



High Grove Solar

Preliminary Environmental Information Report

Chapter 7 Climate Change

April 2025

Contents

7	Climate Change	1
7.1	Introduction	1
7.2	Relevant legislation, policy, standards and guidance	2
7.3	Consultation	10
7.4	Study area	10
7.5	Assessment methodology	12
7.6	Baseline conditions	26
7.7	Design Principles, embedded and good practice measures	35
7.8	Assessment of effects	37
7.9	Additional mitigation	48
7.10	Residual effects	48
7.11	Monitoring	48
7.12	Opportunities for enhancement	48
7.13	Summary	48
	References	52

Tables

Table 7-1	Climate Change - Legislation	3
Table 7-2	Climate Change - Policy	4
Table 7-3	Standards and guidance	7
Table 7-4	Potential impacts of the Proposed Development during the construction stage	13
Table 7-5	Summary of the potential operational impacts and emission sources	14
Table 7-6	Measure of receptor susceptibility to climatic impact	20
Table 7-7	Measure of receptor vulnerability to climatic impact	20
Table 7-8	Definitions of the likelihood of the climate impact affecting the receptors	21
Table 7-9	Consequence of climatic impact and the description of varying consequence of impact on the receptor	21
Table 7-10	Significance criteria for assessment of impacts from greenhouse gas emissions	23
Table 7 -11	Significance criteria for climate resilience	24
Table 7-12	Baseline BaU emissions scenario (Be) for natural gas equivalent (fixed panels)	29
Table 7-13	Baseline BaU emissions scenario (Be) for natural gas equivalent (tracking panels)	29
Table 7-14	Projected Global Impacts of Climate Change	30
Table 7-15	Quantitative summary of the future baseline for key climatic variables for the draft Order Limits.	34
Table 7-16	Absolute emissions (Ab) of the Proposed Development (fixed panels)	37
Table 7-17	Absolute emissions (Ab) of the Proposed Development (tracker panels)	38
Table 7-18	Estimated Embodied Carbon for the Proposed Development (fixed panels)	39
Table 7-19	Estimated Embodied Carbon for the Proposed Development (tracker panels)	40

Table 7-20	Total emission savings of the Proposed Development compared to natural gas equivalent (fixed panels)	41
Table 7-21	Total emission savings of the Proposed Development compared to natural gas equivalent (tracker panels)	41
Table 7-22	Likely significant effects of climate change that may affect the Proposed Development	42
Table 7-23	Assessment of Susceptibility and Vulnerability of receptors during construction	42
Table 7-24	Assessment of Magnitude of climate change Impacts during construction	43
Table 7-25	Assessment of Significance of climate change effects during construction	43
Table 7-26	Assessment of Sensitivity of receptors during operation	44
Table 7-27	Assessment of Magnitude of climate change Impacts during operation	44
Table 7-28	Assessment of Significance of climate change effects during operation	45
Table 7-29	Assessment of Susceptibility and Vulnerability of receptors during decommissioning	46
Table 7-30	Assessment of Magnitude of climate change Impacts during decommissioning	47
Table 7-31	Assessment of Significance of climate change effects during decommissioning	47
Table 7-32	Climate Change (assessment of GHG emissions) - Preliminary assessment summary	49
Table 7-33	Climate Change (assessment of climate resilience) - Preliminary assessment summary	49

Insets

Inset 7-1	Simplified modular lifecycle stages for EIA GHG emissions assessment [20]	11
Inset 7-2	The GHG emissions assessment scope includes the before use stage (A), the use stage (B) and the end of life stage (C)	12
Inset 7-3	Different levels of significance plotted against the UK's net zero compatible trajectory (adapted from IEMA, 2022 [23])	22
Inset 7-4	Different levels of significance plotted against the UK's net zero compatible trajectory (adapted from IEMA)	28
Inset 7-5	Projected changes in mean seasonal air temperature across four RCP scenarios, from 2024 - 2100 compared to the 1981 - 2000 baseline, using the probabilistic projections (50th Percentile)	32
Inset 7-6	Projected changes in maximum seasonal air temperature across four RCP scenarios, from 2024 - 2100 compared to the 1981 - 2000 baseline, using the probabilistic projections (50th Percentile)	33
Inset 7-7	Projected changes in seasonal precipitation rate (%) across four RCP scenarios, from 2023 - 2100 compared to the 1981 - 2000 baseline, using the probabilistic projections (50th Percentile)	34

Appendices

Appendix 7.1 Climate Change Supporting Evidence

7 Climate Change

7.1 Introduction

- 7.1.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the findings of the preliminary assessment of the likely significant effects arising from the construction, operation and decommissioning of the Proposed Development on Climate Change.
- 7.1.1.2 This chapter sets out the relevant legislation, policy, standards and guidance applied to the assessment process; consultation undertaken to inform the assessment; assessment methodology; the relevant baseline conditions upon which the assessment is based; embedded and good practice mitigation considered in place before the assessment is undertaken; the likely significant effects that may arise as a result of the Proposed Development considering embedded and good practice mitigation; and any further mitigation requirements to avoid or reduce the likely significant effects; the remaining residual effects following further mitigation; and any monitoring required for remaining significant effects.
- 7.1.1.3 The following matters have been assessed as part of this chapter:
- **Greenhouse gas emissions:** An assessment on the potential effects of greenhouse gas emissions (GHG) from the Proposed Development on the climate through an assessment of whole life carbon. This includes an overview of how the Proposed Development aids in the mitigation of climate change.
 - **Climate resilience:** A review of the resilience of the Proposed Development to the potential effects arising from projected changes in future climate. This includes a qualitative discussion of the vulnerability and sensitivity of the Proposed Development to climate change impacts, with an assessment of the magnitude of impacts and their potential effects.
- 7.1.1.4 Understanding intra-project effects between topics is an integral part of the Environmental Impact Assessment (EIA) process and have therefore been considered within this chapter. The assessment of all other topics assessed within the PEIR forms part of the climate resilience assessment, and as such are taken into account in the overall assessment for Climate Change. For example, the impact of climate change on other topics over the project lifetime could influence their significance of effects. However, it is not feasible to accurately predict or assess the impact climate change will have on a particular discipline due to the scale of variability associated with climatic changes and the lack of data available at a local level.
- 7.1.1.5 This chapter is supported by the following appendix:
- Appendix 7.1 Climate Change Supporting Evidence

7.2 Relevant legislation, policy, standards and guidance

- 7.2.1.1 This section identifies the relevant legislation, planning policy, standards and guidelines which have informed this assessment, including the methodology and identification of mitigation.

7.2.2 Legislation

Table 7-1 Climate Change - Legislation

Legislation	Relevance to assessment
The Climate Change Act 2008, as amended by the Climate Change Act (2050 Target Amendment) Order 2019 [1] The Act creates a framework which enables the UK to meet its domestic targets as well as ensuring the UK can meet its existing and future international commitments for emissions reductions. The Act provides a pathway to achieving long-term carbon reduction goals by setting legally binding carbon limits in its 'carbon budgets'. These oblige the Government to put in place policies to help facilitate delivery of emission reduction, for example, by enabling low carbon generation schemes to take place where impacts can be shown to be acceptable. The Amendment Order increases the minimum percentage by which the net UK carbon account for the year 2050 must be lower than the 1990 baseline from 80% to 100%.	This assessment considered the whole life carbon impact of the Proposed Development, which detailed the relative carbon savings that of the Proposed Development against natural gas alternative. The Proposed Development emission savings will make a marked contribution to the UK meeting the 2050 target. Evidence is detailed in section 7.8.
The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 [2] This legislation sets out the requirements for assessment within the EIA framework: "5.2 The EIA must identify, describe and assess in an appropriate manner, in light of each individual case, the direct and indirect significant effects of the proposed development on the following factors—[inter alia] c) land, soil, water, air and climate;" Schedule 4 provides further information: "INFORMATION FOR INCLUSION IN ENVIRONMENTAL STATEMENTS ... 4. A description of the factors specified in regulation 5(2) likely to be significantly affected by the development: [inter alia] climate (for example greenhouse gas emissions, impacts relevant to adaptation)..."	This chapter (in section 7.8) categorically addresses the direct and indirect significant effects on the global climate, as well as the impacts on the global climate on the Proposed Development.

Legislation	Relevance to assessment
5. A description of the likely significant effects of the development on the environment resulting from, inter alia— (f)the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change;	

7.2.3 Policy

Table 7-2 Climate Change - Policy

Policy	Relevance to assessment
Overarching National Policy Statement for Energy (NPS EN-1) [3] EN-1 highlights the importance of decarbonizing electricity grid and role of renewable technologies within that. Solar power has been categorized as one of the most affordable electricity supplies as it is not reliant on fuel supply. Section 4.10 of this sets out the generic considerations that applicants should consider to ensure that electricity networks infrastructure is resilient to the effects of climate change. It states that “applicants should demonstrate that proposals have a high level of climate resilience built-in from the outset and should also demonstrate how proposals can be adapted over their predicted lifetimes to remain resilient to a credible maximum climate change scenario. These results should be considered alongside relevant research which is based on climate change projections”. Section 4.10 of EN-1 advises that the “resilience of the project to the effects of climate change must be assessed in the Environmental Statement (ES) accompanying an application”. Section 5.3.4 outlines the contents of GHG assessments for energy infrastructure projects. These include:	The climate resilience mitigation measures are a central part of this assessment and are detailed in section 7.7 Greenhouse gas emissions and the associated whole life carbon emissions are covered in section 7.8; and mitigation measures to address the reduction in operational emissions are highlighted in section 7.7.

Policy	Relevance to assessment
• “A whole life GHG assessment showing construction, operational and decommissioning GHG impacts, including impacts from change of land use. • An explanation of the steps that have been taken to drive down the climate change impacts at each of those stages. • Measurement of embodied GHG impact from the construction stage. • How reduction in energy demand and consumption during operation has been prioritised in comparison with other measures. • How operational emissions have been reduced as much as possible through the application of best available techniques for that type of technology. • Calculation of operational energy consumption and associated carbon emissions. • Whether and how any residual GHG emissions will be (voluntarily) offset or removed using a recognised framework. • <i>Where there are residual emissions, the level of emissions and the impact of those on national and international efforts to limit climate change, both alone and where relevant in combination with other developments at a regional or national level, or sector level, if sectoral targets are developed”.</i>	
NPS for Renewable Energy Infrastructure (EN-3) [4] Para 2.4.11 of EN-3 states “Solar photovoltaic (PV) sites may also be proposed in low lying exposed sites. For these proposals, applicants should consider, in particular, how plant will be resilient to: • increased risk of flooding; and • <i>impact of higher temperatures.”</i>	This assessment states what mitigation measures have been applied within the section 7.7 to ensure the Panel Areas are resilient to increases in flooding and higher temperatures.
NPS for Electricity Networks Infrastructure (EN-5) [5] Section 2.3 of EN-5 on climate change adaptation and resilience states that applicants should consider any impact on the development from flooding, effects of wind and storms on overhead lines, storms, ground and coastal movements and droughts.	This assessment states what mitigation measures have been applied within the section 7.7 to ensure the Panel Areas are resilient to the aforementioned points.
National Planning Policy Framework (NPPF) 2023 [6] The NPPF highlights national transition to low carbon future in a changing climate and emphasizes the need for the increased supply of renewable and low carbon energy. Relevant policies to climate change, can be found in Chapter 14, <i>‘Meeting the challenge of climate change, flooding and coastal change’</i>.	This assessment addresses the requirement to reduce greenhouse emissions, whilst ensuring the development minimises vulnerability and is resilient to a changing climate. This will support the NPPF objectives stated here.

Policy	Relevance to assessment
Paragraph 157 states that the planning system should, inter alia, "support the transition to a low carbon future in a changing climate", "shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience", and "support renewable and low carbon energy and associated infrastructure". Paragraph 158-164 provides instructions on planning requirements for new developments in relation to climate change.	
UK Climate Change Risk Assessment Third National Adaptation Programme (NAP3) [7] NAP3 sets out the actions that government and others will take to adapt to the impacts of climate change from 2023 to 2028. NAP3 sets out actions for infrastructure (including energy). It recognises "<i>as the energy system decarbonises and other infrastructure systems electrify to meet the UK's net zero targets, the exposure of the energy system to climate hazards will change. Continuing to embed climate resilience in both the current and future energy systems is therefore essential to securing our energy supply.</i>"	This assessment states what mitigation measures have been applied within the section 7.7 to ensure the Panel Areas are resilience to the aforementioned points.
The Clean Growth Strategy [8] This strategy document sets out key policies and proposals to accelerate clean growth. It projects power sector emissions, taking into account the clean growth pathway between 1990 and 2050.	The reduction in GHG emissions evidenced within section 7.8 of the PEIR assessment will contribute towards the Clean Growth Strategy targets.
Sixth Carbon Budget [9] The Carbon Budget Order 2021 sets the carbon budget for the sixth budgetary period (2033-2037) (the sixth carbon budget), at 965 million tonnes of carbon dioxide equivalent	This report provides additional justification to support emissions reduction as part of the EIA process.
Energy Security Strategy [10] The Energy Security Strategy is a proposal that intends to speed up the UK's efforts towards a low-carbon, energy-independent future. Its primary aim is to expand the number of sources of home-grown, low-carbon energy (such as Solar PV) in the UK over the next 20 years.	The Proposed Development is a large solar farm which will provide support to the aims of the Energy Security Strategy.
UK's Nationally Determined Contribution [11] The UK's Nationally Determined Contribution (NDC) was updated in 2022. The UK commits to reducing economy-wide greenhouse gas emissions by at least 68%, compared to 1990 levels.	The reduction in GHG emissions evidenced within section 7.8 of the PEIR assessment will contribute towards the NDC target.
Breckland Council Local Plan 2019 (Partial update in 2023) [12]	This assessment comprehensively meets the Breckland Council LDP as well as core policy

Policy	Relevance to assessment
The Breckland Council Local Development Plan (LDP) was adopted in 2019 and had a partial update in 2023. Breckland’s Strategic Vision states ‘new growth will be balanced, ensuring that the District adapts to, and mitigates against the impacts of climate change.	requirements listed. Policies GEN 01, COM 01 and ENV 01 are all addressed in section 7.7.
Policy GEN 01 – “The Local Plan will seek and enable development that improves the economic, social and environmental objectives of Breckland through the application of the following national and locally distinctive sustainable development principles:	
• Mitigate and adapt to climate change”	
Policy COM 01 – Design requires new development to be ‘designed to the highest possible standards’. This policy requires new development “ <i>Incorporates sustainable design and durable construction, observing best practice in energy efficiency and climate change mitigation, and is accessible and adaptable to different activities and land uses and the changing needs of all, including disabled and older people</i> ”	
Policy ENV 01 Green Infrastructure. “ <i>Green infrastructure performs many functions and plays a significant role in helping to attract people, employment and investment to the District. Green infrastructure also helps in meeting social and environmental goals, such as encouraging active, healthy lifestyles and helping the District to be resilient to more frequent occurrence of extreme weather events resulting from climate change.</i> ”	

7.2.4 Standards and guidance

Table 7-3 Standards and guidance

Standards	Relevance to assessment
Environmental Impact Assessment: Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022), Institute of Environmental Management and Assessment [13]	The methodology for this assessment, as described in section 7.5, was developed in accordance with this guidance and therefore this assessment covers the whole life carbon emissions and provides a robust worst-case scenario in the proportionate assessment reported in section 7.8.
This is the most recent guidance available and is applicable to the UK. It is also considered to be the most holistic method of assessing GHG emissions as it applies a whole lifecycle methodology, incorporating not just the construction and operational phase of a development,	

but also the decommissioning/end of life and beyond asset lifecycle stages. The whole lifecycle methodology allows for a more robust 'worst case scenario' to be applied which is proportionate to the nature and scale of the Proposed Development.

Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation (2020), Institute of Environmental Management and Assessment [14]	This guide has been applied to the assessment of resilience of the Proposed Development to climate change as this is the most recent available and is applicable to the UK.
The European Investment Bank (EIB) 'EIB Project Carbon Footprint Methodologies. Methodologies for the Assessment of Project GHG Emissions and Emissions Variations' (2023), Version 11.3, European Investment Bank [15]	This guidance was used to expand upon the Institute of Environmental Management and Assessment (IEMA) guidance to establish the baseline scenarios for the assessment. This goes into greater detail in terms of a baseline methodology and allows for easier comparison of impacts where there is no prior development in an area.
Royal Institution of Chartered Surveyors (RICS), 'Whole life carbon assessment for the built environment' (2nd Edition, Version 2, 2023); [16]	Solar farms fall under the category of 'Power-generation plants' in infrastructure assets/civil engineering works, which are applicable for such assessments as listed in annex D of the guideline.
This document provides comprehensive guidance for industry professionals to calculate and report on the quantity of carbon impacts expected throughout all life cycle stages of a project, from manufacturing, transport, installation, use and end of life. It also considers assessment of the potential benefits and loads occurring beyond the system boundary.	This assessment meets the guidelines provided within the RICS document, and section 7.4.1.3 describes the life cycle stages considered within the report.
Assessment is required 'during the early design, technical design, construction and post-completion phases of a project, in order to be integrated into the decision-making framework for a project'.	
BSI - PAS 2080:2023 'Carbon Management in Buildings and Infrastructure' (2023), The Green Construction Board, Construction Leadership Council, the British Standards Institution. [17]	The Proposed Development will contribute towards the governments net zero pathway as the solar farm will provide significant emissions savings relative to the natural gas equivalent. The comparison and emission savings are detailed in section 7.8.
This provides guidance for whole life carbon management in infrastructure and any development to be in line with Government's Net Zero 2050 pathway.	
United Nations Economic Commission Europe's (UNECE), 'Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources' (2022); United Nations [18]	This assessment uses this guidance to provide a Whole Life Cycle (WLC) assessment of the natural gas equivalent by using the emissions factor of 0.203 kilograms of carbon dioxide equivalent per kilowatt hour (kgCO ₂ e/kWh) to calculate the baseline B emissions in section 7.6.2.
The report presents an assessment of various electricity generation technologies and their associated environmental impacts across its various metrics such as health, ecosystems, and	

resource requirement through their life cycle. It also provides an update on existing data and the status of the technology in the international context.

It gives information on global statistics of solar PV, comparison of different life cycle inventories, specific environmental impacts associated with each PV technology such Silicon-based or thin film based, ground-mounted or roof-mounted etc. The document also provides information on energy storage, comparison of lifecycle impacts of selected electricity storage options which could be useful in the design stage and during considering alternatives that have a minimum carbon footprint.

7.3 Consultation

7.3.1 Scoping Opinion

- 7.3.1.1 An EIA Scoping Report was submitted to PINS on 6 September 2024, and a Scoping Opinion was published by the Planning Inspectorate on 17 October 2024. A summary of the key comments received and how these have been addressed in this assessment or will be addressed in the Environmental Statement (ES) is presented in this section.
- 7.3.1.2 The Scoping Report explains that the Proposed Development is not located in an area that is susceptible to high levels of snow or cloud cover or sea level rise. The Planning Inspectorate agreed that the Proposed Development is therefore unlikely to be significantly affected by these climate conditions and is content to scope these matters out.
- 7.3.1.3 The Scoping Report proposed to scope out an In-combination Climate Change Impacts Assessment (ICCI) assessment for all project phases. The Planning Inspectorate agreed that the Proposed Development, in combination with changes in temperature, precipitation, wind patterns and sea level rise are unlikely to result in significant effects upon receptors identified by other environmental disciplines. These matters are therefore scoped out of the ES.
- 7.3.1.4 Full responses to comments received as part of the Scoping Opinion will be provided as part of the ES submitted with the application for development consent.

7.4 Study area

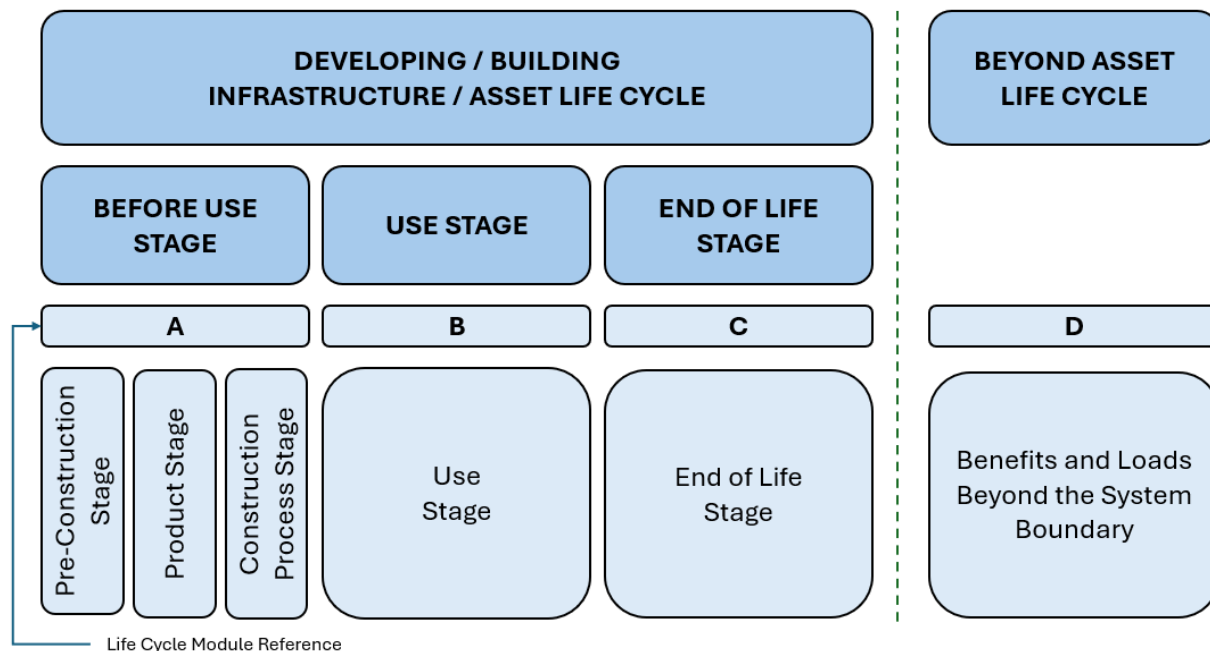
Greenhouse gas emissions

- 7.4.1.1 The study area for this topic differs from other technical disciplines, which focuses on the impact within a defined boundary. In line with IEMA guidance [13], a reference study period for the Proposed Development has been chosen as the basis for the GHG emissions assessment based on the expected service and construction period. The study period comprises up to 30 months for construction, 40 years for operation and 24 months for decommissioning of the Proposed Development.
- 7.4.1.2 The study area for emissions will cover all elements of the Proposed Development, including but not limited to, the solar PV modules and mounting frames, the inverters and transformers, Battery Energy Storage Systems (BESS), substations and access tracks, and all activities associated with the introduction or modification of these elements into the environment.
- 7.4.1.3 The seven 132kV substations that are expected to be required across the Proposed Development will be treated similarly, accounting for their construction and operation emissions but assuming that at the end of the life of the solar farm they will either be decommissioned alongside the rest of the Proposed Development, with zero emissions being released, or will be adopted by the Distribution Network Operator (DNO), and will continue operating in a zero emission manner.

7.4.1.4 Climate change is a global phenomenon, and the Proposed Development will impact global GHG concentrations. Therefore, within a climate change context, the key sensitive receptor to the impacts of the Proposed Development will be the global climate. This receptor differs from others listed within an EIA context as it is not at a distinct local scale but a global one. The study area considers all the greenhouse gas emissions that arise throughout the lifecycle of the Proposed Development.

7.4.1.5 All sources of GHG emissions will have a long-term adverse effect on the climate by contributing to (human-enhanced) global warming. Therefore, a different approach to defining the extent of the study area is required for the assessment of impacts. The assessment will consider the whole lifecycle emissions from the Proposed Development that will contribute to global climate change based on the information available at the planning stage. A 'cradle to grave' system boundary has been applied to cover the whole lifecycle stages of the Proposed Development. These lifecycle modules have been simplified in the diagram in Inset 7-1 below, but include the following:

- before use stage (pre-construction, product, and construction process stage);
- use stage;
- end of life stage; and
- beyond asset life cycle (benefits and loads beyond the system boundary).



Inset 7-1 *Simplified modular lifecycle stages for EIA GHG emissions assessment [20]*

Climate resilience

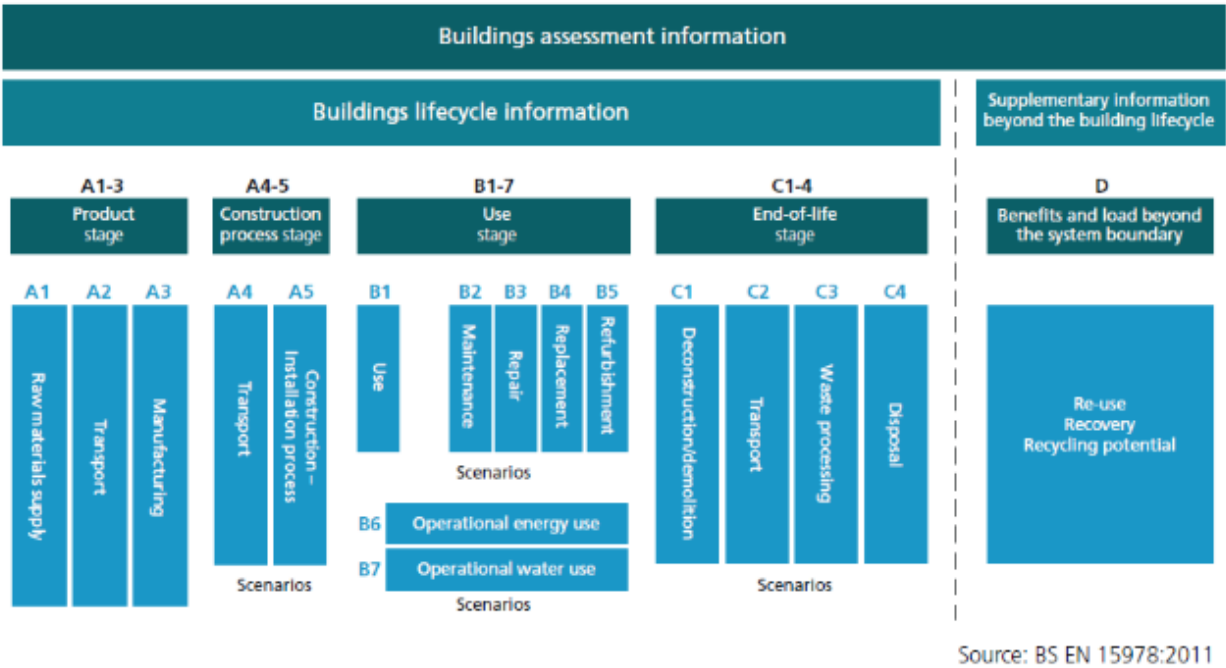
- 7.4.1.6
- In terms of climate resilience, the location of a site has a considerable influence when assessing vulnerability and adaptability to future climate change. Site location features within the draft Order Limits that may have the potential to cause, mitigate, or be at risk from climate change have been identified within paragraph 7.6.1.5.
- 7.4.1.7
- As with the assessment of GHG emissions, the study period will be 44.5 years to encompass the construction, operation and decommissioning of the Proposed Development.

7.5 Assessment methodology

7.5.1 Baseline sources of information

Greenhouse gas emissions

- 7.5.1.1
- The following desktop source has been used to inform the existing baseline conditions of the study area for GHG emissions assessment: UK local authority and regional greenhouse gas emissions national statistics [19].
- 7.5.1.2
- The PAS 2080 provides guidance on how to conduct a GHG emission lifecycle assessment by breaking down emission sources into modules which relate to construction, operation and decommissioning of a development. This is shown in Inset 7-2.



Inset 7-2 The GHG emissions assessment scope includes the before use stage (A), the use stage (B) and the end of life stage (C)

7.5.1.3 Using the PAS2080 template, the Proposed Development's emission sources during construction are outlined in Table 7-4

BESS whole life cycle emissions

7.5.1.4 An Environmental Product Declaration (EPD) for the type of battery and manufacturer that the Proposed Development will use is not currently available, as the supplier has not been confirmed. Appropriate assumptions have been made which use a best practice methodology developed by Emilsson & Dahllöf (2019) [20].

7.5.1.5 The whole life carbon emissions associated with the Proposed Development are calculated based on:

- Emissions associated with building the batteries. This includes Mining and Refining, Battery Material Production, Cell Production and Battery Pack Assembly;
- Emissions associated with charging and discharging the batteries during normal operations; and
- Emissions associated with recycling or disposing of the batteries.

7.5.1.6 Even though the operational emissions associated with the charging and discharge of the BESS from the grid electricity are included within this assessment, the BESS in essence provides a considerable beneficial role to enable further capacity on the grid to allow the expansion and connection of renewable energy assets.

Table 7-4 *Potential impacts of the Proposed Development during the construction stage*

Module	Activity	Emission source and Impact
A1-3	Raw material extraction	The embodied greenhouse gas emissions from fossil fuel energy are used to extract and manufacture materials and components.
A1-3	Manufacturing of the materials and components	
A4	Transportation of the materials to the manufacturing centre and construction site by Heavy Goods Vehicle (HGV)	Emissions from diesel, petrol, or other fuels are used in construction vehicles to transport materials and components.
A4	Site workers and managers travel to and from the site	Emissions from fuel use in vehicles by construction workers.
A5	Construction activities to build Proposed Development	Emissions from construction compounds used on the site due to energy consumption, such as electricity and other fuels from plant, vehicles, and generators.
A5	Use of construction infrastructure, including construction worker welfare facilities, a site office, wheel wash area, plant and machinery storage, waste storage areas	Emissions from energy consumption such as gas and electricity in temporary built infrastructure.

Module	Activity	Emission source and Impact
A5	Disposal and treatment of construction waste	Emissions from diesel or other fuel use in HGV or other vehicles to transport waste to appropriate waste centre.
A5	Land use change	Release of emissions from carbon sink as a result of soil disruption.
A5	Water use and treatment	Emissions from the provision of clean water on the site and energy use for wastewater treatment.
A5	Use of construction machinery and equipment	Emissions from energy consumption such as electricity, diesel, and other fuels for machinery and equipment.
7.5.1.7	In-line with the EIB (2023) methodology, the absolute operational emissions of the Proposed Development will be “ <i>zero or minor absolute emissions</i> ”. This is in relation to the operational energy use [lifecycle module B6]. Solar power, through the production of low carbon electricity, reduces the exploitation of fossil fuel (coal and natural gas) by generating electricity from a renewable source. The Proposed Development would offset the emissions associated with non-renewable methods of electricity generation and, therefore, reducing the impact on climate change.	
7.5.1.8	A summary of the potential operational impacts and emission sources is shown in Table 7-5.	

Table 7-5 Summary of the potential operational impacts and emission sources

Module	Activity	Emission source and impact
B1	Generation of renewable electricity	Offset the use of fossil fuels and reduce the carbon intensity of the National Grid, lowering emissions at the national level.
B2	Maintenance of the solar array	Release of greenhouse gas emissions from energy consumption, material use, and waste generation as a result of ongoing site maintenance on a regular basis. Emissions via this source are expected to be negligible so they were not assessed.
B2	Travel to the Site for maintenance purposes.	Release of emissions from vehicles used to travel to the site for maintenance operations. Emissions via this source are expected to be negligible so they were not assessed as part of the assessment.
B4	Component replacement	The model includes for one wholesale replacement of the original BESS, which have a nominal lifespan of 20yrs. Additionally, 50% of the BESS are expected to require replacement over their operational life, which equates to a second wholesale replacement over the two BESS lifespans of the Proposed Development. Wholesale replacement of the substation transformers, and ongoing replacement of other components during their service life, such as inverters and transformers, have also been accounted for.

- 7.5.1.9 For the purposes of this assessment, it is assumed that the activities associated with decommissioning will be largely the reverse of the activities associated with the construction phase, with similar procedures used to remove components from the draft Order Limits, as were required to install them. It is reasonable to assume, however, that the emissions from these activities so far into the future are likely to be quite different to those released during the construction phase.
- 7.5.1.10 The decommissioning phase will fall well after the end of the 6th UK Carbon Budget (the latest published budget) and post-2050, when the UK is supposed to reach net zero. The decommissioning phase should in theory then be undertaken with no release of emissions at all.
- 7.5.1.11 Although it is not possible to accurately predict the technological advancements that may occur before decommissioning takes place, it is reasonable to assume that there will be considerable decarbonisation of vehicles and processes in advance of the 2050 net zero deadline. Therefore, it is assumed that all energy use at that time should be net zero, all vehicles should be net zero, and materials should be recycled or reused where feasible to do so. This is not the worst-case scenario but is a reasonable and pragmatic assumption for a point in time nearly 20 years after the net zero deadline.

Climate resilience

- 7.5.1.12 The following desktop sources have been used to inform the existing baseline conditions of the study area for the assessment of climate resilience:
- Current climate data from the UK Met Office to determine the existing baseline for the vulnerability of the Proposed Development to climate change [21].
 - The projected climate data for the East of England region – UK Climate Projections 2018 (UKCP18), for high emissions scenario (RCP8.5), and 50% probability of occurrence [22]. Using RCP8.5 at the 50th percentile is recommended as best practice in the IEMA 2020 guidance [14]. There are four Representative Concentration Pathways (RCPs) available in the UKCP18 climate projections. These are 2.6, 4.5, 6.0 and 8.5. They are named according to the concentration of greenhouse gases modelled to occur in the atmosphere in 2100.

7.5.2 Assessment methodology

Greenhouse gas emissions

- 7.5.2.1 IEMA (2022) [23] is the primary guidance for the climate change assessment, as this is the most recent available and is applicable to the UK. It is considered to meet the requirements of the NPS EN-1 and be the most holistic method of assessing GHG emissions as it applies a WLC methodology incorporating not just the construction and operational phase of development, but also the decommissioning/end of life and beyond asset life cycle stages, allowing a more robust “worst case scenario” to be applied.

Scope of assessment

- 7.5.2.2 The scope of the GHG assessment includes those activities associated with the Proposed Development that either directly or indirectly release GHG emissions that contribute to climate change effects, irrespective of their source, and across all relevant project lifecycle stages (whole lifecycle carbon emissions). The system boundary applied for this assessment will be Cradle-to-Grave as this is proportional to the nature and scale of the Proposed Development.
- 7.5.2.3 The 44.5-year reference study period was taken as the basis for the GHG emissions assessment, and this forms the temporal boundary for the assessment. This study period incorporates construction (up to 2.5 years), operational life (40 years) and decommissioning (up to 2 years) phases.
- 7.5.2.4 The objective of the assessment is to ensure the minimum overall lifetime carbon emissions and the maximum lifetime resource efficiency, and to demonstrate how the Proposed Development will mitigate the impact it will have on climate change through the release of GHG emissions in the longer term.

Setting a baseline

- 7.5.2.5 A baseline is a reference point against which the impact of a development can be compared. In addition to the current emissions baseline, it is necessary to establish a second (sectoral) emissions baseline against which the project can be meaningfully compared. This is represented by a typical 'Business as Usual' (BaU) development of a similar type built elsewhere to minimum regulatory standards, where assumptions are made on current or future GHG emissions. These are summarised as baselines A and B:
- A. GHG emissions within the system boundary of the GHG quantification but without the Proposed Development; or
 - B. GHG emissions arising from an alternative project design and/or BaU for a project of this type. The alternative project design considers the equivalent electrical generation but from a fossil fuel generator for comparison.
- 7.5.2.6 The assessment considers both forms of baseline represented by points A and B to provide a meaningful comparison of impacts associated with the Proposed Development. As stated in the IEMA (2022) guidance [23], the goal of establishing a baseline is assessing and reporting a proposed project's net GHG impact. The EIB 'Project Carbon Footprint Methodologies' (2022) guidance [15] was used to establish the baseline scenario, as this goes into greater detail in terms of baseline methodology for assessing GHG emissions from projects.
- 7.5.2.7 The current baseline represents existing GHG emissions before construction and operation of the Proposed Development and should account for expected land use change resulting in the release of previously sequestered carbon (such as the disturbance of soils). The baseline represents a realistic worst-case scenario as considered best practice.

- 7.5.2.8 The future baseline captures both direct and indirect operational and user GHG emissions associated with the baseline scenarios, irrespective of their source as recommended by the 2022 IEMA guidance.
- 7.5.2.9 The approach to setting a credible baseline for this assessment is endorsed by a 2019 Technical Note published by European Bank for Reconstruction and Development (EBRD) [24]. This Technical Note states that this type of baseline is appropriate since “*it is recognised that ‘something’ must be done*” and allows for a comparison of relative effects.
- 7.5.2.10 This assessment method for setting a baseline is a slightly different approach to other technical disciplines which describe a ‘no development scenario’ as the future baseline for the assessment of impacts, however, it is still compliant with the requirements of the EIA Regulations.

Estimating emissions within the system boundary

- 7.5.2.11 Emissions have been calculated by multiplying the activity data with the emission factors published annually by the Department for Energy Security and Net Zero (DESNZ) and the Department of Environment, Food and Rural Affairs (DEFRA) [25], in line with IEMA (2022) best practice guidance [13]. The general equation for emission estimation is:

$$GHG \text{ emission factor} \times \text{Activity data} = GHG \text{ emission or removal}$$

- 7.5.2.12 Activities where expected emissions are less than 1% of the total emissions will be excluded, but only where all exclusions total up to a maximum of 5% of total overall emissions associated with the Proposed Development across all project lifecycle modules within the applied system boundary (the whole lifecycle carbon emissions).
- 7.5.2.13 Emissions are expressed in terms of tonnes of carbon dioxide equivalent (tCO₂e). This is a universal metric measure used to compare the emissions from various greenhouse gases on the basis of their global warming potential (GWP), by converting amounts of other gases to the equivalent amount of CO₂ with the same GWP.
- 7.5.2.14 In terms of CO₂e emissions, the Proposed Development as a whole is assessed for its ‘relative emissions (Re)’ or net emissions. This is expressed as the difference between absolute emissions generated by the Proposed Development and the baseline emissions for a ‘typical’ fossil fuel development.

$$\text{Relative Emissions (Re)} = \text{Absolute Emissions (Ab)} - \text{Baseline Emissions (Be)}$$

- 7.5.2.15 The relative emissions are then used as a reference point in combination with industry expertise on carbon reduction targets to evaluate the project against the defined significance criteria.
- 7.5.2.16 This methodological approach is recommended by the EIB (2023) [15] and is fully compatible with the EIA Regulations.

Climate resilience

- 7.5.2.17 IEMA's guidance [14] presents a methodology for the consideration of climate change resilience and adaption in the EIA process, which has been followed in this assessment.
- 7.5.2.18 The aim of the second part of the assessment is to assess the vulnerability of the Proposed Development to global climate change, which highlights the potential risk of major accidents, and identifies adaptation and resilience measures to mitigate risk.
- 7.5.2.19 The first stage of the assessment is to review the future climate projections published by the Met Office (through the UK Climate Projections (UKPC18, [26]) website), which includes variables such as annual mean temperatures and annual changes in summer and winter precipitation.
- 7.5.2.20 The location of the Proposed Development is assessed for climate projections under four different future climate scenarios, to cover the life of the Proposed Development in varying future conditions. These range from RCP2.6 where atmospheric emission concentrations are strongly reduced through to the worst-case scenario, RCP8.5, where emission concentrations continue to rise, unmitigated. A range of probability levels are available, although this assessment uses the 50% probability level (i.e. a central estimate with less uncertainty).
- 7.5.2.21 The principal steps that are undertaken include:
- Define the current climate at the draft Order Limits and surrounding region;
 - Assess the future climate scenario for the draft Order Limits and region;
 - Qualitatively assess, using professional judgement, how any sensitive receptors identified across other EIA topics are likely to be affected by the future climate scenario described above; and
 - Consider and identify the resilience and adaptive measures associated with the Proposed Development's design or management to mitigate the risk to receptors and the Proposed Development as a whole.
- 7.5.2.22 Assessing the impacts of climate change on a development varies from the assessment of impacts arising from a scheme in other EIA topics, since it focusses on the global impact of an external factor (climate change) on a development, rather than the local impact of a development on receptors in a confined geographical location. The resilience of the Proposed Development to climate change is assessed based on the susceptibility and vulnerability of a range of different receptors.

Survey

- 7.5.2.23 No surveys are required with respect of the Climate Change assessment.

7.5.3 Sensitive receptors

Greenhouse Emissions

- 7.5.3.1 Climate change is a global phenomenon and the Proposed Development will impact global GHG concentrations. Therefore, within a climate change context, the key sensitive receptor to the impacts of the Proposed Development will be the global climate.

Climate resilience

- 7.5.3.2 The resilience of the Proposed Development and its surroundings to climate change is assessed based on the susceptibility and vulnerability of a range of different sensitive receptors. Sensitive receptors within the vicinity of the Proposed Development that are relevant to the location, nature and scale of the Proposed Development have been identified and include the following:

- Buildings and infrastructure (including equipment and building operations);
- Human health (e.g., construction workers, occupants and site users); and
- Environmental (e.g., habitats and species).

7.5.4 Assigning receptor sensitivity

Greenhouse gas emissions

- 7.5.4.1 The global climate has been assigned a sensitivity of high. This is based upon the IEMA guidance [13] which states: *‘GHG emissions are not geographically limited. They have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The receptor for GHG emissions is the global atmosphere. The receptor has a high sensitivity, given the severe consequences of global climate change and the cumulative contributions of all GHG emission sources’.*

Climate resilience

- 7.5.4.2 The 2020 IEMA guidance [13] describes the sensitivity of the receptor/receiving environment as *“the degree of response of a receiver to a change and a function of its capacity to accommodate and recover from a change if it is affected”*. Therefore, in-line with the IEMA guidance, the following factors have been considered to ascribe the sensitivity of receptors in relation to potential climate change effects:

- Value or importance of receptor;
- Susceptibility of the receptor (e.g., ability to be affected by a change); and
- Vulnerability of the receptor (e.g., potential exposure to a change).

- 7.5.4.3 The guidance suggests that *“a combination of susceptibility and vulnerability in addition to value/importance of the receptor should be used to reach a reasoned conclusion on sensitivity.”*

- 7.5.4.4 The extent of the study area for an assessment of vulnerability to climate change are the features within and surrounding the draft Order Limits, which include:
- Users adjacent to the draft Order Limits;
 - A47 and other public, private and countryside roads within and surrounding the draft Order Limits;
 - Residential areas surrounding the draft Order Limits; and
 - Species and habitats within the draft Order Limits
- 7.5.4.5 The susceptibility of the receptor is determined using the scales detailed in Table 7-6 below.

Table 7-6 Measure of receptor susceptibility to climatic impact

Scale	Susceptibility
Low	Receptor has the ability to withstand or not be altered much by the projected changes to the existing/prevaling climatic factors.
Medium	Receptor has some limited ability to withstand or not be altered by the projected changes to the existing/prevaling climatic conditions.
High	Receptor has no ability to withstand or not be substantially altered by the projected changes to the existing/prevaling climatic factors.

- 7.5.4.6 Table 7-7 details the scale used to determine the vulnerability of the receptor.

Table 7-7 Measure of receptor vulnerability to climatic impact

Scale	Vulnerability
Low	Climatic factors have little influence on the receptors.
Medium	Receptor is dependent on some climatic factors but able to tolerate a range of conditions.
High	Receptor is directly dependent on existing/prevaling climatic factors and reliant on these specific existing climate conditions continuing in future or only able to tolerate a very limited variation in climate conditions.

7.5.5 Assigning magnitude of impact

Greenhouse gas emissions

- 7.5.5.1 Assignment of the magnitude of the expected impact is central to the assessment of greenhouse gas emissions. The IEMA GHG emissions guidance [13] indicates that “activity data consists of information that defines and describes the size, magnitude and physical nature of the proposed project”. It goes on to state that:

GHG emissions factor x Activity data = GHG emission or removal.

- 7.5.5.2 The magnitude of impacts range from major adverse to beneficial and are discussed further below, in Table 7-10, in relation to assessing Significance.

Climate resilience

- 7.5.5.3 Following the IEMA climate resilience guidance [14], the assessment of resilience uses a combination of probability and consequence to reach a reasoned conclusion on the magnitude of the effect of climate change on the Proposed Development, including the risk of vulnerability to increased heatwaves, flooding, and extreme weather.
- 7.5.5.4 The IEMA guidance states that magnitude is based on a combination of:
- Probability, which takes into account the chance of the impact occurring over the lifespan of the Proposed Development if the risk is not mitigated.
 - Consequence, which reflects the geographical extent of the impact, or the number of receptors affected (e.g. scale), the complexity of the impact, the sensitivity of receptors and the duration, frequency and reversibility of impact.
- 7.5.5.5 The guidance states, “it is likely that if the probability and/or consequence of the effect is high, then the magnitude of the effect would also be high.”
- 7.5.5.6 Categorisation of likelihood tiers are detailed in Table 7-8.

Table 7-8 Definitions of the likelihood of the climate impact affecting the receptors

Likelihood category	Description (probability and frequency of occurrence)
Very High	The event occurs multiple times during the lifetime of the Proposed Development (assumed 44.5 years), e.g. approximately annually, typically 44.5 events.
High	The event occurs several times during the lifetime of the Proposed Development (44.5 years), e.g. approximately once every five years, typically 7 events.
Medium	The event occurs limited times during the lifetime of the Proposed Development (44.5 years), e.g. approximately once every 15 years, typically 2 events.
Low	The event occurs during the lifetime of the Proposed Development (44.5 years), e.g. once in 43 years.
Very Low	The event may occur once during the lifetime of the Proposed Development (44.5 years).

- 7.5.5.7 From likelihood, the consequence of impact is determined, as indicated in in Table 7-9.

Table 7-9 Consequence of climatic impact and the description of varying consequence of impact on the receptor

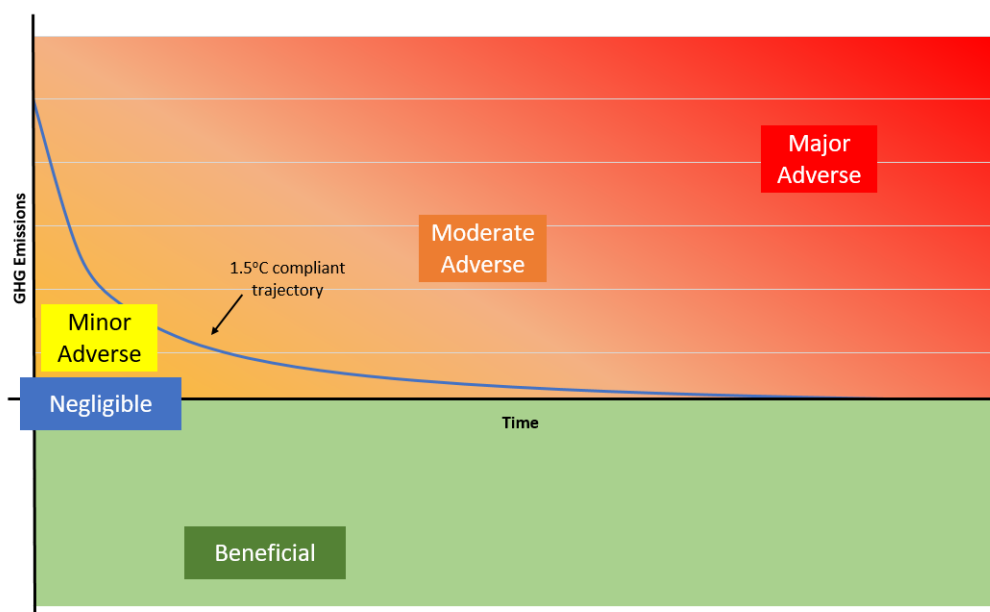
Consequence of impact	Description of impact
Extreme Adverse	National-level (or greater) disruption lasting more than 1 week.

Major Adverse	National-level disruption lasting more than 1 day but less than 1 week.
Moderate Adverse	Or Regional-level disruption lasting more than 1 week.
Minor Adverse	Regional-level disruption lasting more than 1 day but less than 1 week.
Negligible	Regional-level disruption lasting less than 1 day.

7.5.6 Significance criteria

Greenhouse gas emissions

- 7.5.6.1 The significance of the impacts associated with the Proposed Development are assessed in line with the criteria set out within the IEMA guidance (2022) [23]. Where GHG emissions cannot be avoided, the goal of the EIA process is to reduce the project's residual emissions at all stages.
- 7.5.6.2 All sources of GHG emissions will contribute to global climate change, but the IEMA GHG guidance [13] suggests that *"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"*.



Inset 7-3 Different levels of significance plotted against the UK's net zero compatible trajectory (adapted from IEMA, 2022 [23])

- 7.5.6.3 The significance of the impacts associated with the Proposed Development has been assessed in-line with the criteria set out within the IEMA guidance [23] and shown in Inset 7-3, which is also summarised in Table 7-10.

Table 7-10 *Significance criteria for assessment of impacts from greenhouse gas emissions*

Criteria	Impact	Significance
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.	Major Adverse	Significant
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.	Moderate Adverse	Significant
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.	Minor Adverse	Not Significant
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.	Negligible	Not Significant
The project's GHG impacts are below zero and 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.	Beneficial	Significant

7.5.6.4 Minor adverse and negligible effects are not considered to be significant. However, impacts are only considered to be minor adverse if the project's GHG impacts are fully consistent with existing and emerging policy requirements and good practice.

7.5.6.5 Impacts are only considered to be negligible if a development goes well beyond existing policy and design standards. It needs to be viewed as well 'ahead of the curve' for the net zero trajectory and have minimal residual emissions. Projects that actively reverse (rather than only reduce) the risk of severe climate change can be judged as having a beneficial effect.

7.5.6.6 IEMA [13] also states "A project that causes GHG emissions to be avoided or removed from the atmosphere has a **beneficial** effect that is **Significant**." This is particularly relevant for renewable energy generation projects that lead to avoided emissions from fossil fuel-based electricity generation. This point is important as these benefits are not explicitly apparent in the whole life carbon assessment that deals with comparing specific generators that provide the same output in isolation rather than the electricity generation system as a whole.

- 7.5.6.7 Moderate adverse and major adverse effects are considered to be significant if a project's GHG impacts are not consistent with existing and emerging policy requirements and good practice and therefore don't contribute towards the UK's net zero trajectory.

Climate resilience

- 7.5.6.8 The significance of the effects of climate change impacts on the Proposed Development is determined using the significance matrix for climate resilience as shown in Table 7 -11 below. Effects of moderate or major adverse are considered significant, and minor or negligible effects considered not significant, however professional judgment can be applied to the determination of significance.

Table 7 -11 Significance criteria for climate resilience

Climate resilience significance matrix		Sensitivity of Receptor				
		Very low	Low	Medium	High	Very high
Magnitude of Impact	Negligible	Negligible (Not Significant)	Negligible (Not Significant)	Negligible (Not Significant)	Minor Adverse (Not Significant)	Minor Adverse (Not Significant)
	Minor	Negligible (Not Significant)	Minor Adverse (Not Significant)	Minor Adverse (Not Significant)	Moderate Adverse (Significant)	Moderate Adverse (Significant)
	Moderate	Minor Adverse (Not Significant)	Minor Adverse (Not Significant)	Moderate Adverse (Significant)	Moderate Adverse (Significant)	Moderate Adverse (Significant)
	Major	Minor Adverse (Not Significant)	Moderate Adverse (Significant)	Moderate Adverse (Significant)	Moderate Adverse (Significant)	Moderate Adverse (Significant)
	Extreme	Minor – Moderate Adverse (Not Significant)	Moderate Adverse (Significant)	Moderate - Major Adverse (Significant)	Major Adverse (Significant)	Major Adverse (Significant)

7.5.7 Assumptions and limitations

Greenhouse gas emissions

- 7.5.7.1 The assessment considers the operational CO₂e emissions over the 40-year operational lifetime period, including the embodied emissions. It has been assumed that energy generated during operation will experience reductions of 0.4%, year on year, throughout the assessment period, due to the effects of panel degradation. This degradation will not have a direct effect on emissions, but panels will also periodically fail and need to be replaced, which will have an impact on the embodied carbon figures. An annual panel replacement rate of 0.25% has been used. This figure equates to an additional 40,771 tCO₂e of embodied emissions across the project's lifetime for the fixed panel layout and 35,570 tCO₂e for the trackers (see Table 7-16; Table 7-17 Absolute/Total Emissions for overall emissions calculations). Several of the other components, such as the BESS and

transformers, are also assumed to require a degree of replacement due to service life or unexpected faults.

- 7.5.7.2 The assessment has used an emissions calculation based on installed capacity of the solar PV modules rather than the amount of energy they generate over their lifetime. This is due to the vast majority of the lifecycle emissions coming from the before use stage.
- 7.5.7.3 The potential impact of the Proposed Development is the release of greenhouse gas emissions from its lifecycle stages.
- 7.5.7.4 This comparison between Solar PV and natural gas energy generation scenarios (Baseline B), with the equivalent amount of energy generated by the Proposed Development, allows for a comparison that helps to understand the emissions in the context of an alternative that meets the same outputs.
- 7.5.7.5 For the purposes of the GHG assessment, where a firm decision between adopting fixed and tracking panels has not yet been made, estimates of the emissions associated with both options have been provided. For clarity, there are slightly differing numbers of solar PV panels in the two layouts because of different panel densities achieved between the two framing systems. The tracking panels will also require some parasitic energy in order to operate the motors to track the sun's path across the sky. Consequently, the two options have slightly different characteristics in terms of their embodied carbon and operational carbon balance. This assessment will be updated for the ES.

Climate resilience

- 7.5.7.6 Data provided by UKCP18 [26], following the Intergovernmental Panel on Climate Change's high emissions scenario, 'RCP8.5', indicates changes to such climate factors such as temperature and precipitation, which are projected over the next 80 years. These have been used to help inform the assessment of likely climate changes that will occur over the life of the Proposed Development.
- 7.5.7.7 The IEMA guidance [14] explains how climate is changing, but there remain uncertainties in the magnitude, frequency and spatial occurrence, either as changes to average conditions or extreme conditions, which generally makes it difficult to assess the impacts of climate change in relation to a specific project. Therefore, scientific assumptions must be made to assess the resilience of new developments to any future changes in climate.
- 7.5.7.8 Whilst the Applicant can implement measures to reduce the impacts and increase climate resilience according to global and regional climate projections with relevance to the scale of the Proposed Development, uncertainties associated with probabilistic climate projections are outside of the Applicant's control and cannot be fully mitigated against.
- 7.5.7.9 This assessment relies on data provided by third parties with other technical disciplines providing information regarding the embedded mitigation to determine the development's resilience to climate change.

- 7.5.7.10 Currently only climate projections are available to help understand the likely future weather conditions, and these follow a range of different scenarios. A current 'worst-case' scenario has been adopted for this assessment. This will be especially important in the event that there is any deviation from the projected patterns or increased volatility in the system that risks compromising the Proposed Development's climate resilience.

7.6 Baseline conditions

7.6.1 Existing baseline conditions

Greenhouse gas emissions

- 7.6.1.1 The draft Order Limits are located within the open countryside between Swaffham and Dereham in the county of Norfolk in the East of England. The land use is predominately arable. Agricultural land typically emits emissions in the form of methane (CH₄) and nitrous oxide (N₂O) from the soils.
- 7.6.1.2 In the absence of a detailed assessment of the carbon balance of the agricultural system, which is likely to fluctuate dramatically from year to year as crops change or some areas are left fallow, a zero emissions baseline is assumed. In practice, this is likely to represent a worst-case scenario in comparison to the project emissions, as most agricultural systems import carbon in the form of fertilisers and fuels for machinery which is then lost from the system through the sale of crops and emissions to air. As such, the difference between the existing baseline and the emissions from the Proposed Development is likely to be smaller in reality than the worst case scenario presented here.
- 7.6.1.3 There are no existing buildings within the draft Order Limits. The draft Order Limits have no existing demands for regulated or unregulated energy and, therefore, no emissions are associated with these sources.
- 7.6.1.4 Baseline emissions also include emissions that may be avoided as a result of the Proposed Development, i.e. existing emissions from the generation of grid electricity if the Proposed Development does not go ahead. This will be a cumulative total of all emissions avoided over the lifetime of the Proposed Development, assuming 100% of the energy generated by the Proposed Development is displacing energy generated by fossil fuels.

Climate resilience

- 7.6.1.5 The current climate baseline is a temperate oceanic climate with warm summers and milder winters. Temperate climates are defined by the Met Office [27]. The average temperature at the climate station in Marham, near the draft Order Limits, is 10.4°C. The region experiences an average rainfall of 660mm per year [28].

7.6.2 Future baseline conditions

- 7.6.2.1 The future baseline for Climate Change is expected to change in the absence of the Proposed Development.

Greenhouse gas emissions

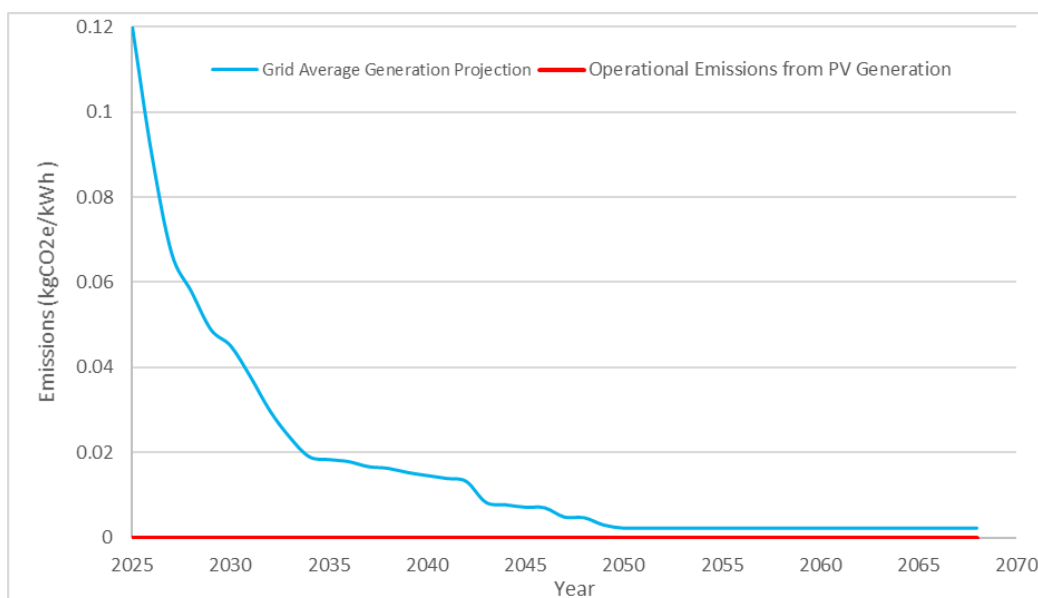
- 7.6.2.2 For GHG emissions assessment, the future (sectoral) baseline represents a typical 'business as usual' development of a similar type built elsewhere to minimum regulatory standards.
- 7.6.2.3 As set out in Section 7.5, for the purposes of this assessment, the absolute emissions (Ab) are compared to 'a sectoral future baseline' (Be) that has been developed to provide a credible comparison of relative effects, as recommended by the 2023 EIB guidance [15]. The baseline BaU emissions scenario (Be) represents Baseline B as described in Section 7.5 (Assessment Methodology).
- 7.6.2.4 The baseline BaU emissions scenario assumes that the expected energy generation of an alternative development on the site of the Proposed Development is instead obtained from an alternative energy source, in this case fossil fuels (i.e. natural gas). Annual emissions and whole life carbon emissions have been calculated based on the method explained in Section 7.5.2.11. Lifetime covers project lifecycle stages A1 (raw material extraction and supply) through to C4 (end of functional life).
- 7.6.2.5 The UNECE assessment calculates the WLC impact of 1kWh of natural gas power production (excluding carbon capture and storage) as 434gCO_{2e}/kWh. It has been assumed that this figure covers lifecycle stages A1 (raw material extraction and supply) through to C4 (end of functional life) and is, therefore, representative of the system boundary applied for this assessment. This figure has been applied to estimate baseline BaU lifetime (whole lifecycle carbon emissions) for the reference study period for this assessment.
- 7.6.2.6 Carbon capture is still not really commercially viable without some form of subsidy, and there are no unsupported operational plants. Being carbon capture 'ready' is very different from actually capturing all its carbon emissions, and provides no assurance about when such a plant would commence carbon capture.
- 7.6.2.7 Although the baseline comparison is being made against the introduction of a hypothetical new CCGT power plant (without carbon capture), in order to account for the embodied emissions associated with it, the real purpose of this Proposed Development is to displace the existing fossil fuel generation on the grid, whose embodied carbon has already been expended and would still contribute emissions to the global atmosphere.
- 7.6.2.8 Taking the average grid emissions does not form a congruent baseline against the whole life emissions from the Proposed Development either. Government-published emission factors for the average grid mix, include some of the other generators embodied emissions (e.g. transmission and distribution losses, and fuel

extraction) but do not include the embodied emissions from construction of the generating stations themselves, so these are not directly comparable.

7.6.2.9 For the above reasons, it is still considered more helpful and legitimate to draw comparison against the CCGT fossil fuel generator.

7.6.2.10 However, it is potentially helpful to consider average grid emissions against just the operational emissions of the Proposed Development. As a renewable energy technology, the operational emissions are effectively almost zero. Even allowing for the ongoing grid decarbonisation, projected emissions from the grid average will be considerably higher, especially over the short term. The grid average projections are provided for reference only and help contextualise the emissions benefits of the project, but this does not form part of the significance assessment itself as that is based on a whole life carbon assessment.

7.6.2.11 Inset 7-4 shows the expected operational emissions from the Proposed Development against the Government projected grid decarbonisation rates [21].



Inset 7-4 Different levels of significance plotted against the UK's net zero compatible trajectory (adapted from IEMA)

7.6.2.12 Appendix 7.1 to this PEIR provided further details on the future (sectoral) baseline for natural gas generation.

Future (Sectoral) Baseline Emissions

7.6.2.13 The counterfactual baseline model assumes an equivalent amount of energy generation to that expected from the Proposed Development. The annual energy generation from the fixed panel solar PV, is expected to be 1,187,136 MWh/yr (megawatt hours per year), see Table 7-16. Where tracking panels are used, the overall generation is slightly lower due to fewer panels in the installation and a small amount of parasitic demand to operate the trackers. This has been assumed to consume approximately 0.3% of the generation produced so the annual generation from the tracking panels is 1,155,722 MWh/yr.

7.6.2.14 The baseline BaU emissions scenario (Be), as calculated based on the energy generation of natural gas, is indicated in Table 7-12 (fixed panels) and Table 7-13 (tracking panels) below. This forms part of the baseline for the assessment of impacts associated with the Proposed Development (Baseline B).

Table 7-12 Baseline BaU emissions scenario (Be) for natural gas equivalent (fixed panels)

BASELINE B: NATURAL GAS EQUIVALENT OF SOLAR PV				
	No. Years	Energy Generation (MWh)	Operational Emissions (tCO₂e) <i>(Nat Gas Emissions Factor: 0.202 kgCO₂e/kWh)</i>	Whole Lifecycle Carbon Emissions (tCO₂e) <i>(Assuming 0.434kgCO₂e/kWh)</i>
Annual	1	1,187,136	436,564	-
Lifetime	40	47,485,440	17,462,555	19,130,648
OTHER COMPONENTS AND INFRASTRUCTURE				
		(e.g. Substation and cables)		Embodied Emissions (tCO₂e)
Lifetime	40	-	-	89,241
TOTAL LIFECYCLE CARBON EMISSIONS – EQUIVALENT OF SOLAR PV				
Total	(tCO₂e)	-	-	19,219,889

Table 7-13 Baseline BaU emissions scenario (Be) for natural gas equivalent (tracking panels)

BASELINE B: NATURAL GAS EQUIVALENT OF SOLAR PV				
	No. Years	Energy Generation (MWh)	Operational Emissions (tCO₂e) <i>(Nat Gas Emissions Factor: 0.203 kgCO₂e/kWh)</i>	Whole Lifecycle Carbon Emissions (tCO₂e) <i>(Assuming 0.434kgCO₂e/kWh)</i>
Annual	1	1,155,722	425,012	-
Lifetime	40	46,228,880	17,000,460	18,624,413
OTHER COMPONENTS AND INFRASTRUCTURE				
				Embodied Emissions (tCO₂e)

Lifetime	40	89,241
TOTAL LIFECYCLE CARBON EMISSIONS – EQUIVALENT OF SOLAR PV AND BESS		
Total	(tCO₂e)	18,713,654

- 7.6.2.15 The Baseline B scenarios estimate emissions from alternative forms of generation based on published studies showing the whole lifecycle carbon associated with each technology. The Combined Cycle Gas Turbine (CCGT) emissions, referred to as the natural gas equivalent, have been derived from the UK GHG conversion factors [29] to calculate the operational emissions and a UNECE [18] paper for the WLC emissions.
- 7.6.2.16 Figures per MWh are most appropriate for a CCGT where the whole lifecycle emissions are heavily related to operational phase and the combustion of fuel on a per hour basis. In such a case, the longer the gas turbine is operating, the higher its WLC emissions will be, and emissions will increase with every MWh of generation.
- 7.6.2.17 However, for a renewable energy technology, most of the emissions are embodied in its initial raw materials and construction processes. Only net carbon savings arise from the operational phase, and each MWh of electricity generated results in slightly lower lifecycle emissions. In this case, emissions given based on the installed capacity of the generator (i.e. per MW installed or per MWp) are more appropriate and this figure is used in preference (where such an emission factor is available). Here, the longer the renewable generator is in place, the better. Such a figure has been used for the solar generation.
- 7.6.2.18 At present, no assessment of actual emissions associated with the change of use of the land have been calculated. However, is not expected to be of a magnitude that would change the overall significance of effects reported in this PEIR assessment, as defined in 7.5.2.12.

Climate resilience

Global climate change projections

- 7.6.2.19 The global Climate Change issues that will affect the resilience of a development within the UK are listed in Table 7-14.

Table 7-14 Projected Global Impacts of Climate Change

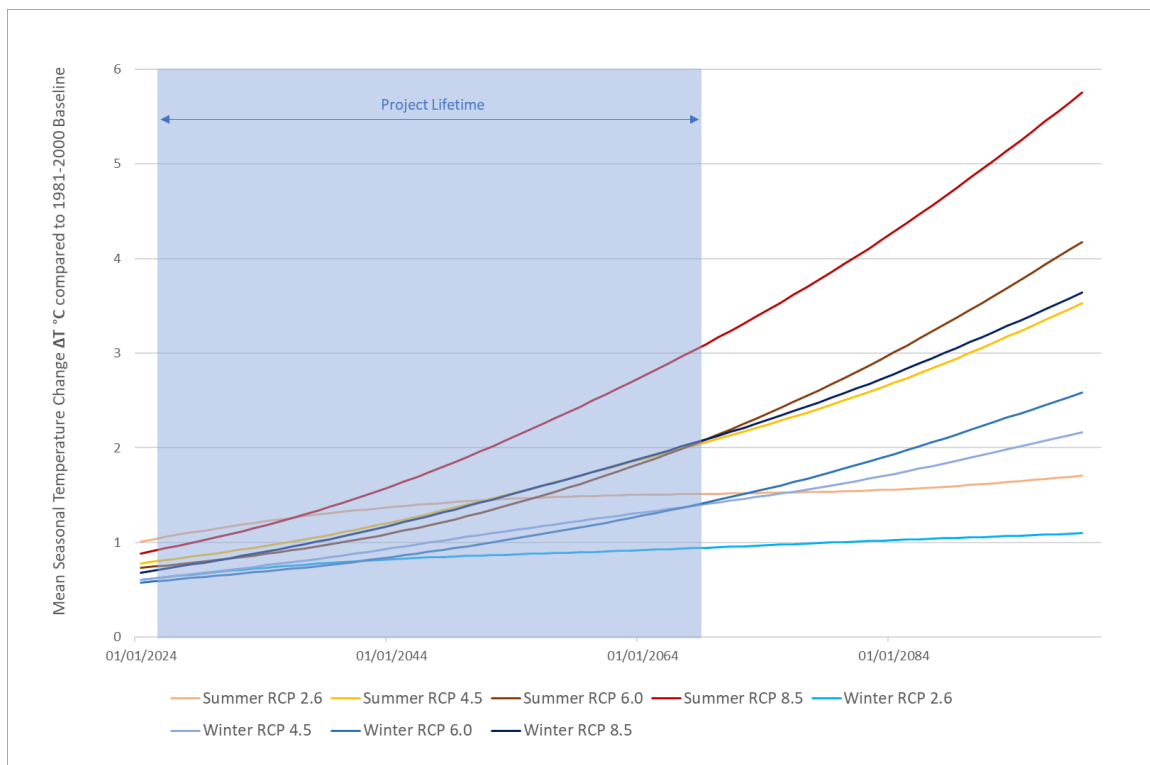
Climate Change Issue	Projected Global Impacts
Solar Radiation	Long-term projected changes in surface solar radiation, because of global warming, would suggest a decrease in available solar power due to a decrease in downwelling shortwave radiation, likely linked to the increase of water vapour and hence cloud presence. Anthropogenic strengthening of ‘natural’ decadal variability in irradiance, known as global dimming and brightening, is influenced by synoptic weather patterns, cloud variations and atmospheric aerosols.

Climate Change Issue	Projected Global Impacts
Increased Global Mean Surface Temperature (GMST)	As stated within Intergovernmental Panel on Climate Change (IPCC) Special Report [30], “The increase GMST, which reached 0.87° C in 2006 – 2015 relative to 1850 – 1900, has increased the frequency and magnitude of impacts” . This strengthens the evidence of how a 1.5° C increase or more, in GMST, could impact natural and human systems.
Heat Waves	The IPCC predict that temperature extremes will increase more rapidly than global mean surface temperature, with the number of hot days projected to increase in most land regions. In the 1.5° C warming scenario heat waves in mid latitudes could warm by up to 3° C.
Extreme Rainfall and Flooding	IPCC and Met Office both suggest a general uncertainty in the projection of changes in heavy precipitation for the UK due to position in the transition zone between north and south Europe’s contrasting projected changes. It is generally agreed that Northern Europe is one of the regions that will experience the largest increase in heavy precipitation events for 1.5° C to 2° C warming. Overall, the UK is expected to see a general increase in precipitation trends up to the year 2100. With slightly wetter winters and drier summers expected to occur annually during the project lifetime.
Storms and Winds	Atmospheric circulations have large variability across interannual through to decadal time scales, which makes forming projections with any reasonable confidence very difficult. There is more robust evidence in the Northern Hemisphere that, since the 1970s, there has been a general poleward shift of storm tracks and jet streams and near-surface terrestrial wind speeds have been declining by approximately 0.1-0.14 ms ⁻¹ per decade across land. Despite anemometers being used for decades to measure near surface wind speed, the data has rarely been used to analyse trends and lacks important instrumentation meta data. In general, confidence is low in wind speed projections due to large uncertainties across global data sets.
Cold Spells and Snow	It has been observed that spring snow cover has been continuing to decrease in extent in the Northern Hemisphere and that cold temperature extremes are projected to decrease along with the number of frost days.

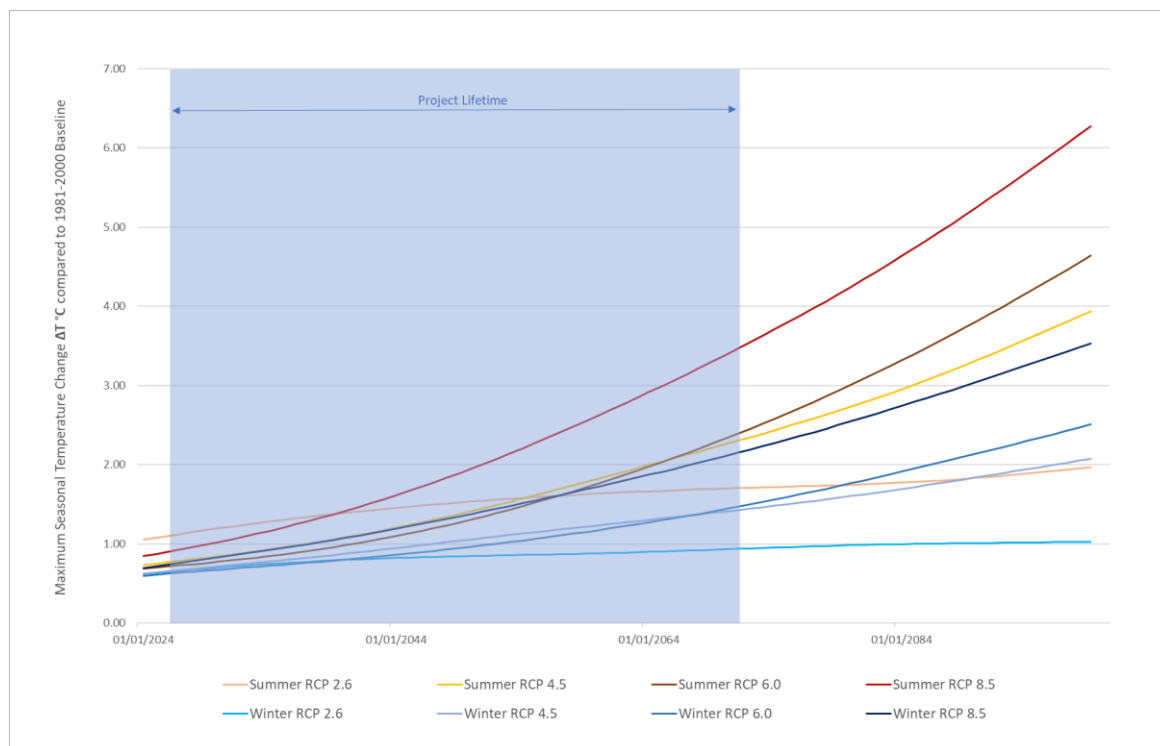
Regional Climate Change Projections

- 7.6.2.20 Climate change projections for the UK (UKCP18 [26]) are based on global climate simulation models to explore regional responses to climate change. UKCP18 considers the effects arising from a series of emissions scenarios and Representative Concentration Pathways (RCP), which project how future climatic conditions in the UK are likely to change at a regional level, taking account of naturally occurring climate variations. Probabilistic projections provide a range of possible climate change outcomes and their relative likelihoods (ranging across 10th to 90th percentiles).
- 7.6.2.21 The UKCP18 dataset provides future climate change projections for land and marine regions, as well as observed climate data for the UK. Analysing time series plume data from UKCP18 provides an indication of climate projections for the regional 25km grid that encompasses the draft Order Limits.
- 7.6.2.22 The following graphs are based on the four RCPs and show how the climate at the location of the Proposed Development could change up to the year 2100, compared

to a 1981-2000 baseline. The RCPs are used to analyse how different emission scenarios could affect climate projections. These range from RCP2.6 where atmospheric emission concentrations are strongly reduced through to the worst-case scenario, RCP8.5, where emission concentrations continue to rise unmitigated.



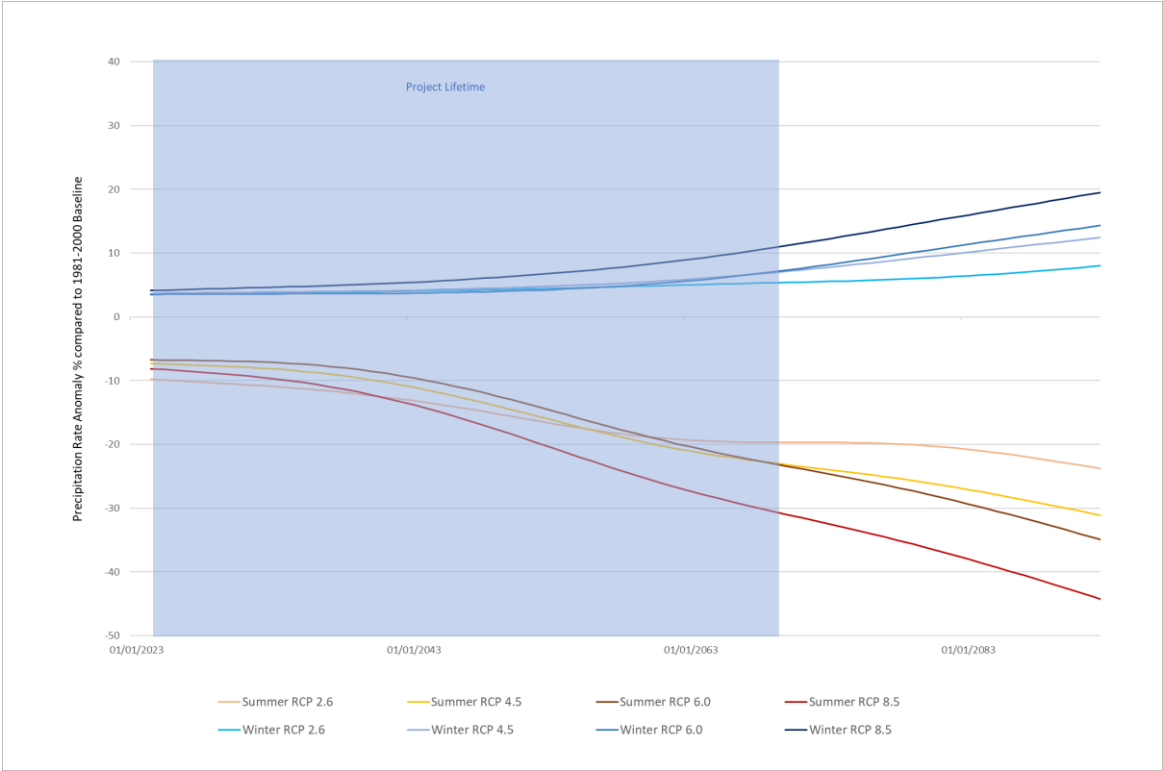
Inset 7-5 ***Projected changes in mean seasonal air temperature across four RCP scenarios, from 2024 - 2100 compared to the 1981 - 2000 baseline, using the probabilistic projections (50th Percentile)***



Inset 7-6 *Projected changes in maximum seasonal air temperature across four RCP scenarios, from 2024 - 2100 compared to the 1981 - 2000 baseline, using the probabilistic projections (50th Percentile)*

7.6.2.23 Inset 7-5 and Inset 7-6 show that the temperature is set to rise in summer and winter, even in a best-case scenario (RCP2.6), until the end of the century. Over the 44.5-year reference time period, the average temperature rise could be between 1.5°C (RCP2.6) and 2.75°C (RCP8.5) in the summer; and 0.9°C (RCP2.6) and 1.9°C (RCP8.5) in the winter. By 2064, maximum temperatures could increase between 1.7°C (RCP2.6) and 2.9°C (RCP8.5) in the summer; and 0.84°C (RCP2.6) and 1.9°C (RCP8.5) in the winter.

7.6.2.24 Inset 7-7 below, shows that summer precipitation rates are reducing over the 44.5-year reference time period, from between -19.8% (RCP2.6) to -28% mm (RCP8.5). Climate projections suggest that winter precipitation rates will increase from between 5.0% (RCP2.6) to 9.3% (RCP8.5) by 2064.



Inset 7-7 Projected changes in seasonal precipitation rate (%) across four RCP scenarios, from 2023 - 2100 compared to the 1981 - 2000 baseline, using the probabilistic projections (50th Percentile)

7.6.2.25 A summary of a range of projected changes to climate variables is provided in Table 7-15, which can be used to build-up a holistic view of future climate and assess potential impacts to determine a future climate baseline.

Table 7-15 Quantitative summary of the future baseline for key climatic variables for the draft Order Limits.

Season	Variable	Time period	Projected change at 50th percentile
Winter	Mean Temperature (°C)	2030s	0.85
		2050s	1.37
		2070s	2.12
	Mean Precipitation (%)	2030s	5.38
		2050s	8.83
		2070s	15.43
Summer	Mean Temperature (°C)	2030s	1.11
		2050s	1.90
		2070s	3.15
	Mean Precipitation (%)	2030s	-13.49
		2050s	-26.15
		2070s	-37.30

7.7 Design Principles, embedded and good practice measures

7.7.1 Design Principles

7.7.1.1 The Proposed Development is being designed with regard to a set of design principles, as described in the draft Design Approach Document (DAD).

7.7.2 Embedded and good practice measures

7.7.2.1 Embedded measures are modifications to the design of a scheme that are an inherent part of the design and do not require additional action to be taken.

7.7.2.2 Good practice measures are standard approaches and actions undertaken to avoid or reduce environmental impacts in line with best practice guidance and legislative requirements.

Greenhouse gas emissions

7.7.2.3 The Proposed Development is currently evolving through an iterative design process. Measures for the Proposed Development relevant to climate change already committed to include the following mitigation measures detailed within the construction, operation and decommissioning phases.

7.7.2.4 Retention of all mature trees, woodland blocks and hedgerow boundaries wherever practical within the Panel Areas. This will ensure construction activities are designed to minimise tree felling and vegetation clearance that may result in the release of GHG emissions and the removal of sequestration potential.

Climate resilience

7.7.2.5 Embedded mitigation includes the following:

- Avoid locating critical infrastructure within Flood Zones 2 and 3, ensuring that solar PV modules are raised above the predicted maximum flood depth for the 100 year plus climate change scenario.
- Sustainable Drainage Systems (SuDS) will be provided at source, ensuring that surface water run-off is managed consistently with existing site conditions.
- Access tracks will be permeable using compacted gravel to allow water to filtrate through and maintain greenfield runoff rates.

7.7.2.6 A suite of management plans relevant to climate change will be in place for the Proposed Development, including:

- Outline Construction Environmental Management Plan (oCEMP)
- Outline Battery Safety Management Plan (oBSMP).
- Outline Landscape and Ecological Management Plan (oLEMP)

- Outline Decommissioning Environmental Management Plan (oDEMP)
- Outline Operational Environmental Management Plan (oOEMP)
- Outline Construction Traffic Management Plan (oCTMP)

7.7.2.7 These management plans incorporate embedded and good practice measures, as well as any further mitigation identified during the EIA.

7.7.2.8 Draft outline versions of these management plans are provided with this PEIR for review during statutory consultation. These will be updated and submitted with the DCO application to secure the commitments contained within. Appropriate Requirements will be included in the DCO application to ensure these management plans will be developed to full versions and submitted to the relevant planning authority for approval. This will take place prior to the commencement of relevant works and measures described in them are implemented.

7.7.2.9 The following measures that are considered standard good practice to be implemented by the Applicant to reduce the likelihood of impacts or their magnitude, if they were to occur. These measures are outlined below:

- Increasing recyclability by segregating construction waste to be re-used and re-cycled where reasonably practicable;
- Adopting the Considerate Constructors Scheme (CCS) to assist in reducing pollution, including GHGs, from the Proposed Development by employing good industry practice measures;
- Designing, constructing and implementing the Proposed Development in such a way as to minimise the creation of non-recyclable waste and maximise the use of alternative materials with lower embodied carbon, such as locally sourced products and materials with a higher recycled content where feasible;
- Reusing suitable infrastructure and resources already available in the draft Order Limits where possible to minimise the use of natural resources and unnecessary materials (e.g. reusing excavated soil for fill requirements or storing, preserving and restoring top soil);
- Implementing a Travel Plan to reduce the volume of construction staff and employee trips to the Proposed Development. Exploring the use of lower carbon modes of transport, to be set out in the worker travel plan. The plan can also involve liaising with construction personnel for the potential to implement car sharing options.
- Switching vehicles and plant off when not in use and ensuring construction vehicles conform to current European Union (EU) emissions standards.
- Conducting regular planned maintenance of the construction plant and machinery to optimise efficiency.
- Preference for the specification of alternative materials with lower embodied GHG emissions for use in replacement parts and routine maintenance activities.
- Low carbon design specifications such as energy-efficient lighting and durable construction materials to reduce maintenance and replacement cycles.

- The use of recycled materials during construction wherever possible.
- Additional planting and/or enhancement of existing habitats seek to use native species that are climate resilient.
- Main river crossings, where required, will use an appropriate trenchless methodology (assumed to be HDD at this stage).

7.8 Assessment of effects

7.8.1 Greenhouse gas emissions

Absolute emissions

- 7.8.1.1 The absolute emissions (Ab) of the Proposed Development are all direct emissions that arise from the lifecycle stages of the Proposed Development. The emissions will be zero or minor because it is assumed that the renewable energy “*will displace (at least in part) fossil fuels*” that are used to create grid electricity generation. Table 7-16 and Table 7-17 state the Ab based on the energy generation of the Proposed Development for the fixed and tracking panels respectively.
- 7.8.1.2 The emissions from BESS have been provided separately, but form part of the overall GHG emissions assessment. The emissions from BESS were calculated using 100kgCO_{2e}/kWh for the cradle-to-grave emissions [20].

Table 7-16 Absolute emissions (Ab) of the Proposed Development (fixed panels)

GROUND MOUNTED SOLAR PV				
	No. Years	Energy Generation (MWh)	Operational Emissions (tCO_{2e}) (Solar PV Emissions Factor: 0kgCO _{2e} /kWh)	Whole Lifecycle Carbon Emissions (tCO_{2e}) (Assuming 615 kgCO _{2e} /kWp)
Annual	1	1,187,136	0	-
Lifetime	40	47,485,440	0	751,344
BESS				
		Storage Capacity (MWh)	Operational Emissions (tCO_{2e}) (BESS Emissions Factor: 0kgCO _{2e} /kWh)	Embodied Emissions (tCO_{2e})
Lifetime	40	2,880 (est.)	0	694,499
OTHER COMPONENTS AND INFRASTRUCTURE				
				Embodied Emissions (tCO_{2e})
Lifetime	40			89,241

TOTAL LIFECYCLE CARBON EMISSIONS

Total WLC emissions (tCO₂e)	1,535,085
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Table 7-17 Absolute emissions (Ab) of the Proposed Development (tracker panels)

GROUND MOUNT SOLAR PV				
	No. Years	Energy Generation (MWh)	Operational Emissions (tCO₂e) (Solar PV Emissions Factor: 0kgCO ₂ e/kWh)	Whole Lifecycle Carbon Emissions (tCO₂e) (Assuming 615 kgCO ₂ e/kWp)
Annual	1	1,155,722	0	-
Lifetime	40	46,228,880	0	655,490
BESS				
		Storage Capacity (MWh)	Operational Emissions (tCO₂e) (BESS Emissions Factor: 0kgCO ₂ e/kWh)	Embodied Emissions (tCO₂e)
Lifetime	40	2,880 (est)	0	694,499
OTHER COMPONENTS AND INFRASTRUCTURE				
				Embodied Emissions (tCO₂e)
Lifetime	40			89,241
TOTAL LIFECYCLE CARBON EMISSIONS				
Total WLC emissions (tCO₂e)				1,638,070

- 7.8.1.3 The potential impact of the WLC emissions associated with the Proposed Development is interpreted below.

Lifecycle assessment

- 7.8.1.4 The release of short-term (over 30 months) greenhouse gas emissions into the atmosphere as a result of the construction of the Proposed Development will have permanent and long-term effects on the global climate. The embodied carbon of solar photovoltaic panels is likely to result in the biggest proportion of whole lifecycle emissions.
- 7.8.1.5 The reduction in the release of long-term (over 40 years) greenhouse gas emissions into the atmosphere because of the operation of the Proposed Development will have long-term, positive effects on the global climate.

- 7.8.1.6 Decommissioning emissions, which will occur more than 15 years after the UK's 2050 net zero target date, are assumed to be minimal but the release of any short-term (24 months) emissions into the atmosphere as a result of the decommissioning of the Proposed Development will have permanent and long-term effects on global climate.
- 7.8.1.7 Using the 615kg/kWp embodied carbon figure used within a paper by Pehl et al (2016) [31], the assumed total embodied carbon for the fixed solar PV modules is 751,344 tCO_{2e}. The embodied emissions from the BESS (including wholesale replacement of the BESS after 20yrs operational lifetime, as well as 50% replacement of components during their operational life) and other elements of site infrastructure, including substations and inverters, have been added to this figure to give total embodied carbon of 1,535,085 tCO_{2e}, as stated in Table 7-18.
- 7.8.1.8 Based on the annual operational emission savings provided in it will take approximately 3.52 years to pay back the embodied carbon of the fixed solar PV system.

Table 7-18 Estimated Embodied Carbon for the Proposed Development (fixed panels)

EMBODIED CARBON	
Embodied carbon per unit (tCO _{2e} /kWp)	0.615
Installed capacity (kWp)	1,155,403
Sequestered carbon (tCO ₂)	0
Embodied carbon in solar PV (tCO _{2e}) including replacements	751,344
Embodied carbon in BESS (tCO _{2e}) including replacements	694,499
Embodied carbon in other infrastructure (tCO _{2e})	89,241
Total embodied carbon (tCO_{2e})	1,535,085
Years to pay back carbon	3.52

- 7.8.1.9 Similarly, for the tracking panels, an embodied carbon figure of 655,490 tCO_{2e} has been predicted based on the lower overall installed capacity in the tracking solar PV panel layout. Including the embodied carbon from the BESS and other site components, the total embodied carbon of the Proposed Development using a tracking system is estimated to be 1,439,230 t CO_{2e}, as shown in Table 7-9.
- 7.8.1.10 A period of 3.39 years is expected for the carbon payback for the tracking panels. This is slightly quicker than the fixed panels because they are more efficient at capturing the sun's insolation, meaning fewer panels are required to generate the same amount of energy.

Table 7-19 Estimated Embodied Carbon for the Proposed Development (tracker panels)

EMBODIED CARBON	
Embodied carbon per unit (tCO ₂ e/kWp)	0.615
Installed capacity (kWp)	1,008,000
Sequestered carbon (tCO ₂)	0
Embodied carbon in solar PV (tCO ₂ e) including replacements	655,490
Embodied carbon in BESS (tCO ₂ e) including replacements	694,499
Embodied carbon in other infrastructure (tCO ₂ e)	89,241
Total embodied carbon (tCO₂e)	1,439,230
Years to pay back carbon	3.39

- 7.8.1.11 The Proposed Development will result in the short-term release of GHG emissions during construction (including embodied emissions), which has a long-term and permanent adverse effect contributing to global warming and climate change. However, during the rest of its operational life the Proposed Development will generate electricity without producing emissions, offsetting other fossil fuel generation.
- 7.8.1.12 The embedded emissions from the BESS, and emissions associated with the replacement of battery components during the operational phase increase the overall emissions from the Proposed Development. However, the operation of the BESS will also allow the Proposed Development as a whole to offset much higher carbon generating assets such as gas peaking plant or diesel generation which is generally deployed when the grid is under stress.
- 7.8.1.13 In line with the IEMA guidance [13], it is therefore beneficial to also assess the development against the sectoral baseline (Baseline B) which results in a more balanced assessment.
- 7.8.1.14 In this instance, it is appropriate to consider the relative emissions of solar PV compared to natural gas generation. This is because the solar PV generation is intended to displace natural gas generation.
- 7.8.1.15 Taking the natural gas scenario, the relative emissions are negative, therefore, showing a net reduction in whole lifecycle carbon emissions. These negative emissions have been determined to have a beneficial impact on climate change in comparison to a CCGT.

Table 7-20 *Total emission savings of the Proposed Development compared to natural gas equivalent (fixed panels)*

RELATIVE EMISSIONS	
Baseline Emissions (tCO ₂ e)	19,219,889
Absolute Emissions (tCO ₂ e)	1,535,085
Relative Emissions (tCO ₂ e)	-17,684,804
Total Emission Savings (tCO₂e)	17,684,804

Table 7-21 *Total emission savings of the Proposed Development compared to natural gas equivalent (tracker panels)*

RELATIVE EMISSIONS	
Baseline Emissions (tCO ₂ e)	18,713,654
Absolute Emissions (tCO ₂ e)	1,439,230
Relative Emissions (tCO ₂ e)	-17,274,424
Total Emission Savings (tCO₂e)	17,274,424

7.8.1.16 The emission savings from using fixed solar PV panels, instead of natural gas over the lifetime of the project totals approximately 17,684,804 tCO₂e, as shown in Table 7-20. For the tracking panel installation this is expected to be 17,274,424 tCO₂e (see Table 7-21). This positive impact, derived from the negative relative emissions, demonstrates the substantial lifetime emission savings associated with energy generated from the Proposed Development, compared to the equivalent amount of electricity supplied from natural gas.

7.8.1.17 Although, when the whole lifecycle of the Proposed Development is taken into account, the GHG impacts are above zero, the project would indirectly result in a reduction in atmospheric GHG concentration, through offsetting sources of electricity generation with higher emissions. Although UK grid average emissions are lower than those used in the baseline assessment (which is comparing whole life carbon of generators that provide electricity to the grid as opposed to operational emissions which is only part of the total) the project will still result in avoided emissions. As such, in line with IEMA's definitions of significance, seen in Table 7-10, the impacts on GHG emissions from the Proposed Development are **Beneficial**, which is **Significant**.

Climate resilience

7.8.1.18 The Proposed Development is assumed to have a design life of 40 years, plus the time required to construct and decommission. Climate conditions are expected to change over this period and have the potential to negatively impact the Proposed Development, affect the efficiency of solar generation and potentially increase the

frequency of repair and replacement. Table 7-22 identifies the climate resilience effects and describes the likely impact they will have on the Proposed Development.

Table 7-22 *Likely significant effects of climate change that may affect the Proposed Development*

Parameter	General impact
Soil drying	The Proposed Development may be vulnerable to ground shrinkage failure due to affected foundations in clay soils.
Increase in temperature	High temperatures and heat waves may result in overheating and/or heat stress of materials and structures.
Extreme rainfall and flooding	The Proposed Development may be vulnerable to damage to wires, landslides or ground shrinkage, and damage to structures or drainage systems.
Gales, storms, extreme weather	The Proposed Development may be vulnerable to extreme weather events such as storm damage to structures and assets.

Construction

Susceptibility & vulnerability

7.8.1.19 The results of the assessment of the susceptibility and vulnerability of receptors existing within the construction phase are given in Table 7-23.

Table 7-23 *Assessment of Susceptibility and Vulnerability of receptors during construction*

Climate Change Issue	Receptors Impacted	Susceptibility (Low / Medium / High)	Vulnerability (Low / Medium / High)	Sensitivity of Receptors
Increase in temperature	Solar PV module structure, substations, BESS, site workers	Low	Low	Low
Extreme rainfall and flooding		Low	Medium	Medium
Snow and Ice		Low	Low	Low
Gales, Storms, Extreme Weather		Low	Medium	Medium
Solar Radiation		Low	Medium	Medium
Cloud Cover		Low	Low	Low
Soil Drying		Low	Low	Low

Magnitude of Impacts

7.8.1.20 The level of consequence considers the likelihood of the event occurring and both the value and sensitivity of the receptor to the climatic impact. The latter has been determined based on the susceptibility and vulnerability of the receptor to the various climatic impacts.

Table 7-24 Assessment of Magnitude of climate change Impacts during construction

Climate Change Issue	Likelihood	Consequence	Magnitude of Impact
Increase in temperature	Low	Minor Adverse	Minor Adverse
Extreme rainfall and flooding	Low	Minor Adverse	Minor Adverse
Snow and Ice	Very Low	Minor Adverse	Minor Adverse
Gales, Storms, Extreme Weather	Low	Minor Adverse	Minor Adverse
Solar Radiation	Very Low	Minor Adverse	Minor Adverse
Cloud Cover	Low	Minor Adverse	Minor Adverse
Soil Drying	Low	Minor Adverse	Minor Adverse

7.8.1.21 The impact of changes to the future climate baseline for the Proposed Development during the operational phase (summarised in Table 7-24) has been assessed to be of low or very low likelihood and minor consequences with the consideration of embedded mitigation.

Significance matrix

7.8.1.22 In-line with the IEMA guidance, the significance matrix is used to reach a reasoned conclusion on the level of effect on climate change on the Proposed Development, as shown in Table 7-25, is based on a combination of the probability (which considers mitigation) and consequence (which considers the receptor sensitivity) of the climate change impact on the Proposed Development.

Table 7-25 Assessment of Significance of climate change effects during construction

Climate Change Issue	Sensitivity of Receptors	Magnitude of Impact	Significance of Effect
Increase in temperature	Low	Minor Adverse	Not Significant
Extreme rainfall and flooding	Medium	Minor Adverse	Not Significant
Snow and Ice	Low	Minor Adverse	Not Significant
Gales, Storms, Extreme Weather	Medium	Minor Adverse	Not Significant
Solar Radiation	Medium	Minor Adverse	Not Significant
Cloud Cover	Low	Minor Adverse	Not Significant
Soil Drying	Low	Minor Adverse	Not Significant

Operation

Susceptibility & vulnerability

7.8.1.23 The results of the assessment of the susceptibility and vulnerability of receptors existing within the operational phase are given in Table 7-26. These are assessed

taking into account the embedded mitigation measures highlighted in section 7.7.2.7.

Table 7-26 Assessment of Sensitivity of receptors during operation

Climate Change Issue	Receptors Impacted	Susceptibility (Low / Medium / High)	Vulnerability (Low / Medium / High)	Sensitivity
Increase in temperature	Solar PV module structure, BESS, plant, workers. Visitors to site, habitat mitigation	Low	Low	Very Low
Extreme rainfall and flooding		Low	Low	Very Low
Snow and Ice		Low	Low	Very Low
Gales, Storms, Extreme Weather		Low	Low	Very Low
Solar Radiation		Low	Low	Very Low
Cloud Cover		Low	Low	Very Low
Soil Drying		Low	Low	Very Low

Magnitude of Impacts

- 7.8.1.24 The level of consequence considers the likelihood of the event occurring and both the value and sensitivity of the receptor to the climatic impact during the operation phase. The latter has been determined based on the susceptibility and vulnerability of the receptor to the various climatic impacts.

Table 7-27 Assessment of Magnitude of climate change Impacts during operation

Climate Change Issue	Likelihood	Consequence	Magnitude of Impact
Increase in temperature	Low	Minor Adverse	Minor Adverse
Extreme rainfall and flooding	Low	Minor Adverse	Minor Adverse
Snow and Ice	Very Low	Minor Adverse	Minor Adverse
Gales, Storms, Extreme Weather	Low	Minor Adverse	Minor Adverse
Solar Radiation	Very Low	Minor Adverse	Minor Adverse
Cloud Cover	Low	Minor Adverse	Minor Adverse
Soil Drying	Low	Minor Adverse	Minor Adverse

- 7.8.1.25 The impact of changes to the future climate baseline for the Proposed Development during the operational phase (summarised in Table 7-27) has been assessed to be of low or very low likelihood and minor consequences with the consideration of embedded mitigation.

Significance matrix

- 7.8.1.26 In line with the IEMA guidance, the significance matrix is used to reach a reasoned conclusion on the magnitude of the impact of climate change on the Proposed Development, as shown in Table 7-28, is based on a combination of the probability (which considers embedded mitigation) and consequence (which considers the receptor sensitivity) of the climate change impact on the Proposed Development.

Table 7-28 Assessment of Significance of climate change effects during operation

Climate Change Issue	Sensitivity of Receptors	Magnitude of Impact	Significance of Effect
Increase in temperature	Very Low	Minor Adverse	Not Significant
Extreme rainfall and flooding	Very Low	Minor Adverse	Not Significant
Snow and Ice	Very Low	Minor Adverse	Not Significant
Gales, Storms, Extreme Weather	Very Low	Minor Adverse	Not Significant
Solar Radiation	Very Low	Minor Adverse	Not Significant
Cloud Cover	Very Low	Minor Adverse	Not Significant
Soil Drying	Very Low	Minor Adverse	Not Significant

Increased average temperatures and incidence of heatwaves

- 7.8.1.27 At the end of the 44.5-year reference time period, temperatures within the RCP8.5 scenario are projected to increase by 3.0°C.
- 7.8.1.28 The solar PV modules are proposed to be a maximum of 3-3.5 m above ground. This will reduce the impact of increasing temperature on output efficiency. With less than a 1.2% change in efficiency and air ventilation, the impact of increased temperature on Proposed Development is minor.
- 7.8.1.29 Therefore, the impact of increased temperature from the projected climatic changes of a RCP8.5 scenario remains within tolerable thresholds and the effect on the efficiency of the panels is likely to be small.

Increased frequency of heavy precipitation events

- 7.8.1.30 At the end of the 44.5-year reference time period, precipitation anomalies within the RCP8.5 scenario are projected to increase by 10% during the winter.
- 7.8.1.31 The risk of flooding to areas downstream of the Proposed Development may increase as a result of development due to an increase in impermeable area and an increase in rainfall intensity (i.e. climate change) resulting in increased rates and volumes of surface water runoff. To mitigate this increased risk, it is proposed that surface water runoff from the Proposed Development is managed in a sustainable manner and in accordance with Environment Agency and LLFA guidelines.

- 7.8.1.32 There is always a possibility that the design standards of any proposed flood risk management measures will be exceeded by an extreme storm event. As any mitigation will be designed in accordance with the Environment Agency guidelines, it is considered that the residual risk will be minimal.
- 7.8.1.33 The design and assessment process set out in the Flood Risk Assessment (FRA), will consider whether it is necessary to raise ground levels within the draft Order Limits to help protect sensitive electrical equipment such as BESS, inverters and substation units if these cannot be removed from flood risk areas through refinements to the site layout and design. A Preliminary FRA is provided as Appendix 14.1 to this PEIR.
- 7.8.1.34 With the proposed embedded mitigation, it is considered that the proposed mitigation features will be sufficient in ensuring that the Proposed Development is resilient to increased flood risk with climate change.
- 7.8.1.35 The overall magnitude of the climatic impacts on receptors within the operation phase, as shown in Table 7-28 is Minor Adverse and the effect would be **Not Significant**.

Decommissioning

Susceptibility & vulnerability

- 7.8.1.36 The results of the assessment of sensitivity, determined by the susceptibility and vulnerability of receptors existing within the decommissioning phase, are given in Table 7-29.

Table 7-29 Assessment of Susceptibility and Vulnerability of receptors during decommissioning

Climate Change Issue	Receptors Impacted	Susceptibility (Low / Medium / High)	Vulnerability (Low / Medium / High)	Sensitivity
Increase in temperature	Array structure, substations, BESS, site workers	Low	Low	Very Low
Extreme rainfall and flooding		Low	Medium	Low
Snow and Ice		Low	Low	Very Low
Gales, Storms, Extreme Weather		Low	Medium	Low
Solar Radiation		Low	Medium	Low
Cloud Cover		Low	Low	Very Low
Soil Drying		Low	Medium	Low

Magnitude of Impacts

Table 7-30 *Assessment of Magnitude of climate change Impacts during decommissioning*

Climate Change Issue	Likelihood	Consequence	Magnitude of Impact
Increase in temperature	Low	Minor Adverse	Minor Adverse
Extreme rainfall and flooding	Low	Minor Adverse	Minor Adverse
Snow and Ice	Very Low	Minor Adverse	Minor Adverse
Gales, Storms, Extreme Weather	Low	Minor Adverse	Minor Adverse
Solar Radiation	Very Low	Minor Adverse	Minor Adverse
Cloud Cover	Low	Minor Adverse	Minor Adverse
Soil Drying	Low	Minor Adverse	Minor Adverse

7.8.1.37 The impact of changes to the future climate baseline for the Proposed Development during the decommissioning phase (summarised in Table 7-30) has been assessed to be of low or very low likelihood and minor consequences with the consideration of embedded mitigation.

Significance matrix

Table 7-31 *Assessment of Significance of climate change effects during decommissioning*

Climate Change Issue	Sensitivity of Receptors	Magnitude of Impact	Significance of Effect
Increase in temperature	Very Low	Minor Adverse	Not Significant
Extreme rainfall and flooding	Low	Minor Adverse	Not Significant
Snow and Ice	Very Low	Minor Adverse	Not Significant
Gales, Storms, Extreme Weather	Low	Minor Adverse	Not Significant
Solar Radiation	Low	Minor Adverse	Not Significant
Cloud Cover	Very Low	Minor Adverse	Not Significant
Soil Drying	Low	Minor Adverse	Not Significant

7.8.1.38 Activities carried out during the decommissioning phase will likely mirror the construction phase, but the climate may have altered substantially during the intervening period.

7.8.1.39 Although weather during the decommissioning phase may be more erratic and volatile than during construction, the process will be short and temporary and, provided suitable planning is made to ensure site safety during this time, there are

not expected to be any excessive risks. The overall effect of the climatic impacts on receptors (workers) within the decommissioning phase is Minor Adverse and the effect would be **Not Significant**.

7.9 Additional mitigation

Greenhouse gas emissions

- 7.9.1.1 The whole lifecycle emissions for the Proposed Development are considered to be beneficial overall. No additional mitigation measures are identified as required at this stage.
- 7.9.1.2 In conclusion, although some emissions are unavoidable and will have an adverse effect on the global climate, the generation of renewable energy as opposed to a fossil fuel alternative (natural gas) will have a much larger positive effect (reduced GHG emissions) in the short, medium and long term on the global climate. Therefore, the overall assessment on the Proposed Development concludes that the level of effects will be **Beneficial** and **Significant**, with no further mitigation required.

Climate resilience

- 7.9.1.3 No further mitigation measures are identified as required, as the embedded mitigation measures demonstrate the level of effects for the construction, operation and decommissioning phases as Minor Adverse and **Not Significant**.

7.10 Residual effects

- 7.10.1.1 No further mitigation has been identified and therefore residual effects remain as reported in Section 7.8.

7.11 Monitoring

- 7.11.1.1 No monitoring has been identified as required.

7.12 Opportunities for enhancement

- 7.12.1.1 No opportunities for enhancement were considered related to climate change.

7.13 Summary

- 7.13.1.1 Table 7-32 presents a summary of the greenhouse gas emissions impact assessment, which can be applied to both the fixed and tracking panel layouts, detailing further mitigation requirements and residual effects.
- 7.13.1.2 Table 7-33 presents a summary of the climate resilience assessment, similarly addressing any additional mitigation requirements and residual effects.

Table 7-32 Climate Change (assessment of GHG emissions) - Preliminary assessment summary

Receptor	Embedded and good practice measures	Description of impact and magnitude	Significance of effect	Additional mitigation	Residual effect
Global climate	Production of GHG emissions during construction, operation and decommissioning of the Proposed Development (long term and permanent) but vastly more emissions offset by displacement of fossil fuel generation.	Beneficial	Significant	None identified	Beneficial and Significant

Table 7-33 Climate Change (assessment of climate resilience) - Preliminary assessment summary

Receptor	Embedded and good practice measures	Description of impact and magnitude	Significance of effect	Additional mitigation	Residual effect
Construction					
Solar PV module structure, substations, BESS, site workers	None identified	Minor adverse	Minor adverse, not significant	None identified	Minor Adverse, Not Significant
Operation					
Solar PV module structure, BESS plant, workers. Visitors to site,	Access tracks will be permeable using compacted	Minor adverse	Minor adverse, not significant	None identified	Minor Adverse, Not Significant

Receptor	Embedded and good practice measures	Description of impact and magnitude	Significance of effect	Additional mitigation	Residual effect
habitat mitigation, planting	- gravel to allow water to filtrate through and maintain greenfield runoff rate - SuDS will be provided at source, where practicable, ensuring that surface water run-off is managed consistently with existing site conditions. - Avoid locating critical infrastructure within Flood Zones 2 and 3, ensuring that solar PV modules are raised above the predicted maximum flood depth for the 100 year plus climate change scenario.				

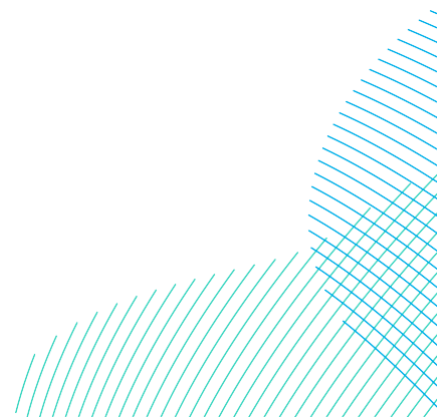
Receptor	Embedded and good practice measures	Description of impact and magnitude	Significance of effect	Additional mitigation	Residual effect
Decommissioning					
Solar PV module structure, substations, BESS, site workers	None identified	Minor adverse	Minor adverse, not significant	None identified	Minor Adverse, Not Significant

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