EAST YORKSHIRE SOLAR FARM

East Yorkshire Solar Farm

EN010143

Environmental Statement

Volume 1, Chapter 6: Climate Change
Document Reference: EN010143/APP/6.1

Regulation 5(2)(a)
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

November 2023
Revision Number: 00

2009

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6. Climate Change

6.1 Introduction

6.1.1 This chapter of the Environmental Statement (ES) presents the findings of an assessment of the likely significant effects on climate change as a result of the proposed East Yorkshire Solar Farm (hereafter referred to as the Scheme). It also considers the impact of climate change on the Scheme and on receptors in the surrounding environment as identified by the relevant technical disciplines (**Chapters 7 to 16, ES Volume 1 [EN010143/APP/6.1]**). For a description of the Scheme, refer to **Chapter 2: The Scheme, ES Volume 1 [EN010143/APP/6.1]**.

6.1.2 This chapter identifies and proposes measures to address the likely significant effects of the Scheme on climate change, during the construction, operation, and decommissioning phases. Additionally, climate change interfaces with many other topics and as such, should be considered alongside the other technical chapters **(Chapters 7 to 16, ES Volume 1)**.

6.1.3 This chapter is supported by the following appendices in **ES Volume 2 [EN010143/APP/6.2]**:

a. **Appendix 6-1: Legislation, Policy and Guidance (Climate Change)**;

b. **Appendix 6-2: Climate Change Risk Assessment**; and

c. **Appendix 6-3: In-combination Climate Change Impact (ICCI) Environmental Technical Disciplinary Risk Assessment**.

6.1.4 No figures or drawings have been produced in relation to this chapter.

6.1.5 A glossary and list of abbreviations are defined in **Chapter 0: Table of Contents, Glossary and Abbreviations, ES Volume 1 [EN010143/APP/6.1]**.

6.1.6 A Non-Technical Summary of the ES is presented in **ES Volume 4 [EN010143/APP/6.4]**.

6.1.7 In line with the requirements of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (hereafter referred to as the EIA Regulations) (Ref. 6-1), consideration has been given to the following aspects of Climate Change assessment:

a. **Lifecycle greenhouse gas (GHG) impact assessment:** the impact of GHG emissions arising over the lifetime of the Scheme on the climate (Section 5(2)(c) and Schedule 4(4) and (5) of the EIA Regulations);

b. **Climate Change Risk Assessment (CCRA):** the resilience of the Scheme to projected future climate change impacts, including damage to the Scheme resulting from climate change (Section 5(2)(c) of the EIA Regulations); and

c. **In-combination Climate Change Impact (ICCI) assessment:** an ICCI assessment identifies how the resilience of receptors in the surrounding environment are affected by the combined impact of future climate conditions and the Scheme (Section 5(2)(e) of the EIA Regulations). The receptors have been identified by the relevant technical disciplines and include receptors such as soil resources.

6.2 Legislation, Policy and Guidance

6.2.1 Legislation, planning policy, and guidance relating to climate change and pertinent to the Scheme comprise of the documents listed below. More detailed information can be found in **Appendix 6-1, ES Volume 2 [EN010143/APP/6.2]**.

Legislation and International Instruments

6.2.2 Legislation considered comprises:

a. The Infrastructure Planning (Environmental Impact Assessment (EIA)) Regulations 2017: section 5(2) and Schedule 4(4) and (5) (Ref. 6-1);

b. The Paris Agreement (2015) (Ref. 6-2);

c. Climate Change Act 2008 (Ref. 6-3);

d. UK Nationally Determined Contribution (2020, updated September 2022) (Ref. 6-4);

e. Climate Change Act 2008 (2050 Target Amendment) Order 2019 (Ref. 6-5);

f. The Carbon Budgets Order 2009 (Ref. 6-6);

g. The Carbon Budget Order 2011 (Ref. 6-7);

h. The Carbon Budget Order 2016 (Ref. 6-8); and

i. The Carbon Budget Order 2021 (Ref. 6-9).

National Policy

6.2.3 National policy considered comprises:

a. UK Climate Change Risk Assessment (Ref. 6-10)

b. Net Zero Strategy: Build Back Greener (Ref. 6-11);

c. Energy white paper: Powering our Net Zero future (Ref. 6-12);

d. National Infrastructure Strategy (Ref. 6-13);

e. National Policy Statement (NPS) for Energy (NPS EN-1) (2011) (Ref. 6-14);

f. NPS for Renewable Energy Infrastructure (NPS EN-3) (Ref. 6-15);

g. NPS for Electricity Networks Infrastructure (NPS EN-5) (Ref. 6-16);

h. National Planning Policy Framework (NPPF) (Ref. 6-17);

i. Environmental Improvement Plan 2023 (Ref. 6-18);

j. England Biodiversity Strategy (Ref. 6-19); and

k. Powering Up Britain: the Net Zero Growth Plan (Ref. 6-20).

6.2.4 Draft versions of the above NPSs are also pertinent to the Scheme as they may be adopted planning policy within the period of the DCO Application and consenting process and are further discussed in **Appendix 6-1, ES Volume 2 [EN010143/APP/6.2]**.

National Guidance

6.2.5 National guidance considered comprises:

a. Planning Practice Guidance (PPG) for Climate Change (Ref. 6-21);

b. Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance (Ref. 6-22); and

c. Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation (Ref. 6-23).

Local Policy

6.2.6 Local policy considered comprises:

a. East Riding of Yorkshire Council Sustainable Environmental Policies and Strategies (Ref. 6-24);

b. Adopted East Riding Local Plan 2019-2029 (Ref. 6-25);

c. Selby District Core Strategy (2013) (Ref. 6-27); and

d. Selby District Local Plan (2022) (Ref. 6-28).

6.3 Consultation

6.3.1 A scoping exercise was undertaken in September 2022 to establish the content of the assessment and the approach and methods to be followed.

6.3.2 The Scoping Report (**Appendix 1-1, ES Volume 2 [EN010143/APP/6.2]**) was issued on 9 September 2022 and records the findings of the scoping exercise and details the technical guidance, standards, best practice and criteria to be applied in the assessment to identify and evaluate the likely significant effects of the Scheme on climate change.

6.3.3 The Scoping Opinion was received on 20 October 2022 (**Appendix 1-2, ES Volume 2 [EN010143/APP/6.2]**). The feedback received from stakeholders at scoping and Applicant responses in relation to climate change are presented in **Appendix 1-3, ES Volume 2 [EN010143/APP/6.2]**. This is also summarised in **Table 6-1.**

Table 6-1. Scoping opinion responses (Climate Change)

ID	Consultee	Summary of comment	How matter has been addressed	Location of response
3.1.4	Planning Inspectorate	The Applicant proposes to scope changes in wind patterns out [i.e. In-combination climate change impact assessment - wind] of the ICCI on the basis that the Scheme is not likely to significantly affect receptors in combination with projected changes in wind patterns. Table 6-3 notes that the Scheme may be vulnerable to changes in wind patterns, such as high winds, and that the resilience of the Scheme to these changes will be assessed within the climate change resilience review to identify any adaptation measures required, as stated in paragraph 6.6.9 of the Scoping Report. On the basis that the Scheme would be designed to be resilient to changes in wind patterns the Inspectorate is content that significant in-combination effects on receptors in relation to wind are unlikely to occur and as such agrees that this matter can be scoped out.	An ICCI assessment has been undertaken. The Planning Inspector has agreed that in-combination effects in relation to wind can be scoped out and are therefore not further considered.	The outputs of the ICCI assessment are presented in **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**.
3.1.1	Planning Inspectorate	The Scoping Report states that although impacts are expected as a result of projected temperature increases, when considered in combination with the Scheme these are not expected to have a significant impact on receptors. No justification is provided for this conclusion. In the absence of additional information, including the location of sensitive receptors, the Inspectorate is not in a position to agree to scope this matter out at this stage. The ES should assess the potential for temperature changes to exacerbate Likely Significant Effects (LSE) relating to the Scheme, including the deliverability of mitigation measures such as, for example,	An ICCI assessment has been undertaken to assess the exacerbation of LSEs relating to the scheme on BNG. It has considered the combined impacts of temperature increases and the Scheme on receptors in the surrounding environment.	The outputs of the ICCI assessment are presented in **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**.

ID	Consultee	Summary of comment	How matter has been addressed	Location of response
		vegetation screening and implications for achieving Biodiversity Net Gain (BNG).		
3.1.3	Planning Inspectorate	The Scoping Report states that significant impacts on surface water or groundwater levels are not expected as a result of precipitation changes in combination with the Scheme. It is stated that flow of precipitation to the ground would not be hindered and conversion from agricultural land to grassland would increase infiltration and reduce runoff rates. No drainage or flood risk modelling is presented to support this assertion. Solar PV panels have potential to alter runoff rates and patterns. In the absence of more detailed information regarding drainage design and controls, the Inspectorate does not agree to scope this matter out.	An ICCI assessment has been undertaken. It has considered the combined impacts of surface water and groundwater and the Scheme on receptors in the surrounding environment.	The outputs of the ICCI assessment are presented in **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**. A Flood Risk Assessment (FRA) is presented within this ES (**Appendix 9-3, ES Volume 2 [EN010143/APP/6.2]**) and outlined in **Chapter 9: Flood Risk, Drainage, and Water Environment, ES Volume 1 [EN010143/APP/6.1]**.
3.1.2	Planning Inspectorate	The Applicant proposes to scope these matters [in-combination impacts from sea level rise and resilience of the Scheme to rising sea levels] out on the basis that the location of the Scheme means it is not susceptible to sea level rise. However, no evidence is provided to support this statement. The adjacent River Ouse is noted to be a tidal river at the point where it crosses the site boundary. On the basis of the current information, the Inspectorate does not agree to scope this	An ICCI assessment has been undertaken. It has considered the combined impacts of sea level rise and the Scheme on receptors in the surrounding environment.	The outputs of the ICCI assessment are presented in **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**.

ID	Consultee	Summary of comment	How matter has been addressed	Location of response
		matter out. The ES should include an assessment of in-combination impacts from sea level rise and resilience of the Scheme to sea level rise where significant effects are likely to occur.		
	Environment Agency	Climate parameters for the in-combination climate change impact assessment of the Scheme – this indicates that sea level rise may be scoped out of Chapter 6 [Climate Change], which we feel contradicts with Chapter 9 [Flood Risk, Drainage and Water Environment]. For clarity, we believe the Site is likely to be susceptible to the risks of sea level rise. Flood risk in the area is tidal from some sources, and therefore rising sea levels are likely to increase that risk in the future. To ensure the risk is not underestimated, an FRA should be produced before that risk is considered for scoping out.	The impact of sea level rise on the Scheme as a result of climate change is included in the CCRA. An ICCI assessment has also been undertaken. It has considered the combined impacts of sea level rise and the Scheme on receptors in the surrounding environment.	The outputs of the CCRA are summarised in **Appendix 6-2, ES Volume 2 [EN010143/APP/6.2]**. An FRA is presented within this ES (**Appendix 9-3, ES Volume 2 [EN010143/APP/6.2]**) and outlined in **Chapter 9: Flood Risk, Drainage, and Water Environment, ES Volume 1 [EN010143/APP/6.1]**. The outputs of the ICCI assessment are presented in **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**.

ID	Consultee	Summary of comment	How matter has been addressed	Location of response
	Natural England	The England Biodiversity Strategy published by Defra establishes principles for the consideration of biodiversity and the effects of climate change. The ES should reflect these principles and identify how the Scheme's effects on the natural environment will be influenced by climate change, and how ecological networks will be maintained. The NPPF requires that the planning system should contribute to the enhancement of the natural environment *"…by establishing coherent ecological networks that are more resilient to current and future pressures"* (NPPF, Paragraph 174), which should be demonstrated through the ES.	An ICCI assessment has been undertaken. It has considered the impacts of climate change and the Scheme on ecological receptors in the surrounding environment.	The outputs of the ICCI assessment are presented in **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**.

6.3.4 Further consultation in response to formal pre-application engagement was undertaken through the Preliminary Environmental Information Report (PEI Report), issued in May 2023. Responses to this statutory consultation are presented in the **Consultation Report [EN010143/APP/5.1]**. **Table 6-2** outlines the statutory consultation responses relating to climate change and how these have been addressed through the ES.

6.3.5 Further detail on consultation can also be found in **ES Chapter 4: Consultation, ES Volume 1 [EN010143/APP/6.1]**.

Table 6-2. Statutory consultation responses (climate change)

Consultee	Summary of comment	How matter has been addressed	Location of response
Natural England	Any grant of planning permission should be made subject to conditions to safeguard soil resources and agricultural land, including a required commitment for the preparation of reinstatement, restoration and aftercare plans; normally this will include the return to the former land quality (ALC grade).	The ICCI assessment takes into consideration, as far as is practicable, the combined effects of climate change and the Scheme on surrounding sensitive receptors, including risks to soil of erosion and structural damage.	**Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**
Ouse and Derwent IDB	It is currently unclear as to what impact the Solar PV panels may have on the soil properties such as carbon storage, structure and biodiversity. For example, as a result of changes in shading; temperature changes; preferential flow pathways; micro-climate; and vegetation growth caused by the panels.	The impact that the Scheme may have on soil carbon storage is difficult to quantify. However, the ICCI assessment takes into consideration, as far as is practicable, the combined effects of climate change and the Scheme on surrounding sensitive receptors, including risks to soil of erosion and structural damage.	**Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**

Consultee	Summary of comment	How matter has been addressed	Location of response
Historic England	While Historic England broadly welcomes measures to mitigate and adapt to the effects of climate change, we are aware that such developments have the potential to harm the significance of heritage assets and their settings. With this in mind Historic England has drawn up guidance for planners and developers on climate change and renewable energy technologies (Ref. 6-26).	The ICCI assessment takes into consideration, as far as is practicable, the combined effects of climate change and the Scheme on surrounding sensitive receptors, including heritage assets. The guidance from Historic England (Ref. 6-26) has been considered.	**Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**
Environment Agency	It is good to see that Sea level rise is scoped in and that **Table 6-1** shows that storm surge, tidal risk, flash flooding, including both pluvial and fluvial will be assessed in detail in the full FRA produced for the ES. We are supportive that a longer lifetime has been considered, which includes the parameters detailed in 6.5.35.	The impact of sea level rise on the Scheme as a result of climate change is included in the CCRA. An ICCI assessment has also been undertaken. It has considered the combined impacts of sea level rise and the Scheme on receptors in the surrounding environment.	The outputs of the CCRA are summarised in **Appendix 6-2, ES Volume 2 [EN010143/APP/6.2]**. An FRA is presented within this ES (**Appendix 9-3, ES Volume 2 [EN010143/APP/6.2]**) and outlined in **Chapter 9: Flood Risk, Drainage, and Water Environment, ES Volume 1 [EN010143/APP/6.1]**. The outputs of the ICCI assessment are presented in **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**.

6.3.6 Further engagement was undertaken for the PEI Report with key stakeholders including the Climate Change Officer and project leads at Selby District, North Yorkshire County, and East Riding of Yorkshire Councils. Scoping in an ICCI assessment and reporting the outputs alongside the CCRA was discussed and is reflected in the approach taken for the ES. No comments or feedback beyond those in **Table 6-1** were received during the consultation process.

6.3.7 As a result, further engagement previously suggested in the PEI Report was not required.

6.4 Assessment Methodology

Assumptions, Limitations and Uncertainties

6.4.1 The climate change assessment has been based on the parameters outlined in **Chapter 2: The Scheme, ES Volume 1 [EN010143/APP/6.1].** The Solar PV Site, Ecology Mitigation Area, Interconnecting Cable Corridor, Grid Connection Corridor, and Site Accesses have been considered together when considering the effects of the Scheme on climate (and the impacts of climate change on the Scheme), and the effects are presented for the Site as a whole. This chapter forms an assessment which has been based on available information at the time of preparing the ES. The technology for solar photovoltaic (PV) continues to evolve, to maintain commercial flexibility to meet the changing demands of the UK market. The 'Rochdale Envelope' approach (**Chapter 5: Environmental Impact Assessment Methodology, ES Volume 1 [EN010143/APP/6.1]**) has been applied within the EIA to ensure a robust assessment of the likely significant environmental effects of the Scheme; however, any adverse impacts are expected to be lower as a result of developing technology. It is assumed that the Scheme has an energy generation capacity of 480MW (megawatts) oversized AC peak and anticipated yields based on existing PV technology.

6.4.2 The largest single source of GHG emissions from the Scheme is likely to result from the manufacture and transport of Solar PV panels. The infrastructure manufacturer has not been confirmed and therefore for the purposes of estimating the GHG impact of the Scheme, a conservative estimate is to assume that the Solar PV panels will be sourced from China (or a country of similar distance from the UK). This will increase the embodied and transport emissions compared to the Solar PV panels being sourced from Europe. This assumption is consistent with other large scale UK solar schemes.

6.4.3 The Environmental Product Declaration (EPD) used as a reference for embodied carbon from the manufacture and supply of Solar PV panels is for the Jolywood JW-D144N-166 module rated at 470 Watts (W) (Ref. 6-29) (hereafter referred to as the 'Jolywood EPD'). The Jolywood EPD includes data on embodied carbon in kilograms carbon dioxide equivalent per kilowatt hour (kg CO_2e/kWh) of electricity generated for various lifecycle stages including supply of raw materials, manufacture, and transport to a solar farm in China. The Jolywood EPD was published in November 2020, prepared in accordance with ISO 14025 (Ref. 6-31) and EN 15804 (Ref. 6-32), and subject to independent third-party verification.

6.4.4 The Jolywood EPD shows upstream manufacturing with an embodied carbon figure of 0.00748kg CO_2e/kWh, but the generation data is from an actual site in southern China with 22% higher yield than anticipated for the Scheme. When a correction is made for the lower anticipated generation for the Scheme, the embodied carbon figure rises to 0.00956kg CO_2e/kWh generated over the Scheme's operational lifetime.

6.4.5 Minimum yields for the Scheme are assumed to be 922 kilowatt hours per year per kilowatt peak (kWh/yr/kWp), with the output of the Solar PV panels assumed to degrade by 2% in the first year and by 0.45% per year thereafter (Ref. 6-29). For an installation rated at 480MWp (megawatt peak) oversized AC peak operating for 40-year lifetime generation is estimated at 15.9 terawatt hours (TWh) of electricity.

6.4.6 It is assumed that 10% of the panels will need to be replaced on an ad hoc basis for repairs/failures. The embodied emissions from these replacement panels are included in the operational emissions calculations.

6.4.7 Sulphur hexafluoride (SF_6) is an extremely powerful GHG with a global warming potential (GWP) of 23,900. Fugitive emissions of SF_6 from certain electrical items, such as gas insulated switchgear, have historically been a significant source of emissions. Manufacturers of such equipment are now increasingly able to offer SF_6-free components, and those that do continue to use SF_6 are sealed-for-life with extremely low leakage rates (Ref. 6-33). The Applicant has confirmed that although there will most likely be SF_6 within the switchgear located at the Field Stations, these will be 'sealed for life' solutions with no leakage expected. For these reasons, it is assumed that emissions of SF_6 from the Scheme will be minimal and not material to this GHG assessment, but are considered in the assessment for completeness.

6.4.8 The Institute for Environmental Management and Assessment's (IEMA) 'Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance' (Ref. 6-22) states that a comparable baseline must be used as a reference point against which the impact of a new project can be assessed, which may be *"GHG emissions arising from an alternative project design for a project of this type"*. Currently, marginal load-following generation capacity[1] is generally provided by gas-fired Combined Cycle Gas Turbine (CCGT) (Ref. 6-34). The benefit of any renewable electricity scheme is to displace the use of fossil fuelled power sources. It is reasonable to assume that as additional renewable energy generation capacity becomes available, such as from developments like the Scheme, it will reduce demand for the marginal generator, i.e., directly displace the use of CCGT. On this basis, the GHG assessment has used the operational emissions of a CCGT as the future baseline.

6.4.9 As described in **Chapter 2: The Scheme, ES Volume 1 [EN010143/APP/6.1]**, the most rapid feasible construction programme for the Grid Connection Cables and solar farm (Solar PV Site and Interconnecting Cables) are anticipated to be 12 months and 24 months respectively, with operation therefore anticipated to commence in 2027. The GHG assessment has used a two-year construction period, with the two elements of construction running in parallel.

[1] A power source that adjusts its power output as demand for electricity fluctuates throughout the day, as opposed to the base load (continuously running over extended periods of time) or peaking plant (running in periods of high demand).

6.4.10 As described in **Chapter 2: The Scheme, ES Volume 1 [EN010143/APP/6.1],** The design life of the Scheme is 40 years with decommissioning to commence 40 years after final commissioning (currently anticipated to be 2027 to 2067). The climate change assessments presented in this chapter, therefore consider that that the entire Scheme is decommissioned at the end of the 40 years (2067).

6.4.11 Emissions from the decommissioning process at the end of the design life are very difficult to estimate due to the substantial uncertainty surrounding decommissioning methodologies and approaches so far into the future. It has been assumed that the resources and effort required for decommissioning will be equivalent to those required for construction. This is considered to be a worst-case scenario, as future developments in methodologies and technological advances are likely to reduce the carbon impact of decommissioning. It is assumed that the land will be returned to its original state following decommissioning of the Scheme.

6.4.12 Where data are not available, for example the number of visits from other, non-permanent staff during operation or the quantity of materials from the demolition of the derelict farmhouse and barn at Johnson's Farm (Solar PV Area 1e), a qualitative approach to addressing GHG impacts has been followed, in line with the IEMA guidance for assessing GHG emissions in EIA (Ref. 6-22).

Matters Scoped in/Scoped out

6.4.13 Following the Scoping Opinion, all elements of the ICCI assessment (excluding wind, as explained in **Table 6-1)** have been scoped into the assessment in agreement with the Planning Inspectorate and Environment Agency. No changes have been made to the scope since the PEI Report stage.

Study Area

Lifecycle GHG Impact Assessment

6.4.14 The Study Area for the GHG impact assessment covers all direct GHG emissions arising from activities undertaken at the Site during the construction, operation (including maintenance), and decommissioning of the Scheme. It also includes indirect emissions embedded within the construction products (e.g., Solar PV panels and cables) and materials (e.g., the steel required to construct the PV mounting structures) arising as a result of the energy used for their production, as well as emissions arising from the transportation of products and materials, waste and construction workers.

6.4.15 The environmental impact associated with GHG emissions is a national and global issue. Consequently, the significance of the Scheme's lifecycle GHG emissions will be assessed by comparing the estimated GHG emissions from the Scheme against the reduction targets defined in the Climate Change Act 2008 (2050 Target Amendment) Order 2019 (Ref. 6-5), associated five year, legally binding carbon budgets (Ref. 6-6 to Ref. 6-9), and the UK's forecast trajectory towards net zero.

Climate Change Risk Assessment

6.4.16 The Study Area for the CCRA (**Appendix 6-2, ES Volume 2**) is the land within the Order limits, i.e., it covers the construction, operation (including

maintenance), and decommissioning of all assets and infrastructure which constitute the Scheme.

In-combination Climate Change Impact Assessment

6.4.17 The ICCI assessment has been scoped into this chapter, with climate parameters (temperature change, sea level rise, and precipitation change) being considered by the other environmental disciplines in the ES (**Chapters 7 to 16, ES Volume 1 [EN010143/APP/6.1]**). Wind as a climate parameter has been scoped out as detailed in **Table 6-1**. The sensitive receptors for the ICCI assessment are those identified by each discipline in their assessment. The Study Area for the ICCI assessment is therefore as identified by each discipline for their individual assessments.

6.4.18 The methodology used by the environmental disciplines to identify ICCIs is described below, and the ICCIs identified by other environmental disciplines are summarised in **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**.

Methodology

6.4.19 The methodologies described in the following section have been developed in line with the relevant planning policy (see Section 6.2) and IEMA guidance for assessing GHGs (Ref. 6-22) and considering climate change resilience and adaptation measures (Ref. 6-23) in EIA. It is considered that by following the most recently published methodology, the assessment provides a robust and comprehensive assessment of the potential climate change impacts of the Scheme.

Lifecycle GHG Impact Assessment

6.4.20 The potential effects of the Scheme on the climate during construction are calculated in line with the GHG Protocol (Ref. 6-39) and the GHG ‘hot spots’ (i.e., materials and activities likely to generate the largest amount of GHG emissions) have been identified. This has enabled priority areas for mitigation to be identified. This approach is consistent with the principles set out in IEMA’s guidance for assessing GHGs in EIA (Ref. 6-22).

6.4.21 The lifecycle approach considers emissions from the following lifecycle stages of the Scheme: construction, operation (including maintenance), and decommissioning.

6.4.22 Where activity data has allowed, expected GHG emissions arising from the construction, operational, and decommissioning activities, and embodied carbon in materials of the Scheme, have been quantified using a calculation-based methodology as per the following equation in line with the GHG Protocol (Ref. 6-39), accompanied with the conversion factors for company reporting published by the UK Government (Ref. 6-40):

Activity data x GHG emissions factor = GHG emissions value

6.4.23 In line with the GHG Protocol, when defining potential impacts (or ‘hot spots’), the seven Kyoto Protocol GHGs have been considered, namely:

a. Carbon dioxide (CO_2);

b. Methane (CH_4);

c. Nitrous oxide (N_2O);

d. Sulphur hexafluoride (SF_6);

e. Hydrofluorocarbons (HFCs);

f. Perfluorocarbons (PFCs); and

g. Nitrogen trifluoride (NF_3).

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

6.4.25 Where data is not available, a qualitative approach to addressing GHG impacts has been followed as detailed in paragraph 6.4.12, in line with the IEMA guidance for assessing GHG emissions in EIA (Ref. 6-22).

6.4.26 **Table 6-3** summarises the key anticipated GHG emissions sources associated with the Scheme, in line with the 'Publicly Available Standard (PAS) 2080 – carbon management in infrastructure' (Ref. 6-41).

Table 6-3. Potential sources of GHG emissions

Lifecycle stage	Activity	Primary emission sources
Product stage	Raw material extraction and manufacturing of products required to build the equipment for the Scheme. Transportation of materials for such processes/ manufacturing (where available).	Embodied GHG emissions from energy use in extraction of materials and manufacture of components and equipment. Emission of potent GHGs during manufacture, such as SF_6. GHG emissions from transportation of products and materials during their processing and manufacture. Due to the nature of the equipment, this could require shipment of certain aspects over significant distances. Transport of materials to the Site is included under construction process stage where these are not included in embodied GHG emissions.
Construction process stage	On-site construction activity including emissions from construction compounds. Transportation of construction materials to the Site. Due to the nature of the equipment required, this could require shipment of certain aspects over significant distances. Transportation of construction workers to and from the Site.	Energy (e.g., electricity, fuel) consumption from plant and vehicles, generators on-site, and construction worker commuting. GHG emissions from transportation of materials and /or waste to and from the Site. GHG emissions from transportation of workers to and from the Site.

Lifecycle stage	Activity	Primary emission sources
	Disposal of any waste generated by the construction processes. Land use change. Water use.	GHG emissions from disposal and transportation of waste. GHG emissions from net loss of carbon sink. Provision of potable water, and treatment of wastewater.
Operation stage	Operation of the Scheme. Maintenance of the Scheme.	GHG emissions from energy consumption, provision of potable water, and treatment of wastewater. These operational aspects are expected to be negligible in the context of overall GHG emissions of the Scheme's lifecycle. Leakage of potent GHGs during operation, such as SF_6 (derived from certain electric items such as gas-insulated switchgear and gas-insulated transformers during production, operation through leakage, and dismantling) – although it is noted that SF_6 containing switchgear at Field Stations will be 'sealed for life' solutions with no leakage predicted. GHG emissions from energy consumption, material use and waste generation as a result of Site maintenance.
Decommissioning stage	On-site decommissioning activity. Transportation and disposal of waste materials. Transportation of workers.	Energy (e.g., electricity, fuel) consumption from plant, vehicles, and generators within the Site. GHG emissions from disposal and transportation of waste. GHG emissions from transportation of workers to the Site.

Significance Criteria – Lifecycle GHG impact assessment

6.4.27 For the lifecycle GHG impact assessment the magnitude of impact considers the output of the GHG quantification process, i.e., the Scheme's GHG lifecycle footprint, in the context of its contribution to the UK's carbon budgets and the possible impact of the Scheme on the UK meeting its Net Zero target. Emissions from the Scheme are presented as a percentage of the carbon budget period under which they fall.

6.4.28 According to the IEMA guidance on assessing GHG emissions in EIA (Ref. 6-22), "*GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant*".

6.4.29 The IEMA guidance describes five distinct levels of significance which are not solely based on whether a project emits GHG emissions alone, but how the project makes a relative contribution towards achieving a science-based 1.5°C aligned transition towards Net Zero.

6.4.30 **Table 6-4** presents the different significance levels as per the latest version of the IEMA guidance, which emphasises that "…*a project that follows a 'business-as-usual' or 'do minimum' approach and is not compatible with the UK's net zero trajectory, or accepted aligned practice or area-based transition targets, results in a significant adverse effect. It is down to the practitioner to differentiate between the 'level' of significant adverse effects e.g. 'moderate' or 'major' adverse effects."*

Table 6-4. Definition of levels of significance

Significance level	Effect	Description in the IEMA guidance	Example in the IEMA guidance
Significant adverse	Major adverse	A project that follows a 'business-as-usual' or 'do minimum' approach and is not compatible with the UK's Net Zero trajectory or accepted aligned practice or area-based transition targets, results in a significant adverse effect. It is down to the practitioner to differentiate between the 'level' of significant adverse effects; e.g., 'moderate' or 'major' adverse effects.	The project's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards Net Zero.
	Moderate adverse		The project's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards Net Zero.

Significance level	Effect	Description in the IEMA guidance	Example in the IEMA guidance
Not significant	Minor adverse	A project that is compatible with the budgeted, science based 1.5°C trajectory (in terms of rate of emissions reduction) and which complies with up-to-date policy and 'good practice' reduction measures to achieve a minor adverse effect that is not significant. It may have residual emissions but is doing enough to align with and contribute to the relevant transition scenario, keeping the UK on track towards Net Zero by 2050 with at least a 78% reduction by 2035[2] and thereby potentially avoiding significant adverse effects.	The project's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards Net Zero.
	Negligible	A project that achieves emissions mitigation that goes substantially beyond the reduction trajectory, or substantially beyond existing and emerging policy compatible with that trajectory, and has minimal residual emissions, is assessed as having a negligible effect that is not significant. This project is playing a part in achieving the rate of transition required by nationally set policy commitments.	The project's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or Net Zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards Net Zero and has minimal residual emissions.
Beneficial	Significant	A project that causes GHG emissions to be	The project's net GHG impacts are below zero and

[2] Or other science-based 1.5°C compatible trajectory as may be defined for a specific sector or local area, as applicable.

Significance Effect level	Description in the IEMA guidance	Example in the IEMA guidance
	avoided or removed from the atmosphere. Only projects that actively reverse (rather than only reduce) the risk of severe climate change can be judged as having a beneficial effect.	it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline. A project with beneficial effects substantially exceeds Net Zero requirements with a positive climate impact.

6.4.31 Moderate and major adverse impacts and beneficial impacts are considered to be 'significant', while minor adverse and negligible significance levels are deemed to be 'not significant'.

6.4.32 A minor adverse or negligible non-significant effect conclusion does not necessarily refer to the magnitude of GHG emissions being carbon neutral (i.e., zero on balance); but refers to the likelihood of avoiding severe climate change, aligning project emissions with a science-based 1.5°C compatible trajectory and achieving Net Zero by 2050.

6.4.33 A project's impact can shift from significant adverse to non-significant effects by incorporating mitigation measures that substantially improve on business-as-usual and meet or exceed the science-based emissions trajectory of ongoing but declining emissions towards Net Zero.

6.4.34 The IEMA guidance also states it is down to the professional judgement of the practitioner to determine how best to contextualise a project's GHG impact and assign the level of significance. It is suggested that sectoral, local, or national carbon budgets can be used, as available and appropriate, to contextualise a project's GHG impact and determine the level of significance. The approach adopted for the purposes of this assessment is outlined below.

6.4.35 Where available, UK national carbon budgets have been used for the purposes of this assessment to represent future emissions inventory scenarios for the UK (Ref. 6-42). These legally binding targets, which outline the total amount of GHGs that the UK can emit over a 5-year period, are currently available to the 6th carbon budget period (2033-2037). The UK is currently in the 4th Carbon Budget period, which runs from 2023-2027. The 3rd, 4th and 5th Carbon Budgets reflect the previous 80% reduction target by 2050. The 6th Carbon Budget aligns with the legislated 2050 Net Zero target.

6.4.36 The appropriate UK national Carbon Budget in which the construction period is expected to fall (i.e., 2025-2027) is the 4th Carbon Budget (2023-2027). The annual average GHG impact of the Scheme has been compared against the annualised Carbon Budget for the period in which the emissions arise to allow separate assessment of each lifecycle stage.

6.4.37 Operational GHG emissions of the Scheme (assumed to be fully operational by 2027 at the earliest) have been compared to all the appropriate and available Carbon Budgets within the design life of the Scheme: the 4th, 5th

and 6th Carbon Budgets (i.e., 2023-2027, 2028-2032 and 2033-2037, respectively).

6.4.38 In order to illustrate the Scheme trajectory towards Net Zero by 2050, the Climate Change Committee's (CCC) balanced Net Zero pathway is utilised post-2037, in the absence of any nationally legally binding Carbon Budgets after the 6th Carbon Budget.

6.4.39 The CCC's balanced net-zero pathway is divided into 5-year periods between 2037 and 2050 to match the time period of the legally binding UK National Carbon Budgets, and the proposed budgets up to 2050 are in line with the UK's 1.5°C trajectory (as detailed in Table 6-5**)**.

6.4.40 However, it should be noted that the CCC's proposed budgets beyond 2037 have not been formally adopted by the UK government or legislated for by parliament and can therefore only be used as an indicative measure to contextualise the Scheme's progress toward the national Net Zero trajectory.

6.4.41 To identify and assess the magnitude of impact of GHG emissions arising from the Scheme, these are first calculated and put into the context of the UK Carbon Budgets. The IEMA guidance and criteria (Ref. 6-22) is then used to test the significance of the magnitude.

6.4.42 **Table 6-4** outlines the significance of effects, with the UK Carbon Budgets being used to provide context to the GHG emissions (**Table 6-5**).

Table 6-5. UK Carbon Budgets and indicative carbon budgets based upon the CCC's Balanced Net Zero Pathway

Carbon budget	UK Carbon Budget ($MtCO_2e$)	Indicative Carbon Budget totals based upon the CCC's Balanced Net Zero Pathway ($MtCO_2e$)
3rd (2018–2022)	2,544	-
4th (2023–2027)	1,950	-
5th (2028–2032)	1,725	-
6th (2033–2037)	965	-
7th (2038–2042)	-	526
8th (2043–2047)	-	195
9th (2048–2050)	-	17

6.4.43 In addition to providing advice that underpins setting National Carbon Budgets, the CCC also provides sector-specific decarbonisation pathways (Ref. 6-43). **Table 6-6** presents the electricity generation sector specific Carbon Budgets as further context to the GHG emissions; however, it should be noted that these are not legislated for like the national-level budgets. The sector-specific Carbon Budget periods begin in 2020.

Table 6-6. Sector specific electricity generation carbon budgets based upon the CCC's Balanced Net Zero Pathway

Carbon budget period	Recommended Carbon Budget ($MtCO_2e$)
2020–2022	105.45
2023–2027	189.16
2028–2032	92.56
2033–2037	35.74
2038–2042	23.22
2043–2047	12.36
2048–2050	4.03

Climate Change Risk Assessment

6.4.44 The EIA Regulations require the inclusion of information on the vulnerability of the Scheme to climate change. Consequently, a CCRA for the Scheme has been conducted which identifies potential climate change impacts. In the Scoping Report this was referred to as the Climate Change Resilience Review, but terminology has been updated (at PEI Report and ES) to reflect the recent update to the IEMA guidance (Ref. 6-23).

6.4.45 The CCRA has included all infrastructure and assets associated with the Scheme. It covers 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) (Ref. 6-36).

6.4.46 The review of potential impacts and the Scheme's vulnerability considers the embedded mitigation measures that have been designed into the Scheme, discussed in Section 6.6.

6.4.47 The assessment has considered climate projections over a 40-year period from the final commissioning of the Scheme (assumed to be 2027).

6.4.48 Climate parameters considered in the CCRA during the construction, operation (including maintenance), and decommissioning of the Scheme include the following:

a. Extreme weather events;
b. Flood risk;
c. Sea level rise (SLR);
d. Temperature change; and
e. Precipitation change.

6.4.49 The CCRA has been undertaken for the Scheme to identify potential climate change impacts on the Scheme and associated receptors, and to consider their potential consequence and likelihood of occurrence, taking account of the adaption measures embedded into the design of the Scheme (Section 6.6).

6.4.50 Climate projections for the Scheme during the enabling works and construction phase have been examined against receptors. Construction

phase receptors of the Scheme include the workforce, plant, machinery, and materials.

6.4.51 Heatwaves and other extreme weather events could present a risk to site workers. Climate change impacts during construction (expected to be approximately two years from 2025-2027) have therefore been considered in the CCRA, covering effects like heat exhaustion and exposure to dangerous weather conditions.

6.4.52 For the operational phase of the Scheme, potential climate change impacts on the Scheme have been identified using relevant projections from UKCP18 and the CCRA considers their potential consequence to receptors and likelihood of occurrence, taking account of the measures incorporated into the design of the Scheme where available. The CCRA therefore considers the impact of climate change on the Scheme itself including its infrastructure (e.g., the Solar PV panels and other equipment), the workers on the Site during operation and maintenance, and any landscaping and habitat creation being undertaken as part of the Scheme.

6.4.53 The following key terms and definitions relating to the CCRA have been used:

a. Climate hazard – a weather or climate related event, which has potential to do harm to environmental or community receptors or assets, such as increased winter precipitation;

b. Climate change risk – risks associated with climatic variables, such as increased winter precipitation leading to flooding;

c. 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

d. Consequence – any effect on the receptor or asset resulting from the climate hazard having an impact.

6.4.54 A stepped approach is used to assess the impacts of climate change on the Scheme:

a. Identify potential climate hazards and associated climate risks;

b. Identify likelihood of climate impact occurring;

c. Identify consequence of impact on the Scheme; and

d. Identify significance of impact (likelihood of impact occurring x consequence of impact).

6.4.55 Once potential climate hazards have been identified (e.g., heatwaves from increased summer temperatures), the likelihood of their occurrence during each project phase (i.e., construction, operation, and decommissioning) is categorised.

6.4.56 The criteria which have been used to determine the likelihood of a climate change risk occurring are detailed in **Table 6-7**. For example, a climate hazard could be; increased summer temperatures, leading to the climate risk of a heatwave, while the climate impact is the impact on the Scheme, e.g., overheated electrical equipment.

Table 6-7. Likelihood of a climate risk occurring

Likelihood of event	Qualitative description	Quantitative description (probability of occurrence)
Very likely	Likely that the event will occur many times (reoccurs frequently).	90-100% probability that the hazard will occur.
Likely	Likely that the event will occur sometimes (reoccurs infrequently).	66-90% probability that the hazard will occur.
Possible, about as likely as not	Possible that the event will occur (has occurred rarely).	33-66% probability that the hazard will occur.
Unlikely	Unlikely that the event will occur (not known to have occurred).	10-33% probability that the hazard will occur.
Very unlikely	Almost inconceivable that the event will occur.	0-10% probability that the hazard will occur.

6.4.57 Following identification of climate hazards and risks, the consequences of climate impacts have been assessed according to **Table 6-8**. For example, permanent damage to electrical equipment from heatwaves causing complete loss of operation. The categories and descriptions provided below are based on IEMA's 'Climate Change Resilience and Adaptation guidance' (Ref. 6-23).

Table 6-8. Level of consequence of a climate change risk occurring

Consequence of impact	Description
High	• Permanent damage to structures/assets; • Complete loss of operation/service; • Complete/partial renewal of infrastructure; • Exceptional environmental damage; and/or • Extreme financial impact.
Moderate	• Partial infrastructure damage and some loss of service; • Some infrastructure renewal; • Adverse impact on the environment; and/or • Moderate financial impact.
Low	• Localised infrastructure disruption and minor loss of service; • No permanent damage, minor restoration work required;

Consequence of impact	Description
	• Slight adverse environmental effects; and/or • Small financial losses.
Negligible	• No damage to infrastructure; • No impacts on the environment; and/or • No adverse financial impact.

Significance criteria – CCRA

6.4.58 The significance in the CCRA is determined as a function of the likelihood of a climate change risk occurring and the consequence to the receptor if the risk occurs. The significance is detailed in **Table 6-9.** The assessment takes into account confirmed design and mitigation measures (referred to as embedded mitigation as set out in Section 6.6).

Table 6-9. Significance of effect matrix for CCRA

		Likelihood of climate-related impact occurring			
		Negligible	**Low**	**Moderate**	**High**
Level of consequence of a climate risk occurring	**Negligible**	Negligible (NS)	Low (NS)	Low (NS)	Low (NS)
	Low	Low (NS)	Low (NS)	Low (NS)	Medium (S)
	Moderate	Low (NS)	Low (NS)	Medium (S)	High (S)
	High	Low (NS)	Medium (S)	High (S)	High (S)

Note: S = significant; and NS = not significant

In-combination Climate Change Impact Assessment

6.4.59 The ICCI assessment has considered the ways in which projected climate change will influence the significance of the impact of the Scheme on receptors in the surrounding environment.

6.4.60 The ICCI assessment has considered the existing and project 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. These impacts have been assessed in liaison with the technical specialists responsible for preparing the applicable technical chapters in **ES Volume 1 [EN010143/APP/6.1]**, listed below:

a. **Chapter 7: Cultural Heritage**;

b. **Chapter 8: Ecology**;

c. **Chapter 9: Flood Risk, Drainage and Water Environment**;

d. **Chapter 10: Landscape and Visual Amenity**;

e. **Chapter 11: Noise and Vibration**;

f. **Chapter 12: Socio-economics and Land Use**;

g. **Chapter 13: Transport and Access**;

h. **Chapter 14: Human Health**;

i. **Chapter 15: Soils and Agricultural Land**; and

j. **Chapter 16: Other Environmental Topics** (Air Quality, Glint and Glare, Ground Conditions and Waste and Materials).

6.4.61 Additionally, the specialists who prepared the **Arboricultural Impact Assessment and Tree Protection Report** (**Appendix 10-5, ES Volume 2 [EN010143/APP/6.2]**) also provided input.

6.4.62 Once the potential ICCIs have been identified in relation to the Scheme, the likelihood of their occurrence during construction, operation and decommissioning phases is categorised. This is the same process as was undertaken for the CCRA, as detailed in **Table 6-7**.

6.4.63 In consideration of the likelihood of the climate risk occurring, and the sensitivity of the receptor, the likelihood of an impact occurring to the receptor is then defined. This includes consideration of any embedded mitigation measures and good practice. These classifications are defined in **Table 6-10.**

Table 6-10. Level of likelihood of the climate-related hazard occurring

Level of likelihood of climate hazard	Qualitative description	Quantitative description
Very likely	Likely that the event will occur many times (reoccurs frequently).	90-100% probability that the hazard will occur during the life of the project.
Likely	Likely that the event will occur sometimes (reoccurs infrequently).	66-90% probability that the hazard will occur during the life of the project.
Possible, about as likely as not	Possible that the event will occur (has occurred rarely).	33-66% probability that the hazard will occur during the life of the project.
Unlikely	Unlikely that the event will occur (not known to have occurred).	10-33% probability that the hazard will occur during the life of the project.
Very unlikely	Almost inconceivable that the event will occur.	0-10% probability that the hazard will occur during the life of the project.

6.4.64 The likelihood of a climate risk occurring and the likelihood of an impact to a receptor is then combined to determine the likelihood of an ICCI occurring. This matrix is illustrated in **Table 6-11.**

Table 6-11. Level of likelihood of the climate-related impact occurring

Level of likelihood of climate impact occurring	Definition of likelihood
High	Likelihood of climate hazard occurring is high and impact is always/ almost always going to occur.
Moderate	Likelihood of climate hazard occurring is high and impact occurs often or the likelihood of climate hazard occurring is moderate and impact is likely to occur always/almost always.
Low	Likelihood of climate hazard occurring is high, but impact rarely occurs or the likelihood of climate hazard occurring is moderate and impact sometimes occurs or the likelihood of climate hazard occurring is low and impact is likely to occur always/almost always.
Negligible	All other eventualities – highly unlikely but theoretically possible.

6.4.65 Once the likelihood of an ICCI has been identified the assessment then considers how this will affect the significance of the identified effects.

6.4.66 The ICCI consequence criteria are defined in **Table 6-12** and are based on the change to the significance of the impact already identified by the environmental discipline. To assess the consequence of an ICCI each discipline has assigned a level of consequence to an impact based on the criteria description and their discipline assessment methodology.

Table 6-12: Consequence criteria for ICCI assessment

Consequence	Consequence criteria
High	The climate change parameter in-combination with the effect of the Scheme causes the significance of the impact of the Scheme on the resource/receptor, as defined by the topic, to increase from negligible, low, or moderate to major.
Moderate	The climate change parameter in-combination with the effect of the Scheme causes the effect defined by the topic to increase from negligible or low, to moderate.
Low	The climate change parameter in-combination with the effect of the Scheme, causes the significance of effect defined by the topic, to increase from negligible to low.
Negligible	The climate change parameter in-combination with the effect of the Scheme does not alter the significance of the effect defined by the topic.

Significance Criteria – ICCI Assessment

6.4.67 The significance of potential effects is determined using the matrix in **Table 6-13.** Where an effect has been identified as moderate or high, against the matrix in Table 6-13, these will be classed as a significant ICCI effect. If significant ICCI effects are assessed, then appropriate additional mitigation measures (secondary mitigation) are identified.

Table 6-13. ICCI significance criteria

		Likelihood of climate-related impact occurring			
		Negligible	**Low**	**Moderate**	**High**
Level of consequence	**Negligible**	NS	NS	NS	NS
	Low	NS	NS	NS	S
	Moderate	NS	NS	S	S
	High	NS	S	S	S

Note: S = significant; and NS = not significant

6.5 Baseline Conditions

6.5.1 This section describes the baseline environmental characteristics for the Scheme and surrounding areas with specific reference to GHG emissions and climatic conditions.

Data Sources

6.5.2 In preparation of this chapter, the following sources of published information have been used to establish the baseline conditions:

a. Historic climate data obtained from the Met Office website at the closest meteorological station to the Scheme (Topcliffe, approximately 15 miles north-west of the Scheme) (Ref. 6-35) to determine the existing baseline conditions;

b. UKCP18 (Ref. 6-36) to determine the future baseline conditions; and

c. The IPCC AR6 Sea Level Projection Tool (Ref. 6-37) and Think Hazard (Ref. 6-38) were also used for other projected trends/impacts, and the UK Climate Change Risk Assessment (Ref. 6-10) analysed for the current state of nationwide climate change risks.

Lifecycle GHG Impact Assessment

Existing Baseline

6.5.3 For the GHG assessment, the current baseline is a ‘no-development’ scenario whereby the Scheme is not implemented. The baseline comprises existing carbon stock and sources of GHG emissions within the boundary of the existing activities on-site.

6.5.4 The current land use within the Site and the local area consists predominately of agricultural fields mainly under arable production, with some areas of pasture, interspersed with individual trees, hedgerows, linear tree belts, small woodland blocks and farm access tracks. The vegetation within the Scheme suggests some carbon sink potential. Current land use within the Scheme has relatively low levels of land use GHG emissions in the context of the overall emissions in the wider area as it is largely arable land. Baseline agricultural GHG emissions are dependent on types of soil and vegetation present, fuel use for the operation of vehicles and machinery, and other inputs such as fertiliser and pesticide use.

Future Baseline

6.5.5 The future baseline for the GHG assessment is a 'business-as-usual' position whereby the Scheme is not implemented. This includes the operational emissions from the generation of electricity that would occur should the Scheme not go ahead but which will be displaced in the case of the Scheme being delivered.

6.5.6 The current land use within the Site will have minor levels of associated GHG emissions from agricultural activities and minor carbon sequestration from vegetation. n. Therefore, for the purpose of the GHG assessment, embodied GHG emissions are considered zero in the future baseline whereby the Scheme is not implemented.

CCRA and ICCI Assessments

Existing Baseline

6.5.7 The baseline for the CCRA and ICCI assessments is the climate in the location of the Scheme for the 30-year period of 1981-2010 (the standard baseline for climate data (Ref. 6-22)). Historic climate data recorded by the closest meteorological station to the Scheme (Topcliffe, located approximately 24.1 kilometres north-west of the Scheme) for the 30-year period of 1981-2010 was obtained from the Met Office website (Ref. 6-35), and is summarised in **Table 6-14.**

Future Baseline

6.5.8 The future baseline is expected to differ from the present-day baseline described above. UKCP18 (Ref. 6-36) provides probabilistic climate change projections for pre-defined 30-year periods for annual, seasonal, and monthly changes to mean climatic conditions over land areas. For the purpose of the assessments, UKCP18 probabilistic projections for pre-defined 30-year periods for the following average climate variables have been obtained:

a. Mean annual temperature;

b. Mean summer temperature;

c. Mean winter temperature;

d. Maximum summer temperature;

e. Minimum winter temperature;

f. Mean annual precipitation;

g. Mean summer precipitation;

h. Mean winter precipitation;

i. Sea level rise; and

j. Extreme weather events (e.g., heat waves, storm surges).

6.5.9 Projected temperature and precipitation variables are presented in **Table 6-14**. UKCP18 probabilistic projections have been analysed for the 25 km^2 (square kilometres) grid square within which the Scheme is located. These figures are expressed as temperature/precipitation anomalies in relation to the 1981-2010 baseline.

6.5.10 UKCP18 uses a wide range of possible scenarios, classified as Representative Concentration Pathways (RCP), 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 has been used for the purposes of this assessment as a worst-case as this predicts a high-emissions or 'business-as-usual' scenario.

6.5.11 As the design life of the Scheme is 40 years, the CCRA has considered a scenario that reflects a high level of GHG emissions at the 10%, 50% and 90% probability levels up to 2099 to assess the impact of climate change over the assessed lifetime of the Scheme.

6.5.12 Construction risks are assessed against the 2020-2049 projection data, while operation and decommissioning are assessed against 2050-2079 and 2070-2099 projection data as a conservative worst-case scenario.

Table 6-14. Climate Change Baseline and Projection Data

Aspect	Baseline data	Projections (change)			Projected trend	Climate projection source
Climatic Variable	1981-2010	2020-2049	2050-2079	2070-2099		
Temperature						
Mean annual maximum daily temperature (°C)	13.30°C	+1.0 (+0.5 to +1.6)	+2.3 (+1.2 to +3.4)	+3.5 (+2.1 to +5.1)	Increase	UKCP18 RCP8.5
Mean summer maximum daily temperature (°C)	20.18°C	+1.3 (+0.4 to +2.0)	+2.8 (+1.3 to +4.4)	+4.4 (+2.3 to +6.6)	Increase	UKCP18 RCP8.5
Mean winter minimum daily temperature (°C)	0.78°C	+0.9 (+0.1 to +1.8)	+2.1 (+0.6 to +3.8)	+3.0 (+1.2 to +5.0)	Increase	UKCP18 RCP8.5
Highest temperature for baseline period (°C)	July 20.88°C	-	-	-		Met Office (Ref. 6-35)
Lowest temperature for baseline period (°C)	December -0.06°C[3]	-	-	-		Met Office (Ref. 6-35)
Rainfall						
Mean annual rainfall (millimetres [mm])	644.03	+0.4% (-6.5% to +7.0%)	-1.9% (-10.4% to +6.8%)	-1.8% (-12.5% to +9.1%)	Decrease	UKCP18 RCP8.5
Mean summer rainfall (mm)	176.31	-7.0% (-25.3% to +12.8%)	-18.0% (-42.5% to +7.5%)	-28.6% (-55.1% to 1.7%)	Decrease	UKCP18 RCP8.5

[3] Figure amended from PEI Report as provided from the Met Office historic data (Ref. 6-35).

Aspect	Baseline data	Projections (change)			Projected trend	Climate projection source
Mean winter rainfall (mm)	153.75	+4.3% (-3.4% to +13.0%)	+10.1% (-2.7% to 25.6%)	+16.4% (-0.9% to 36.4%)	Increase	UKCP18 RCP8.5
Wettest month on average (mm)	November 63.33	-	-	-		UKCP18 RCP8.5
Driest month on average (mm)	February 39.54	-	-	-		UKCP18 RCP8.5
Other						
Sea Level Rise (m)[4]	-	0.27	0.54	0.78	Increase	IPCC AR6 Sea Level Projection Tool SSP8.5
Storm surges	The UKCP18 model suggest a small contribution from storm surges; however, it is unclear if the frequency and severity of future storm surges is going to change. Although, rising sea levels due to climate change are expected to worsen the impacts of storm surges.					UKCP18 RCP8.5
Heatwaves	Under a high emissions scenario, it is estimated that by the end of the 21st Century, all areas of the UK are projected to be warmer with hotter, drier summers and heatwaves likely to become more common and intense.					UKCP18 RCP8.5
Wildfires	Think Hazard has classified the wildfire hazard in Humberside classified as Medium, according to currently available information.					Think Hazard

[4] Note: the sea level rise projection differs from the other variables in that it is given for the decade (2050 and 2080), rather than a 30-year period. The scenarios used for sea level rise are the IPCC's latest 6th Assessment Report scenario SSP8.5 (very high GHGs) (Ref. 6-37).

Aspect	Baseline data	Projections (change)	Projected trend	Climate projection source
Drought	The Met Office has projected a trend towards drier summers on average, with the trend being stronger under a high GHG emission scenario compared to a low one. However, it is the distribution of rainfall throughout the seasons that will determine UK drought risk.			UKCP18 RCP8.5

6.6 Embedded Mitigation

6.6.1 Where possible, mitigation measures have been incorporated into the Scheme design and/or how it shall be constructed. Through iterative assessment, potential impacts have been predicted and opportunities to mitigate them identified with the aim of preventing or reducing impacts as much as possible. This approach provides the opportunity to prevent or reduce potential adverse impacts from the outset. This embedded mitigation/mitigation by design approach has been taken into account when evaluating the significance of the potential impacts.

6.6.2 Once these measures are incorporated into the design, they are termed 'embedded measures'. Embedded measures relevant to the construction phase are described within each technical chapter of this ES (**Chapters 7 to 16, ES Volume 1 [EN010143/APP/6.1]**). For the operational phase, such embedded measures will be represented primarily in the design, e.g., the choice of infrastructure components. Embedded measures are therefore either incorporated into the design from the outset or identified through the assessment process.

6.6.3 Along with any measures required for legislative compliance, the Scheme will also incorporate industry standard control measures, which are common practice on construction sites, into the embedded measures. These are described in each technical chapter of this ES (**Chapters 7 to 16, ES Volume 1 [EN010143/APP/6.1]**). Embedded measures include (but are not limited to) the monitoring of weather forecasts and receipt of Environment Agency flood alerts by Contractors to allow works to be planned and carried out accordingly to manage extreme weather conditions, such as storms and flooding, infrastructure design, and flood resilience measures. The embedded measures are secured through the Framework environmental management plans described below.

Construction and Decommissioning

6.6.4 A **Framework Construction Environmental Management Plan (CEMP) [EN010143/APP/7.7]** is included within the DCO application. This identifies various mitigation measures to be embedded within the Scheme to reduce the GHG impact, including:

a. Adopting the Considerate Constructors Scheme (CCS) to assist in reducing pollution, including GHGs, from the Scheme by employing good industry practice measures which go beyond statutory compliance;

b. Encouraging all construction staff to use lower carbon modes of transport by identifying and communicating local bus and rail connections and pedestrian and cycle access routes to/from the Scheme and providing appropriate facilities for the safe storage of cycles;

c. Implementing a **Framework Construction Traffic Management Plan (CTMP) and Travel Plan** (**Appendix 13-5 ES Volume 2 [EN010143/APP/6.2]**) to reduce the volume of construction staff and employee trips to the Site;

d. Liaising with construction personnel on the potential to implement staff minibuses and car sharing options;

e. Switching vehicles and plant off when not in use and ensuring construction vehicles conform to European Union (EU) vehicle emissions standards for the types of plant and vehicles to be used;

f. Conducting regular planned maintenance of the plant and machinery to optimise efficiency;

g. Increasing recyclability by segregating construction waste to be re-used and recycled where reasonably practicable;

h. Designing, constructing and implementing the Scheme in such a way as to minimise the creation of waste;

i. Where practicable, maximise the use of alternative materials with lower embodied carbon such as locally sourced products and materials with a higher recycled content;

j. Storing topsoil and other construction materials outside of the 1 in 100-year floodplain extent (Flood Zone 3), as far as reasonably practicable (noting that no development will occur within Flood Zone 3 Areas of the Solar PV Site);

k. Named person(s) – likely the Safety, Health and Environment Manager/ Ecological Clerk of Works (ECoW) – to monitor weather forecasts and receive Environment Agency flood alerts to allow works to be planned and carried out accordingly to manage extreme weather conditions, such as storms and flooding; and

l. Health and safety plans developed for construction activities will be required to account for potential climate change impacts on workers, such as flooding and heatwaves. To include measures such as toolbox talks on training on dangers of extreme weather conditions.

6.6.5 The **Framework CEMP [EN010143/APP/7.7]** will be developed into a detailed CEMP prior to the construction phase commences as a means to secure the embedded mitigation measures mentioned above.

6.6.6 Further climate change resilience measures embedded within the Scheme, particularly in relation to flood risk are included in the **Framework CEMP [EN010143/APP/7.7]**. The specific flood risk impacts and associated mitigation measures are discussed in more detail in **Chapter 9: Flood Risk, Drainage and Surface Water, ES Volume 1 [EN010143/APP/6.1]**.

6.6.7 A **Framework Decommissioning Environmental Management Plan (DEMP) [EN010143/APP/7.9]** has been submitted as part of the DCO Application and includes mitigation measures to encourage the use of lower-carbon and more climate resilient methods, including:

a. Health and safety plans developed for decommissioning activities will be required to account for potential climate change impacts on workers, such as flooding and heatwaves. To include measures such as toolbox talks on training on dangers of extreme weather conditions;

b. Removing and recycling all PV modules, mounting poles, inverters, and transformers where possible, in accordance with good practice and market conditions at the time;

c. Preparing a Decommissioning Resource Management Plan (DRMP) prior to works commencing, to control waste generated on-site and set goals regarding volumes of waste produced; and

d. Adopting the CCS to assist in reducing pollution from the decommissioning of the Scheme.

6.6.8 The **Framework DEMP [EN010143/APP/7.9]** will be developed into a detailed DEMP prior to decommissioning as a means to secure the embedded mitigation measures mentioned above. Delivery of the detailed DEMP (and its associated mitigation measures) is secured by a requirement of the DCO.

Operation

6.6.9 A **Framework Operational Environmental Management Plan (OEMP) [EN010143/APP/7.8]** has been submitted as part of the DCO application. This identifies various mitigation measures to be embedded within the Scheme to reduce the GHG and environmental impact of operations, including:

a. Use of motion detection security lighting to avoid permanent lighting and reduce energy demand of the Scheme;

b. Establish, monitor, and manage landscape and ecology mitigation and enhancement (BNG) measures embedded in the design, secured through the **Framework Landscape and Ecological Management Plan (LEMP) [EN010143/APP/7.14],** which has been submitted as part of the DCO application;

c. Regular maintenance of the Scheme will be conducted to optimise the efficiency of the Scheme infrastructure;

d. Operating the Scheme in such a way as to minimise the creation of waste and maximise the use of alternative materials with lower embodied carbon, such as locally sourced products and materials with higher recycled content; and

e. Switching off vehicles and plant when not in use and ensuring vehicles conform to current EU emissions standards.

6.6.10 In addition, adaptation measures to reduce the effect of projected temperature increases on electrical equipment over the course of the Scheme's design life have been taken into account. Inverters will have a cooling system installed to control the temperature and allow the inverters to operate efficiently in warmer conditions. The solar PV panels and transformers have a wide range of acceptable operation temperatures, and it has been determined that increasing temperatures will not adversely affect their operation.

6.6.11 Consideration will also be given to the UKCP18 climate change projections outlined in section 6.5, and the resilience of the Scheme's infrastructure to these, through the detailed design process.

6.7 Assessment of Likely Impacts and Effects

6.7.1 The Scheme has the potential to affect, and be affected by, climate change (positively or negatively), during construction, operation and during decommissioning, in the following ways:

a. Impact of GHG emissions arising over the lifetime of the Scheme on the climate;

b. Resilience of the Scheme to projected future climate change impacts, including damage to the Scheme resulting from climate change; and

c. How the resilience of receptors in the surrounding environment are affected by the combined impact of future climate conditions and the Scheme.

6.7.2 The assessments have been undertaken following consideration of the embedded mitigation measures as described in Section 6.6

Lifecycle GHG impact assessment

6.7.3 Within this section, GHG emissions arising as a result of the Scheme are first identified and assessed for each lifecycle stage individually (construction, operation and decommissioning).

6.7.4 It is important to understand the GHG impacts at each individual lifecycle stage, but it is also important to understand the net lifecycle GHG impact of the Scheme due to the long-term, cumulative nature of GHG emissions over their lifetime.

6.7.5 Therefore, the net impact of the Scheme is also identified and assessed, taking into account the renewable energy generation and the benefit of this in the context of the wider energy generation sector and the National Grid average GHG intensity. The overall assessment, which will account for all GHG emissions over the lifetime of the Scheme, will compare the GHG intensity of the Scheme with the GHG intensity of other predicted grid energy generation sources.

Construction Effects

6.7.6 The greatest GHG impacts of the Scheme would occur during the construction phase (which is expected to last 24 months from 2025-2027) as a result of the manufacture of the materials and components required. The manufacture of the Solar PV panels is estimated to account for 83,568 tCO_2e. **Table 6-15** summarises the emissions resulting from the manufacture of materials required for the construction of the Scheme.

Table 6-15. Embodied emissions from the manufacture of materials and components

Emissions source	Embodied emissions (tCO2e)	Proportion of total embodied emissions
Solar PV panels	83,568	58%
Solar PV Inverters	21,461	15%
Solar PV Framework	33,473	23%
Transformers	4,634	3.2%
Cables	96	0.1%
Concrete	349	0.24%
Aggregate	44	0.03%
Total products	**143,625**	**100%**

6.7.7 Other sources of emissions during construction within the scope of the Lifecycle GHG impact assessment include water, energy and fuel use for construction activities (including fuel consumed by construction plant and machinery, fuel use for the transportation of construction materials to the Site, transportation of construction workers to and from the Site, and the transportation and disposal of waste).

6.7.8 There will be emissions associated with demolition activities, transportation, and disposal of waste materials from Johnson's Farm (Solar PV Area 1e) and the addition of the new office and welfare building to be erected on the footprint of the farmhouse (and potentially the rebuilding of the single storey barn). The extent of these emissions will depend on the disposal methods used (e.g. landfill, recycling), the proportion of materials reused, and the transportation mode and distance to waste facilities. The farmhouse building and its replacement will have a relatively small footprint of less than 65 m^2 and the barn (which will be demolished and may be rebuilt) has an approximate footprint of 105 m^2 so these works are assumed to have a relatively minimal impact on the overall GHG emissions on a Scheme of this size.

6.7.9 As with other solar farm schemes, land use change is anticipated to have a beneficial impact during the lifetime of the Scheme with the **Framework Soil Management Plan (SMP) [EN010143/APP/7.10]** and **Framework LEMP [EN010143/APP/7.14]** securing mitigation measures to protect species, reinstate soil resources and manage BNG. However, as this beneficial impact is largely reversed during decommissioning, the GHG impact associated with land use change has therefore been excluded from the lifecycle GHG impact assessment. This is assumed to represent a robust worst-case scenario as trees and hedges planted prior to or during construction will be retained throughout decommissioning.

6.7.10 Based on the scheme details and assumptions included in Section 6.4, total GHG emissions from the construction phase are estimated to equate to around 167,877 tCO2e. **Table 6-16** summarises the overall construction emissions from various emissions sources.

Table 6-16. Emissions resulting from the construction phase

Emissions source	Embodied emissions (tCO2e)	Proportion of total embodied emissions
Products and materials	143,625	85.6%
Transportation of products and materials	18,814	11.2%
Worker commuting	1,777	1.1%
Waste (including transport)	2,865	1.7%
Fuel use	795	0.5%
Water use	0.6	0.0004%
Construction total	**167,877**	**100%**

6.7.11 The annual emissions of each phase have been compared to the relevant annualised carbon budgets in **Table 6-17** to enable assessment of the phases individually. To improve the robustness of the assessment and allow for temporal flexibility, the annual construction emissions have also been compared to the 5th Carbon Budget (2028 to 2032).

Table 6-17. UK Carbon Budgets Relevant to Construction Period

Relevant UK Carbon Budget	Annualised UK Carbon Budget (tCO_2e)	Annual construction emissions during Carbon Budget period (tCO_2e)	Construction emissions as a proportion of Carbon Budget
4th (2023 to 2027)	390,000,000	83,938	0.022%
5th (2028 to 2032)	353,000,000	83,938	0.024%

6.7.12 The overall significance of GHG emissions in the context of the UK carbon budgets and the national policy environment has been assessed from Section 6.7.37.

Operational Effects

6.7.13 The operational phase of the Scheme is assumed to be 2027-2067 (i.e., 40 years).

6.7.14 For the assessment, these are the effects that are either permanent, endure for a substantial period beyond construction, or represent an extended

cumulative effect of construction or decommissioning activity. This includes the effects of the physical presence of the energy infrastructure, and its operation, use and maintenance.

6.7.15 GHG emissions sources within the scope of the operational emissions include operational energy use (i.e., for auxiliary services and standby power) and fuel used for the transportation of workers to the Scheme and maintenance activities. Maintenance and transportation cover the following:

a. Embodied carbon in replacement parts;
b. Plant and machinery requirements;
c. Fuel and water use during maintenance activities;
d. Transportation of materials and waste to and from the Site; and
e. Waste management activities.

6.7.16 With the exception of the emissions data for Solar PV panels, which have been derived from an EPD, the embodied carbon factors on which these figures are based are subject to considerable uncertainty, with there being no industry-standard emissions factors for many of these items.

6.7.17 Emissions from the transportation of workers assume three workers on the Site each day, with each worker driving to Site in their own vehicle an estimate of 75km each way. This is assumed to be a conservative assumption that is likely to overestimate the distance travelled. The emissions factor applied is for an average van of unknown fuel, from the most recent conversion factors for company reporting (Ref. 6-40). Based on these assumptions, emissions from commuting are estimated at to be 48 tCO_2e per year, for a total of 1,914 tCO_2e over the 40-year design life of the Scheme.[5] This figure is a highly conservative worst-case scenario, with the actual operational transport emissions likely to be much lower with the inevitable transition to electric vehicles (EV) combined with the ongoing decarbonisation of UK grid electricity.

6.7.18 Emissions from the supply of water and treatment of wastewater have been estimated by applying the same emissions factors as for construction emissions. Based on three workers each consuming 90 litres per day, annual emissions from water and wastewater are estimated at 0.04 tCO2e per year or 1.7 tonnes over the 40-year design life of the Scheme. This is also a conservative assumption, as the carbon intensity of water supply and wastewater treatment are expected to fall over time due to improving technologies. Visits from other, non-permanent staff are not considered to have a material effect on emissions due to their limited expected frequency.

6.7.19 While SF_6 is a potential source of GHG emissions over the lifetime of the Scheme (from its use in certain electric components such as gas-insulated switchgears and transformers during production, operation through leakage, and dismantling), it is not likely to be possible to accurately quantify the small level of fugitive emissions from the leakage of SF_6 due to insufficient data. Manufacturers of electrical switchgear and transformers are increasingly able to provide equipment that either does not contain any SF_6 or is sealed for life with extremely low leakage rates. The Applicant has confirmed that although there will most likely be SF_6 within the switchgear located at the

[5] With rounding to two decimal places. Full calculation: 47.85*40 years = 1,914.12

Field Stations, these will be 'sealed for life' solutions with no leakage expected. This will therefore not be considered further in the assessment and is not expected to have a material impact on the predicted effects on GHG emissions associated with the Scheme (Ref. 6-54).

6.7.20 As presented in **Table 6-18** the operational emissions over the design life of the Scheme are estimated at 65,337 tCO_2e. A total of 97% of this figure results from the supply of replacement components, with the remaining 3% the result of ongoing operational emissions.

Table 6-18. Emissions resulting from the operational phase

Emissions source	Embodied emissions (tCO2e)	Proportion of total embodied emissions
Materials (replacement components)	62,241	95.3%
Transportation of materials	1,104	1.70%
Worker transport	1,914	2.9%
Grid electricity	76	0.12%
Water/wastewater	1.66	0.003%
Operations total	**65,337**	**100%**

6.7.21 The Scheme is expected to be operational by no earlier than 2027, therefore operational emissions up to 2037 (the end of the 6th UK Carbon Budget) will fall under the 5th and 6th UK Carbon Budgets, beyond which point no Carbon Budgets have yet been legislated for.

6.7.22 **Table 6-19** presents the estimated operational emissions against the carbon budget periods during which they arise.

Table 6-19. UK carbon budgets relevant to operational period (up to 2037)

Relevant UK Carbon Budget	Annualised UK Carbon Budget (tCO_2e)	Average annual operational emissions for the Scheme during Carbon Budget period (tCO_2e)	Operational emissions for the Scheme as a proportion of Carbon Budget
5th (2028 to 2032)	353,000,000	1,633	0.0005%
6th (2033 to 2037)	193,000,000	1,633	0.0008%

6.7.23 The overall significance of GHG emissions in the context of the UK carbon budgets and the national policy environment has been assessed from paragraph 6.7.38.

Decommissioning Effects

6.7.24 GHG emissions from the Scheme during decommissioning are subject to a very high degree of uncertainty, as the conditions that will apply over 40 years into the future (i.e. 2067) cannot be described with any confidence. Conservatively, for the purpose of this assessment it is assumed that decommissioning emissions from the use of plant, worker travel, water and wastewater consumption would be set at 100% of the corresponding emissions during the construction phase. As the economy decarbonises over the coming years in line with national policy, emissions from sources such as worker transport and waste disposal are anticipated to be much lower. Therefore, this is very likely to be a highly conservative estimate which overestimates decommissioning emissions.

6.7.25 Emissions from the disposal and recovery of materials and components at the end of the Scheme's design life have been estimated based on an assumption that 70% of materials and components will be recovered at the end of life, with 30% going to landfill, together with the most recent emissions factors for recycling published by the UK Government. This is also likely to be a conservative estimate as it is expected that a higher proportion of materials will be recycled. Emissions from end-of-life disposal of all materials and products are estimated at 917 tCO_2e.

6.7.26 Emissions from the transportation of materials and products at end-of-life have been estimated on the assumption that concrete and aggregate will be disposed of within a 50km radius of the Site, while all other products will be disposed of within 200km. Applying the most recent Department for Business, Energy & Industrial Strategy (BEIS) emissions factor (Ref. 6-11) for heavy goods vehicle (HGV) travel gives end of life transport emissions of 3,488 tCO2e. This is very likely to be a highly conservative estimate as HGV transport decarbonises in the future.

6.7.27 Land use change has been excluded from the GHG assessment as discussed in paragraph 6.7.9, due to the beneficial GHG impacts of conversion of arable land to grassland during operation (increased carbon storage in soil and vegetation , being reversed following decommissioning and the reversion of the land to arable farming (carbon stored in soil or vegetation re-released to the atmosphere). This is considered to be a robust worst-case approach and likely to underestimate the beneficial effect of the Scheme, as tree and hedgerow planting may be retained after decommissioning. Any carbon sequestered in these areas would remain in the ground following decommissioning.

6.7.28 **Table 6-20** summarises the emissions expected to result from the decommissioning phase under this worst-case scenario.

Table 6-20. Emissions resulting from the decommissioning phase

Emissions source	Embodied emissions (tCO2e)	Proportion of total embodied emissions
Transportation of materials	3,488	50%
Worker commuting	1,777	25%
Fuel use	795	11%

Emissions source	Embodied emissions (tCO2e)	Proportion of total embodied emissions
Waste recycling/disposal	917	13%
Water use	0.60	0%
Decommissioning Total	**6,978**	**100%**

6.7.29 As above for the operational phase, the decommissioning GHG footprint is considered to reflect a robust worst-case scenario as the calculations have been carried out using current emissions factors. By 2065, GHG emissions associated with energy generation, transportation, operation of plant, and waste disposal throughout the supply chain are anticipated to be much lower as a result of grid decarbonisation and machinery, and vehicle electrification in line with the UK's Net Zero carbon emissions target for 2050.

Carbon Intensity of the Scheme

6.7.30 Renewable energy generation from the Scheme during the first full year of operation (2027) is estimated to be 433,709 MWh based on a 480MW capacity of the Scheme, a typical 922 kWh/kWp/yr (kilowatt hour per kilowatt-peak per year) yield and a 2% reduction in Solar PV Panel performance during the first year. A 0.45% degradation factor has been applied for each subsequent year, resulting in an estimated energy generation figure of 363,754 MWh in the final year of operation (2067), and a total energy generation figure of approximately 15.9 TWh over the 40-year Scheme lifetime. Tracking panels have the potential to achieve a much higher efficiency, so this scenario represents a conservative estimate for total lifetime generation and a worst-case scenario for assessing the GHG savings from the Scheme.

6.7.31 A carbon intensity value represents how many grams of CO_2 are released to produce a kilowatt hour (kWh) of electricity. Dividing the lifetime total energy generation figure into the lifetime emissions total of 240,191 tCO_2e gives a total carbon intensity value of 15.1 gCO_2e/kWh (grams of carbon dioxide equivalent per kilowatt hour).

6.7.32 The current UK grid carbon intensity is 212 gCO_2e/kWh, however these figures cannot be directly compared as the published UK grid carbon intensity figure only takes into account operational emissions from the generation of electricity, overwhelmingly from the fossil fuels used to power gas-fired and occasionally coal-fired power stations (Ref. 6-44). For a meaningful comparison to be made between the Scheme and the UK grid, the operational carbon intensity of the Scheme must only include emissions from the ongoing operations of the Scheme and exclude emissions from construction and decommissioning.

6.7.33 Combining lifetime generation figures and operational emissions figures gives an operational carbon intensity value of 4.1 gCO_2e/kWh.

6.7.34 Comparing the Scheme against a gas fired CCGT generating facility (currently the most carbon-efficient fossil-fuelled technology available), a representative figure for the carbon intensity of a CCGT is 354 gCO_2e/kWh (Ref. 6-30). The operational intensity of the Scheme is therefore 98.8% lower than that of the counterfactual CCGT. Each kWh of electricity generated by

the Scheme will emit 350g CO_2e less than if it was generated by a gas fired CCGT generating facility.

6.7.35 Combining this figure with the estimated lifetime output from the Scheme indicates an overall lifetime carbon reduction, relative to the counterfactual CCGT, of over 5.5 million tCO_2e. This figure is lower than the savings estimated in the PEI Report (i.e., approximately 7 million tCO_2e), as more accurate design data has reduced the need for benchmarking against other comparable Schemes.

6.7.36 A range of other low-carbon electricity generation technologies are available, such as on- and offshore wind, biomass and nuclear power. Each of these technologies will have a different carbon intensity in terms of total emissions per kWh of electricity generated. A literature review indicates a range of carbon intensity figures for each power source, making it challenging to directly compare the carbon impact of a specific installation, such as the Scheme, with data for a broad generation technology.

6.7.37 As the UK electricity sector continues to decarbonise, a range of different low-carbon generation technologies will be required to support an electricity generation system that can balance emissions reductions, security of supply and affordability.

Overall GHG Impact and Significance

6.7.38 In light of UK's climate objective to achieve Net Zero carbon by 2050, and in line with IEMA guidance for assessing GHGs (Ref. 6-22), the UK's Fourth, Fifth and Sixth Carbon Budgets have been used to contextualise emissions from the Scheme.

Construction

6.7.39 Annual emissions from the construction of the Scheme (and their magnitude) are compared to the significance definitions outlined in **Table 6-4.** In line with IEMA criteria for assessing the significance of GHG impacts (Ref. 6-22), construction of the Scheme can be assumed to be consistent with applicable existing and emerging policy requirements. The GHG impact from construction is therefore determined to be **minor adverse** and **not significant**.

6.7.40 As the Scheme directly supports the UK policy environment of decarbonising electricity generation, as laid out in the CCC's 6th Carbon Budget Advice, Methodology and Policy reports (Ref. 6-42), it can be considered to be aligned with the UK's overall trajectory to Net Zero. The National Grid cannot and will not decarbonise without investments in low carbon electricity generation projects like the Scheme.

Operation

6.7.41 The Scheme results in some operational emissions associated with maintenance and worker travel. However, the benefits of generating renewable energy from the Scheme far outweigh the associated emissions as demonstrated in paragraphs 6.7.30 to 6.7.37. Annual emissions from the operation of the Scheme (and their magnitude) are compared to the significance definitions outlined in **Table 6-4.**

6.7.42 As stated in the IEMA guidance on assessing GHG emissions (Ref. 6-22), *"…the crux of significance therefore is not whether a project emits GHG*

emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050".

6.7.43 The Scheme's operational phase indirectly causes a reduction in atmospheric GHG concentration compared to the without-project baseline and aligns with a trajectory towards Net Zero. The GHG impact of the operational phase is therefore considered to be **beneficial** and **significant** when compared to the future baseline 'business-as-usual' scenario – as described above from paragraph 6.7.30.

6.7.44 Based on the assumptions outlined in section 6.4, it would take three years of operation (2027 to 2029) to break even on the cumulative emissions savings from the operation of the Scheme in comparison to a CCGT (446,207 tCO_2e) and the total lifetime emissions of the Scheme (240,191 tCO_2e).

Decommissioning

6.7.45 While there are expected to be GHG emissions associated with the decommissioning phase of the Scheme, actual emissions are anticipated to be lower than the figures presented in **Table 6-20** which represents a robust worst-case scenario. Therefore, the magnitude of impact is considered to be low.

6.7.46 GHG emissions from the decommissioning phase are therefore considered to have a **minor adverse** effect on climate change which is **not significant** effect. As noted in the significance definitions in **Table 6-4**, a negligible effect is not possible where any GHG emissions are released to the atmosphere. However, while there are residual emissions, the Scheme aligns with and contributes to the relevant transition scenario to keep the UK on track towards Net Zero by 2050 and thereby potentially avoiding significant adverse effects (Ref. 6-22).

Summary

6.7.47 The GHG impact of construction and decommissioning are anticipated to result in minor adverse and non-significant effects on climate change. The impact of operations is considered to have a beneficial**,** significant effect due to the operational carbon intensity remaining below that of a gas fired CCGT generating facility throughout its lifetime, its role in achieving the rate of transition required by nationally set policy commitments, and supporting the trajectory towards Net Zero.

6.7.48 The without-project baseline alternative of a CCGT facility would result in substantially higher GHG emissions. As stated in the latest IEMA guidance (Ref. 6-22), "…*a project that causes GHG emissions to be avoided or removed from the atmosphere has a beneficial effect that is significant"*. This Scheme demonstrates an indirect reduction in atmospheric GHG concentration and avoidance of emissions; therefore, it is overall beneficial and has a positive impact on climate change which is considered to be significant.

6.7.49 The GHG savings achieved throughout the lifetime of the Scheme, of over 5.5 million tCO_2e, demonstrates the role solar energy generation has to play in the transition to, and longer-term maintenance of, a low carbon economy. Without low-carbon energy generation projects such as the Scheme, the

average grid GHG intensity will not decrease as is projected, which would adversely affect the UK's ability to meet its carbon reduction targets.

Climate Change Resilience Assessment

6.7.50 Potential climate risks to the construction, operation and decommissioning phase, including the likelihood, consequence and significance are detailed in **Appendix 6-2, ES Volume 2 [EN010143/APP/6.2]**.

6.7.51 Future climate projections have been reviewed and the sensitivity of assets have been examined, before commenting on the adequacy of the embedded climate change mitigation measures built into the Scheme.

Construction Effects

6.7.52 The risks assessed in the CCRA at the construction phase of the Scheme predominantly cover workforce exposure to dangerous working conditions and damage to physical structures/asset damage.

6.7.53 Major climatic variables contributing to these risks include, but are not limited to, increased temperatures, flooding, and storms.

6.7.54 As a result of the embedded climate change mitigation measures (as presented in Section 6.6), it is concluded that all climate change risks during the construction phase have been identified to be **negligible to low** and **not significant**.

Operation Effects

6.7.55 The risks assessed in the CCRA at the operational phase of the Scheme predominantly encapsulate asset damage from extreme weather conditions and changes in annual precipitation and temperatures, as well as workforce exposure to dangerous working conditions.

6.7.56 Major climatic variables contributing to these risks are temperatures, precipitation, and extreme weather events.

6.7.57 As a result of the embedded climate change mitigation measures (as presented in Section 6.6), it has been concluded that all climate change risks during the operation phase have been identified to be **negligible to low** and **not significant**.

Decommissioning Effects

6.7.58 The risks assessed in the CCRA at the decommissioning phase of the Scheme are mainly made up of risks to the workforce.

6.7.59 These risks are driven by climatic variables like increased temperatures, rainfall, and extreme weather events.

6.7.60 As a result of the embedded climate change mitigation measures (as presented in Section 6.6), it has been concluded that all climate change risks during the construction phase have been identified to be **negligible to low** and **not significant**.

In-combination Climate Change Impact Assessment

6.7.61 Potential ICCIs, including the likelihood, consequence, and significance are detailed in **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**.

6.7.62 Future climate projections have been reviewed and the sensitivity of receptors to both climate change and the Scheme have been examined, before commenting on the adequacy of the climate change resilience measures built into the Scheme.

6.7.63 As a result of the embedded mitigation and good practice measures (as presented in section 6.6 and the respective sections in the technical chapters (**Chapters 7 to 16, ES Volume 1 [EN010143/APP/6.1]**)), it is concluded that all ICCIs during the construction, operation, or decommissioning phase have been identified to be **not significant**.

6.8 Additional Mitigation, Enhancement, and Monitoring

6.8.1 Additional mitigation measures are only required where significant effects are identified following the application of embedded mitigation measures. No significant adverse effects have been identified in this assessment therefore no additional mitigation or enhancement measures are proposed.

Monitoring

6.8.2 As no potential significant effects have been identified for climate change, no monitoring of significant effects is required and/or proposed.

6.9 Residual Effects

6.9.1 This section summarises the residual significant effects of the Scheme on climate change following the implementation of embedded and additional mitigation.

6.9.2 The residual effects are the same as presented in section 6.7.

6.9.3 **Table 6-21 to Table 6-23** summarise the residual effects.

Table 6-21. Residual effects – Climate change (construction)

Receptor	Description of impacts including duration	Embedded mitigation	Significance of effect with embedded mitigation	Additional mitigation/enhancement measures	Residual effect
Global atmosphere	Impact of GHG emissions arising during construction of the Scheme on the climate	Best practice measures in the Framework CEMP.	Minor adverse – Not significant	Not required.	Minor adverse – Not significant
The Scheme	Impact of projected future climate change on the Scheme	Best practice measures in the Framework CEMP.	Negligible to Low – Not significant	Not required.	Negligible to Low – Not significant
Various identified by each discipline in their assessment	Combined impact of future climate conditions and the Scheme	As presented in **Chapters 7 to 16, ES Volume 1 [EN010143/APP/6.1]**.	Negligible to Low – Not significant	Not required.	Negligible to Low – Not significant

Table 6-22. Residual effects – Climate change (operation)

Receptor	Description of impacts including duration	Embedded mitigation	Significance of effect with embedded mitigation	Additional mitigation/enhancement measures	Residual effect
Global atmosphere	Impact of GHG emissions arising during operation of the Scheme on the climate	Best practice measures in the Framework OEMP.	Beneficial – Significant	Not required.	Beneficial – Significant
The Scheme	Impact of projected future climate change on the Scheme	Adaptation measures to reduce the effect of projected temperature increases on electrical equipment. Consideration will also be given to the UKCP18 climate change projections, and the resilience of the Scheme's infrastructure to these, through the detailed design process.	Negligible to Low – Not significant	Not required.	Negligible to Low – Not significant

Receptor	Description of impacts including duration	Embedded mitigation	Significance of effect with embedded mitigation	Additional mitigation/enhancement measures	Residual effect
Various identified by each discipline in their assessment	Combined impact of future climate conditions and the Scheme	As presented in **Chapters 7 to 16, ES Volume 1 [EN010143/APP/6.1]**.	Negligible to Low – Not significant	Not required.	Negligible to Low – Not significant

Table 6-23. Residual effects – Climate change (decommissioning)

Receptor	Description of impacts including duration	Embedded mitigation	Significance of effect with embedded mitigation	Additional mitigation/enhancement measures	Residual effect
Global atmosphere	Impact of GHG emissions arising during decommissioning of the Scheme on the climate	Best practice measures in the Framework DEMP.	Minor adverse – Not significant	Not required.	Minor adverse – Not significant
The Scheme	Impact of projected future climate change on the Scheme	Best practice measures in the Framework DEMP.	Negligible to Low – Not significant	Not required.	Negligible to Low – Not significant

Receptor	Description of impacts including duration	Embedded mitigation	Significance of effect with embedded mitigation	Additional mitigation/enhancement measures	Residual effect
Various identified by each discipline in their assessment	Combined impact of future climate conditions and the Scheme	As presented in **Chapters 7 to 16, ES Volume 1 [EN010143/APP/6.1]**.	Negligible to Low – Not significant	Not required.	Negligible to Low – Not significant

6.9.4 As set out in **Appendix 6-2, ES Volume 2 [EN010143/APP/6.2]** and **Appendix 6-3, ES Volume 2 [EN010143/APP/6.2]**, no significant adverse effects of climate change to or because of the Scheme were identified in either the ICCI assessment or CCRA.

6.9.5 Furthermore, as set out in Section 6.7, the significant effects on the climate identified in the operational GHG assessment are beneficial significant owing to atmospheric GHG emissions being avoided by the Scheme and the Scheme's alignment with the UK's Net Zero trajectory. The GHG impact of construction and decommissioning are anticipated to result in **minor adverse (non-significant)** effects on the climate and would be balanced by the beneficial effect during operation. Therefore, the residual effects remain **not significant**.

6.10 Cumulative Effects

6.10.1 This section assesses the potential effects of the Scheme in combination with the potential effects of other proposed and committed plans and projects including other developments (referred to as 'cumulative schemes') within the surrounding area.

6.10.2 The cumulative schemes to be considered in combination with the Scheme have been agreed in consultation with relevant Local Planning Authorities and are listed in **Appendix 17-2, ES Volume 2 [EN010106/APP/6.2].** The cumulative assessment methodology is presented within **Chapter 5: EIA Methodology, ES Volume 1 [EN010106/APP/6.1].**

6.10.3 This cumulative effect assessment identified, for each receptor, the areas where the predicted effects of the Scheme could interact with effects arising from other plans and, or projects on the same receptor based on a spatial and, or temporal basis.

6.10.4 Climate change is inherently the result of cumulative impacts as it is the result of innumerable minor activities. A single activity may itself result in a minor or insignificant impact, but when combined with many other activities, the cumulative impact could be significant. The nature of GHGs is such that their impact on receptors (i.e., the global climate) is not affected by the location of their source. The GHG emissions assessment by its nature is a cumulative assessment and considers whether the Scheme would contribute significantly to emissions on a national level.

6.10.5 The global atmosphere is the receptor for climate change impacts and has the ability to hold GHG emissions. As noted in the third principle of considering the aspect of significance in the IEMA guidance (Ref. 6-22), "*GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant*". While the impact of any individual scheme may be limited, it is the cumulative impact of many schemes over time that could have a significant impact on climate change.

6.10.6 As such it is not possible to define a study area for the assessment of cumulative effects on GHG emissions; nor to undertake a cumulative effects assessment, as the identified receptor is the global climate and effects are therefore not geographically constrained. Consequently, consideration of the

effects of the Scheme together with other developments on GHG emissions is not considered to be applicable.

6.10.7 Further to this, the overall beneficial GHG impact of the Scheme does not have the potential to act cumulatively with other Schemes to contribute to a significant adverse effect, and subsequently does not require a cumulative impact assessment.

6.10.8 It should also be noted that other schemes falling under the EIA Regulations will also need to consider climate change assessment within their own planning application.

6.10.9 The ICCI assessment is, by nature, a cumulative assessment, and any effects are detailed in **Appendix 6-3, ES Volume 2 [EN010106/APP/6.2].**

6.10.10 As the CCRA is only concerned with the assets of the Scheme and a broader consideration of existing interdependent infrastructure, a cumulative assessment is not required.

6.11 References

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