046
Total CO_2 Uncaptured (tonnes '000)	240	300	203	5,402

Table 21-11: Operational GHG Emissions from Turbine Operations, Scenario 3 Assuming 80 Start-Up/Shut Down Dispatch Mode from Years 5 To 25

Years of Operation	Year 1	Years 2-4	Years 5-25	Operational Life Total
Annual Operating Hours	8,424	8,424	5,112	141,048
Annual generation Capacity (MW)	1,680	2,100	2,100	52,080
Total MWh per annum	14,152,320	17,690,400	10,735,200	292,662,720
Total CO_2 Produced (tonnes, 000)	4,808	6,009	3,647	99,418
Total CO_2 Captured (tonnes, 000)	4,568	5,709	3,465	94,447
Total CO_2 Uncaptured (tonnes, 000)	240	300	182	4,971

21.3.48 The worst-case uncaptured CO_2 emissions from these scenarios has been used to inform the total GHG calculations (Scenario 1: 7,451,692 tonnes of CO_2 to the atmosphere over a 25-year operational life). These emissions are detailed in Table 21-9.

21.3.49 As detailed in Table 21-12, using the listed inclusions and exclusions, the total GHG emissions from the Proposed Development are calculated to be 12M tCO_2e with the majority (63%) of emissions associated with fuel usage onsite. Assuming that emission-related activities are similar during the 25-year Development, annual emissions are expected to be approximately 500k tCO_2e.

21.3.50 The design life of the Compressor Station is expected to be operating for 40 years, 15 years beyond the design life of the plant. During this time, the emissions associated with electricity usage for this equipment is calculated to be a total of 2.5M tCO_2e over the 15 years, or an average of 170k tCO_2e per year.

Table 21-12: Operational GHG emissions (using Scenario 1 plant emissions)

Lifecycle stage	Project activity/Emission source	Emissions (tCO2e) over 25-year design life
Operations	Electricity usage	4,306,349
	Fuel usage onsite (Paragraph 21.3.48)	7,451,692
	Waste transport	31
	Waste disposal	155,045
	Worker commute	6,641
	Materials	23
TOTAL		14,503,589
Annual estimation		**476,791**

GHG Avoidance

21.3.51 The GHG avoidance of this Proposed Development is centred on the carbon capture, carbon export pipeline and offshore sequestration technology being operational. Assuming the system is operating and is functioning as expected, using the worst-case emissions scenario (Scenario 1), unabated CO_2 emissions amount to an average of 6M tCO_2 per year, or 150M tCO_2 over the 25-year design life (Table 21-9). With carbon capture technology, up to 95% of these emissions will be captured, geo-sequestered and not released into the atmosphere.

21.3.52 Further, the Proposed Development facilitates the potential capture and store CO_2 currently emitted from nearby operational industrial and energy facilities, significantly reducing the GHG emissions from the region. Currently, industries in Teesside account to over 5% of the UK's total industrial emissions. The Proposed Development will therefore be a vital positive contributor to the UK achieving net zero carbon emissions by 2050. However, as a worst-case scenario, the significant emission avoidance from neighbouring facilities are not included in this assessment.

21.3.53 The carbon capture infrastructure can manage up to 10 million tonnes of CO_2 per year. The worst-case scenario (Scenario 1,Table 21-9) captures 5.7 million tonnes of CO_2 from the plant, leaving 4.3 million tonnes of CO_2 of spare volume capacity per year available for neighbouring industrial facilities. Scenarios 2 and 3 produced less CO_2 from the plant and could therefore provide more capacity for neighbouring nearby existing emitters industrial facilities.

21.3.54 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). Table 21-13 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.

21.3.55 Table 21-13 compares the carbon intensity of the Proposed Development (both with and without the carbon capture technology). Unabated, the carbon intensity of the Proposed Development is slightly lower than the average gas-powered power plant (349 tCO_2 per GWh). Using the carbon capture technology, the abated plant will result in a carbon intensity of 18.9 tCO_2 per GWh, which is significantly less than the grid average emissions in 2018 of 208 tCO_2 per GWh.

Table 21-13: Carbon Intensities of UK Electricity Grid Generation Sources in 2018

Generation source by fuel type	Emissions (tonnes of CO_2 per GWh of Electricity supplied)
Gas (BEIS, 2019a)	349
All fossil fuels (BEIS, 2019a)	450
All fuels, grid average (including nuclear and renewables) (BEIS, 2019b)	173
Proposed Development (unabated- without carbon capture technology)	339.7
Proposed Development (abated- with carbon capture technology)	18.9

21.3.56 The UK electricity grid is in the process of being decarbonised as the UK transitions toward net zero by 2050. BEIS (2019b) provides grid intensity projections to 2035 at which point the UK grid average is expected to emit 41 tCO_2 for every GWh generated. The National Grid (2018) has also produced GHG grid intensity forecasts for two Future Energy Scenarios (FES) beyond 2030 to 2050. The first scenario 'Community Renewables' is based on the large-scale uptake of small, community led renewable energy while the second scenario 'Two degrees' focusses on large centralised initiatives. This second scenario forecasts as grid intensity of 20 tCO_2 per GWh by 2050.

21.3.57 Diagram 21-2 presents the GHG intensity of energy generation from the Proposed Development (18.9 tCO_2 per GWh) alongside forecast average grid intensity. Forecast average grid intensity is based on an anticipated mix of electricity generation sources including fossil fuel, nuclear and renewable energy. Average GHG intensity presented in this figure is based on a combination of forecast data from BEIS (2019b) and National Grid (2018).

21.3.58 Due to no other available interim data a flat rate of reduction in intensity has been estimated from 2035 to 2050. This forecast decrease is predominantly due to an increased uptake of renewable energy and nuclear generation while the use of fossil fuels to generate energy declines. Diagram 21-2 shows that electricity generation from the Proposed Development sits below the grid average through to 2050 even without allowing for carbon capture from off-site industrial emitters.

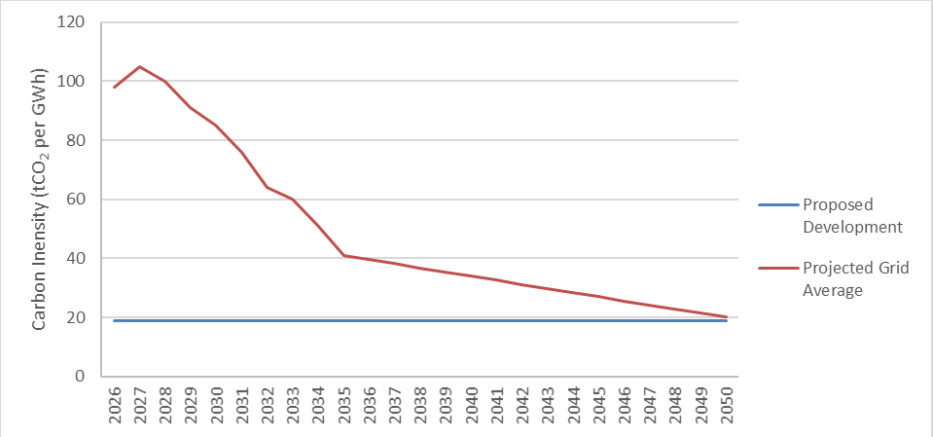

Diagram 21-2: Forecast UK Grid Intensity vs Proposed Development

Decommissioning

21.3.59 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.

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

21.3.61 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 Greenhouse Gas Impacts

21.3.62 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.

21.3.63 Emissions associated with the Proposed Development have been examined for their significance against the UK Carbon Budgets. These emissions are detailed in Table 21-14.

21.3.64 This assumes two years 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 0.05%, and 0.14%, respectively. This assessment will be refined and updated to include construction data and further operational data during the ES.

21.3.65 The magnitude of impact of the Proposed Development is therefore considered ‘low’ against the current UK carbon budgets. As per

21.3.66 Table 21-6, 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.

21.3.67 Once neighbouring industries are able to connect to the CO_2 gathering network and carbon can be captured from existing sources, it is envisaged that the project as a whole could result in a net reduction in carbon emissions from current levels with the objective of achieving net zero status for the NZT plant and connected industrial users with a beneficial effect on annual UK carbon emissions.

Table 21-14: 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	1.0 (two years of operations)	0.05%
5th (2028-2032)	1,725	2.4 (five years operations)	0.14%

21.3.68 The significance of GHG impacts as a result of the Proposed Development will be updated and presented in the ES.

Mitigation and Enhancement Measures

21.3.69 The management of GHG emissions and the application of mitigation measures during construction will be secured through the CEMP. The management of GHG emissions and the application of mitigation measures during operation will be secured through the DCO and the Environmental Permit.

Limitations or Difficulties

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

21.3.71 The current GHG assessment is limited to the availability of data and information. The inclusions and exclusions of data have been detailed in Section 0 and will be updated and refined in the ES.

21.4 In-Combination Climate Change Assessment

Assessment Methodology

Baseline Environment

21.4.1 The current baseline for the In-Combination Climate Change Assessment (ICCI) and Climate Change Resilience (CCR) assessments is based on historic climate data obtained from the Met Office (2020) recorded by the closest meteorological station to the Proposed Development (Stockton-on-Tees, approximately 11 km from Site) for the period 1981-2010. These data are listed in Table 21-15.

Table 21-15: Historic Climate Data

Climatic Variable	Month	Value
Average annual maximum daily temperature (°C)	-	13.1
Warmest month on average (°C)	July	20.4
Coldest month on average (°C)	December and January	0.7
Mean annual rainfall levels (mm)	-	574.2
Wettest month on average (mm)	August	60.6
Driest month on average (mm)	February	32.9

21.4.2 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 21-16.

Table 21-16: Historic 10-year Averages for Temperature and Rainfall for the East and North East England

Climate Period	Climate Variable	
	Mean maximum annual temperatures (°C)	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

21.4.3 The future baseline for the ICCI and CCR assessments is based on future UK Climate Projections 2018 (UKCP18) from the Met Office for the Stockton-on-Tees area (The Met Office, 2019a). 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.

21.4.4 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.

21.4.5 Projected variables are presented in Table 21-17 to Table 21-19. UKCP18 probabilistic projections have been analysed for the 25 km grid square in which the Site 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.

21.4.6 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.

21.4.7 Depending on project economics and phasing, construction of the Proposed Development is expected to take around four years starting in 2022 for three trains. Power generation and carbon capture are then expected from 2026 for up to 25 years. Therefore, the CCR review has considered a scenario that reflects a high level of greenhouse gas emissions at the 10%, 50% and 90% probability levels up to the 2059 projection to assess the impact of climate change over as much of the lifetime of the Proposed Development as possible.

Table 21-17: Projected Changes in Temperature Variables (°C), 50% Probability (10% and 90% Probability in Parenthesis)

Climate Variable	Time Period		
	2020-2039	2030-2049	2040-2059
Mean annual air temperature anomaly at 1.5 m (°C)	+1.0 (+0.4 to +1.6)	+1.3 (+0.6 to +2.1	+1.7 (+0.8 to +2.6)
Mean summer air temperature anomaly at 1.5 m (°C)	+1.0 (+0.2 to +1.8)	+1.3 (+0.3 to +2.3)	+1.9 (+0.6 to +3.2)
Mean winter air temperature anomaly at 1.5 m (°C)	+1.0 (0.0 to +1.9)	+1.3 (+0.1 to +2.5)	+1.6 (+0.4 to +2.9)
Maximum summer air temperature anomaly at 1.5 m (°C)	+1.1 (+0.2 to +2.1)	+1.5 (+0.3 to +2.7)	+2.2 (+0.7 to +3.7)
Minimum winter air temperature anomaly at 1.5 m (°C)	+1.0 (+0.0 to +2.0)	+1.3 (+0.2 to +2.4)	+1.6 (+0.4 to +2.7)

Table 21-18: Projected Changes in Precipitation Variables (%), 50% Probability (10% and 90% Probability in Parenthesis)

Climate Variable	Time Period		
	2020-2039	2030-2049	2040-2059
Annual precipitation rate anomaly (%)	+4.5 (-1.5 to +11.2)	+1.5 (-3.5 to +6.9)	+1.2 (-4.3 to +6.4)
Summer precipitation rate anomaly (%)	-2.0 (-16.8 to +14.7)	-5.1 (-19.9 to +11.3)	-12.1 (-27.8 to +3.9)
Winter precipitation rate anomaly (%)	+9.5 (-3.0 to +22.8)	+12.0 (-1.2 to +26.3)	+15.9 (+1 to +32.4)

21.4.8 Sea level rise may increase up to 14 cm when operations start (approximately 2026) and up to 33 cm when operations are completed and decommissioning initiates (from 2051). The ranges of projected sea level rise from the 1981-2000 baseline are detailed in Table 21-19.

Table 21-19: Projected 50% Probability of Sea Level Rise Under RCP 8.5 Relative to the 1981-2000 Baseline Period (10% And 90% Probability In Parenthesis)

	2022	2026	2051
Sea level anomaly (m)	+0.08 (+0.06 to +0.11)	+0.11 (+0.08 to +0.14)	+0.26 (+0.19 to +0.33)

21.4.9 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.

21.4.10 Using the climate variable likelihood data for future baselines (Table 21-17 Table 21-19) and the definitions for likelihood (Table 21-22 and Table 21-23), the likelihood of occurrence of potential climate hazards are detailed in Table 21-20.

Table 21-20: Potential Climate Hazards and Likelihood of Occurrence (from UKCP18 Projections)

Climate Variable	Potential Hazard	2020- 2039 Likelihood	2030- 2049 Likelihood	2040- 2059 Likelihood
Mean annual air temperature anomaly at 1.5 m (°C)	Increase in mean annual air temperature	Very likely	Very likely	Very likely
Mean summer air temperature anomaly at 1.5 m (°C)	Increase in mean summer air temperature	Very likely	Very likely	Very likely
Mean winter air temperature anomaly at 1.5 m (°C)	Increase in mean winter air temperature	Very likely	Very likely	Very likely
Maximum summer air temperature anomaly at 1.5 m (°C)	Increase in maximum summer air temperature	Very likely	Very likely	Very likely
Minimum winter air temperature anomaly at 1.5 m (°C)	Increase in minimum winter air temperatures	Very likely	Very likely	Very likely
Annual precipitation rate anomaly (%)	Decrease in annual precipitation rate	Unlikely	Unlikely	Possible
Summer precipitation rate anomaly (%)	Decrease in summer precipitation rate	Possible	Likely	Likely
Winter precipitation rate anomaly (%)	Increase in winter precipitation rate	Very likely	Very likely	Very likely
Sea level rise (m)	Increase in sea level	Very likely	Very likely	Very likely
Sea temperature rise (°C)	Increase in sea surface temperature	Very likely	Very likely	Very likely

Project Environment

21.4.11 The project environment is a ‘do something’ scenario with the delivery of the Proposed Development, which includes the construction and operations of the plant.

Study Area

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

Sensitive Receptors

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

Determining Construction Effects

21.4.14 Construction and operation of the Proposed Development has been assessed on the basis of a 29-year period (4 year construction, 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.

Determining Operational Effects

21.4.15 The ICCI assessment considers the ways in which projected climate change will influence the significance of the impact of the Proposed Development on receptors in the surrounding environment. The scope of the final ICCI assessment is detailed in Table 21-21.

21.4.16 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 following consultation in the ES

Table 21-21: Scope of the ICCI Assessment

Climate Parameter	Considered in ICCI Assessment	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.
Precipitation change (flooding and droughts)	In	Climate change may lead to both an increase in substantial precipitation and drought events. The combination of the Proposed Development and 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.

Climate Parameter	Considered in ICCI Assessment	Rationale
Sea level rise	In	The 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.
Sea temperature	In	The Proposed Development will produce thermal discharges which may be directed to sea via the outfall. The combination of this with increasing sea temperatures may cause increased risks to marine ecology and the physico-chemical environment.
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.

Determining Decommissioning Effects

21.4.17 As the decommissioning phase is likely to be shorter than the construction period and therefore less likely to be impacted by changes in climate, the ICCI assessment during the decommissioning assessment will follow a descriptive based approach only.

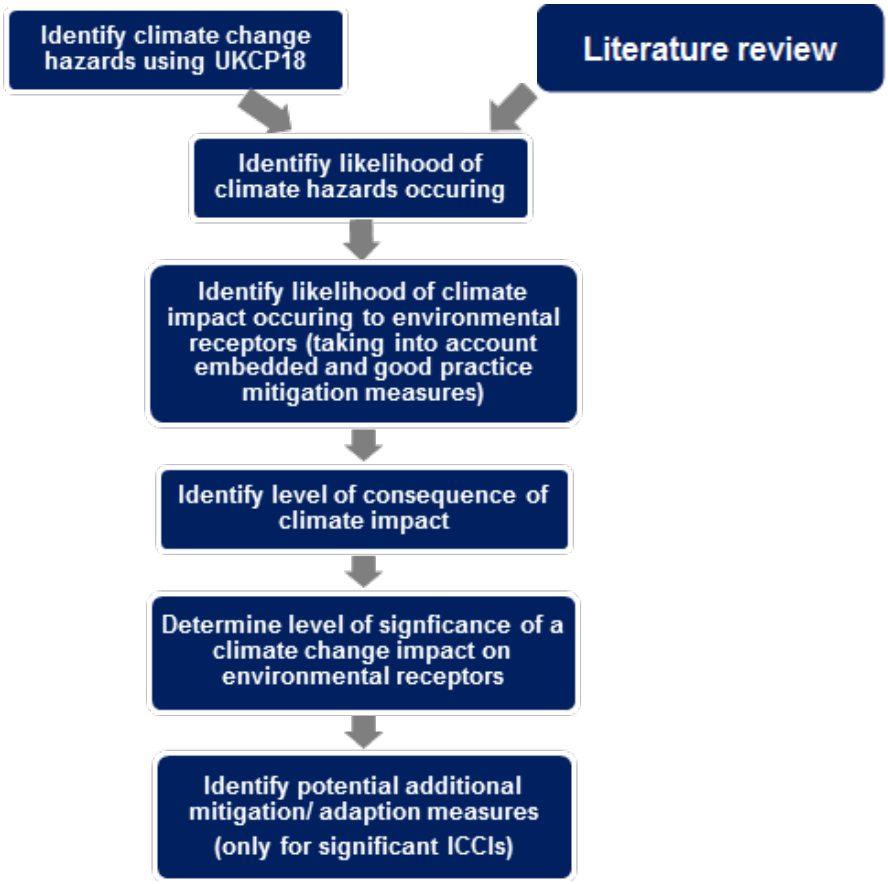

Diagram 21-3: ICCI Assessment Methodology

Classification and Significance of Effects

An assessment of ICCI following the steps shown in Diagram 21-2 will be conducted for the proposed development that identifies potential climate change impacts and considers their potential consequence and likelihood of occurrence.

21.4.18 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.

21.4.19 Information on historic observations on climate change such as the UK Climate Change Risk Assessment (HM 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.

21.4.20 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 21-22 presents the likelihood levels and definitions used. This is in line with the definitions presented in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC, 2014).

Table 21-22: 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

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

21.4.22 Identified climate hazards and the level of likelihood that they will occur is presented in Section 0.

21.4.23 The likelihood of an in-combination climate impact occurring is determined based on the likelihood of a climate hazard occurring (Section 0) 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.

21.4.24 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 21-

23. Table 21-23 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 21-23: 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

21.4.25 Table 21-24 is then used to determine the overall likelihood of the ICCI.

Table 21-24: Level of Likelihood of the ICCI

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

21.4.26 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.

21.4.27 The ICCI consequence criteria are defined in Table 21-25 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 21-25 and their discipline assessment methodology.

Table 21-25: ICCI assessment – Level of Likelihood 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.

Classification and Significance of ICCI Effects

21.4.28 The significance of potential effects is determined by the environmental disciplines using the matrix in Table 21-26. 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 21-26: ICCI Assessment – Significance Criteria

		Likelihood		
		Low	Medium	High
Consequence	Very low	Negligible	Negligible	Minor
	Low	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Major

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

21.4.30 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.

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

Development Design and Impact Avoidance

Construction

21.4.32 Technical analysis, including discussions with the design and technical assessment teams have not identified any receptors that may be impacted

by the combined impact of future climate change and the construction of Proposed Development.

21.4.33 This assessment will be finalised with any updates during the ES.

Operation

21.4.34 Discussions with the design and technical assessment teams have not identified any receptors that may be impacted by the combined impact of future climate change and the construction of Proposed Development.

21.4.35 This assessment will be finalised with any updates during the ES.

Decommissioning

21.4.36 Discussions with the design and technical assessment teams have not identified any receptors that may be impacted by the combined impact of future climate change and the decommissioning of Proposed Development.

21.4.37 This assessment will be finalised with any updates during the ES.

Likely Impacts and Effects

Description of Potential Effects

21.4.38 No potential impacts or effects have been identified. This will be finalised with any updates during the ES.

Construction

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

Operations

21.4.40 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

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

Summary of ICCI Impacts

21.4.42 No ICCI impacts have been identified by the design team and technical assessment teams. This assessment will be finalised with any updates during the ES.

Mitigation and Enhancement Measures

21.4.43 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.

Limitations or Difficulties

21.4.44 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 assessment is based upon UKCP18 predictions for general changes in climate conditions, and only a high-level assessment of acute events are included in this assessment.

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

21.5 Climate Change Resilience Review

Assessment Methodology

Baseline Line Environment

21.5.1 The baseline environment for the CCR review is the same as the ICCI assessment presented in Section 0 above.

Project Environment

21.5.2 The project environment is a ‘do something’ scenario with the delivery of the Proposed Development, which includes the construction and operations of the plant.

Study Area

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

Sensitive Receptors

21.5.4 Sensitive receptors include workers, occupiers, users and associated infrastructure, as outlined in more detail below.

Determining Construction Effects

21.5.5 As the construction phase (circa 4 years) would be much shorter in duration than the operational phase (25 years), and would be undertaken within the next ten years, future climate change is less relevant to the assessment of construction impacts and effects.

21.5.6 Accordingly, the CCR review for the construction phases will follow a descriptive based approach only.

Determining Operational Effects

21.5.7 The CCR assessment has considered the strategic aims and objectives encompassed within national and local planning policy (21.2), such as the Overarching National Policy Statement for Energy (EN-1), The National Planning Policy Framework, the National Planning Policy Guidance on Climate Change, the Tees Valley Climate Change Strategy, and the Redcar and Cleveland Borough Council Local Plan. These documents details the broader aims of minimising the adverse impacts of climate change, whilst requiring new development to take climate change considerations into account within design. Ways in which resilience of the Proposed

Development to climate change can be enhanced have been assessed and mitigation measures have been identified.

21.5.8 The final review ES will provide an updated review of all infrastructure and assets included as part of the Proposed Development. The CCR review considers resilience against both gradual climate change, and the risks associated with an increased frequency of extreme weather events as per the UK Climate Projections 2018 (UKCP18) (The Met Office, 2018a).

21.5.9 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, 2017).

21.5.10 This assessment of climate change resilience is undertaken for the Proposed Development to identify potential climate change impacts, and to consider their potential consequence and likelihood of occurrence, taking account of the measures incorporated into the design of the Proposed Development.

21.5.11 The types of receptors considered vulnerable to climate change, are:

- 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).

21.5.12 The potential climate change impacts identified in the CCR review are determined based on the UKCP18 projections. Climatic parameters that will be included in the CCR review are detailed in Section 0.

21.5.13 Further data will be obtained, where available, for other climate variables and types of extreme acute weather events, namely:

- heavy rainfall events;
- droughts (extended periods of low precipitation);
- heat waves (high temperatures);
- frosts/freezes (low temperatures);
- humidity;
- wind speed;
- storm surges;
- lightning; and
- fog.

21.5.14 The scope of the CCR assessment is set out in

21.5.15 Table 21-27. Consideration of climate change impacts within EIAs is an area of emerging practice. The approach outlined below is aligned with existing guidance such as that of IEMA (IEMA, 2017). The CCR assessment identifies potential climate change impacts and considers their potential consequence and likelihood of occurrence.

Table 21-27: Scope of the CCR Review

Climate Parameter	Considered in CCR Review	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.

21.5.16 The following key terms and definitions relating to the CCR assessment are used:

- Climate hazard – an acute weather or chronic climate related event, which has potential to do harm to environmental or community receptors or assets, for example, increased winter precipitation;
- Climate change impact – an impact from a climate hazard which affects the ability of the receptor or asset to maintain its function or purpose; and
- Consequence – any effect on the receptor or asset resulting from the climate hazard having an impact.

21.5.17 The assessment includes all infrastructure and assets associated with the Proposed Development. It assesses the resilience against both gradual climate change and the risks associated with an increased frequency of severe weather events as per the UKCP18 climate change projections.

21.5.18 The methodology for the CCR assessment is summarised in Diagram 21-4.

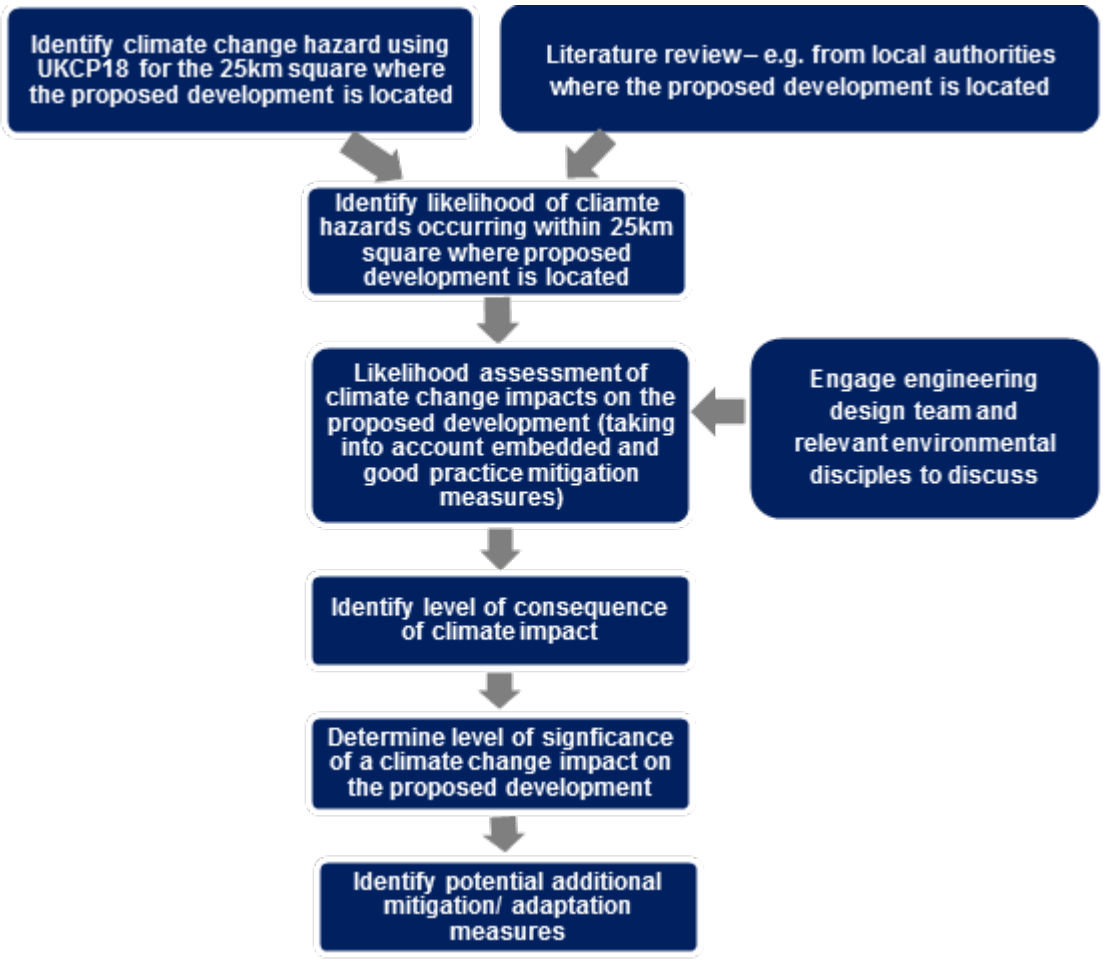

Diagram 21-4: CCR Assessment Methodology

21.5.19 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.

21.5.20 Criteria used to determine the likelihood of an event occurring, based on its probability and frequency of occurrence, are detailed in Table 21-28. The consequence of an impact has been measured using the criteria detailed in Table 21-29.

Table 21-28: Description of Likelihood for Climate Change Hazard

Likelihood Category	Description (probability and frequency of occurrence)
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_

Table 21-29: Measure of Consequence for Climate Change Resilience

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.

21.5.21 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.

21.5.22 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.

21.5.23 The significance is determined by:

Likelihood of climate hazard occurring × consequence to receptor if climate hazard occurs

Determining Decommissioning Effects

21.5.24 Although future climate change is likely to be more relevant during decommissioning phase, this phase is expected to be shorter in duration than construction.

21.5.25 Accordingly, the CCR review for the decommissioning phases will follow a descriptive based approach only.

Classification and Significance of Effects

21.5.26 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 21-30.

Table 21-30: Significance Criteria for Climate Change Resilience Assessment

		Likelihood of climate change hazard occurring				
		Very unlikely	Unlikely	Possible	Likely	Very likely
Consequence	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

21.5.27 The assessment of potential impacts and the Proposed Development's vulnerability takes into account the mitigation measures that have been designed into the Proposed Development, as discussed in Section 0.

21.5.28 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

Development Design and Impact Avoidance

21.5.29 This section presents the findings of the CCR review for the construction and operation of the Proposed Development.

21.5.30 Components of the Proposed Development that have been considered in this assessment include:

- PCC containing up to three CCGT units with associated stacks and CO_2 capture plants;
- CO_2 Gathering Network from neighbouring industries;
- High Pressure CO_2 Compressor Station;
- CO_2 Export Pipeline to offshore;
- Natural Gas Connection;
- Electrical Connection to the national electricity grid;
- Water Connections;
- other associated buildings; and

- bulk chemical storage.

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

Construction and Operation

21.5.32 As the design of the Proposed Development has not been finalised for the PEI Report, the CCR Review will be updated for the ES.

Likely Impacts and Effects

Description of Potential Effects

21.5.33 The potential impacts and effects of projections for climate change to the Proposed Development will be finalised by design team and environmental disciplines during the ES.

21.5.34 The types of impacts and effects that may occur are described in Section 21.5.

Construction

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

21.5.36 Potential climate change impacts on the Proposed Development and the adaptation methods to increase the resilience of the Proposed Development are detailed Table 21-31.

Operations

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

21.5.38 Potential climate change impacts on the Proposed Development and the adaptation methods to increase the resilience of the Proposed Development are detailed Table 21-31.

Decommissioning

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

21.5.40 Potential climate change impacts on the Proposed Development and the relevant adaptation methods to help increase the resilience of the Proposed Development are detailed Table 21-31.

Table 21-31: 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 21-28)	Consequence and significance of inherent risk (Table 21-29Table 21-30 and Table 21-30)	Embedded Adaptation / Resilience measures	Consequence and significance of residual risk
CONSTRUCTION and DECOMMISSIONING							
Built assets, 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/ 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 the any adaptation measures that need to be incorporated into the final design.	Low Minor- not significant
	Increasing summer temperatures, increased humidity and increasing frequency of hot days and heatwaves	Very likely	Overheating of electrical equipment	Very unlikely	Very low Negligible- not significant		Very low Negligible- not significant
	Increased winter rainfall	Very 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	Medium Moderate- 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.	Low Minor- not significant
	Sea level rise	Very likely		Very unlikely	Medium Negligible- not significant		Medium 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 21-28)	Consequence and significance of inherent risk (Table 21-29Table 21-30 and Table 21-30)	Embedded Adaptation / Resilience measures	Consequence and significance of residual 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
OPERATIONS							
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, coastal destabilisation and coastal flooding from erosion and storm surge	Unlikely	Medium Minor- not significant	Initial capture of surface water run-off will be provided by appropriate sustainable drainage system (SuDS) methods. 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
	Increased winter rainfall	Very likely	Surface water flooding and standing waters	Possible	Medium		Medium

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 21-28)	Consequence and significance of inherent risk (Table 21-29Table 21-30 and Table 21-30)	Embedded Adaptation / Resilience measures	Consequence and significance of residual risk
			Deterioration of structures or foundations due to increase in soil moisture levels Damage to building surfaces/ exposed utilities from increased drying/wetting and increase frost penetration Damage to infrastructure through coastal erosion, storm surge and coastal destabilisation.		Moderate- not significant	Development of the Construction Environmental Management Plan (CEMP) and the Surface Water Maintenance and Management Plan that will detail measures to maintain Site drainage systems. All construction materials and temporary compounds associated with the construction of the Proposed Development will be located in Flood Zone 1 where possible. A site-specific FRA has been carried out which considers risks of flooding from all sources on Site and consideration of potential changes to flood risk due to projections for climate change. Initial capture of surface water run-off will be provided by appropriate sustainable drainage system (SuDS) methods where possible. Specific consideration of rainwater harvesting systems, green roofs, swales, filter drains, and underground storage tanks. An outfall retention pond to contain excess surface water run-off with a water storage capacity to accommodate 1% Annual Exceedance Probability (AEP) event with a 40% additional allowance for climate change.	Minor- not significant
	Sea level rise	Very likely		Unlikely	Medium Minor- not significant	Consideration of soft-landscaping. Additional measures to be considered include: - the development of a Flood Emergency Response Plan, which includes design of the buildings i.e. minimum floor heights) and design of the surface water drainage network - subscriptions to the EA's flood warning service, Floodline - pipelines and storage tanks designed to withstand the water pressures associated with high return period event flooding - tanks securely tethered in such a way to ensure the infrastructure remains secure should flooding occur - electrical supply entering the Proposed Development from height and down to required connections	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 21-28)	Consequence and significance of inherent risk (Table 21-29Table 21-30 and Table 21-30)	Embedded Adaptation / Resilience measures	Consequence and significance of residual risk
						- protecting wiring for operational control of the Proposed Development, telephone, internet and other services by suitable insulation in the distribution ducts to prevent damage - materials with low permeability up to 0.3 m and accept water passage through building at higher water depths - flood proofing including the use of flood resistant building materials, use of water-resistant coatings, use of galvanised and stainless-steel fixings and raising electrical sockets and switches - utilising floor materials that are able to withstand exposure to floodwater without significant deterioration and that can be easily cleaned, e.g. concrete-based or stone - incorporating water resistant services within the buildings, i.e. avoid services using ferrous materials - design development to drain water away after flooding - provide access to all spaces to permit drying and cleaning - carefully considering the type of usage and layout of ground floor areas to minimise the potential impact on business operations following a flood; and - suitable waterproofing measures to development located below ground i.e. tanking below ground storage areas etc. - tanks can be bunded to a level higher than the 0.5% AEP plus climate change flood level - site drainage and landscape design following such guidance as CIRIA C635 to minimise the risk from exceedance flows and any overland flow entering the Proposed Development buildings; - landscaping of the Site or building curtilage to direct or divert floodwater away from buildings; and - provision of dry emergency access and egress routes	

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 21-28)	Consequence and significance of inherent risk (Table 21-29Table 21-30 and Table 21-30)	Embedded Adaptation / Resilience measures	Consequence and significance of residual risk
						- the Flood Risk Assessment (FRA) will inform the any adaptation measures that need to be incorporated into the final design and operations management.	
	Decreased summer precipitation	Likely	Water shortages Drying out of pavement structures Deterioration of structures or foundations due to decrease in soil moisture levels	Possible	Medium Moderate- not significant	Consideration of abstraction of water from the Tees to reduce to abstraction of water from groundwater and mains water.	Low Minor- not significant
	Increased summer and winter temperatures	Very likely	Impacts on the thermal comfort of building users 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	Possible	Medium Moderate- 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.	

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 21-28)	Consequence and significance of inherent risk (Table 21-29Table 21-30 and Table 21-30)	Embedded Adaptation / Resilience measures	Consequence and significance of residual risk
Marine assets	Increased frequency and severity of extreme weather events	Likely	Physical damage to marine assets	Very unlikely	Very high Negligible- 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.	Very high Negligible- not significant
	Sea level rise	Very likely		Very unlikely	Very high Negligible- not significant		Very high Negligible- not significant

Summary of CCR Impacts

21.5.41 A range of climate change hazards and their potential impact upon the Proposed Development have been identified. These potential impacts and their assessment of significance will be determined by the environmental disciplines during the ES.

Mitigation and Enhancement Measures

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

21.5.43 The management of impacts and the application of mitigation/adaption measures during operation will be developed for inclusion in the ES.

Limitations or Difficulties

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

21.5.45 While modelled climate change projections represent anticipated average weather conditions, they do not capture the full range of possible future severe weather events (i.e. droughts, heatwaves and prolonged heavy rainfall).

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

21.6 Residual Effects

21.6.1 Without the off-setting of carbon emissions by capture of off-site industrial carbon emissions, this assessment there will be some residual GHG emissions from the Proposed Development, mostly associated with the electricity requirement for the Compressor Station. However, this will result in a minor effect and is **Not Significant.** As set out in the assessment of operations, with the inclusion of carbon capture technology the proposed development will provide a low carbon source of energy generation.

21.6.2 At this stage, there are no residual ICCI or CCR impacts identified. This will be updated during the ES assessment.

21.7 References

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