West Burton Solar Project

Environmental Statement

Chapter 7: Climate Change

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Contents

7	**CLIMATE CHANGE**	**3**
7.1	INTRODUCTION	3
7.2	CONSULTATION	3
7.3	POLICY CONTEXT	12
7.4	ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA	16
7.5	ASSESSMENT ASSUMPTIONS AND LIMITATIONS	22
7.6	BASELINE CONDITIONS	23
7.7	EMBEDDED MITIGATION	27
7.8	ASSESSMENT OF LIKELY IMPACTS AND EFFECTS	29
7.9	IN COMBINATION ASSESSMENT	48
7.10	MITIGATION MEASURES	50
7.11	CUMULATIVE EFFECTS	51
7.12	RESIDUAL EFFECTS	52
7.13	REFERENCES	53

Issue Sheet

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DCO Submission

Environmental Statement Chapter 7: Climate Change

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7 Climate Change

7.1 Introduction

7.1.1 This Chapter of the Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) concerning the potential impacts of the Scheme on the Climate during the construction, operation and maintenance and decommissioning stages. The resilience of the Scheme to physical impacts caused by climate change has also been considered.

7.1.2 The following aspects will be evaluated in the climate change assessment process and will align with the requirements of the Infrastructure Planning (Environmental Impact Assessment) Regulations (2017) (Ref 7.1):

- Lifecycle greenhouse gas (GHG) impact assessment – The impact of GHG emissions arising from the Scheme on the climate over its lifetime;
- Climate Change resilience (CCR) Review – The resilience of the Scheme to climate change impacts; and
- In-combination Climate Change Impact (ICCI) – The combined impact of the Scheme and future climate change on the receiving environment.

7.1.3 This Climate Change Assessment has been undertaken by Bureau Veritas Ltd (see Statement of Competence **[EN010132/APP/WB6.3.1.1]**).

7.2 Consultation

7.2.1 For this Scheme, the stakeholders that have been involved are statutory consultees, landowners, local communities, land managers and heritage groups.

7.2.2 Since September 2021, monthly meetings have been scheduled with all four host authorities involved in the Scheme (Lincolnshire County Council, Nottinghamshire County Council, Bassetlaw District Council and West Lindsey District Council). Climate change has been part of the discussions during these meetings.

7.2.3 The following table (Table 7.1) outlines the consultation to date and at what stage of the project this took place.

Table 7.1 – Main Matters Highlighted During Consultation

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
Planning Inspectorate (EIA Scoping March 2022)	The ES should also consider how other developments cumulatively may affect the vulnerability of the Proposed Development to climate change e.g. any changes in flood flows, and cumulative GHG emissions/savings.	This has been addressed within the ES. In particular, three other nearby major Solar Projects have been taken into consideration (Cottam,	Cumulative Assessment (7.11 of this Chapter)

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
		Tillbridge and Gate Burton Solar Projects)	
Planning Inspectorate (EIA Scoping March 2022)	The adjacent River Trent is noted to be a tidal river subject to flood defences, for which the EA has issued new modelling 'Tidal Trent Climate Change Scenarios 2021'	Latest UK Climate Projections (UKCP) and EA modelling including Tidal Trent Climate Change Scenarios 2021 has been used in the CCR and Hydrology assessment.	CCR assessment (Section 7.9)
Planning inspectorate (EIA Scoping March 2022)	The ES should include an assessment of in-combination impacts from sea level rise where significant effects are likely to occur.	Climate Change including in-combination impacts from sea level rise scoped into ES	CCR assessment (Section 7.9)
Planning inspectorate (EIA Scoping March 2022)	The ES should utilise the most up to date modelling available.	Latest UKCP modelling has been used in the CCR assessment. Latest versions of ICE and UK Government GHG Conversion Factors for Company Reporting tools used.	Referenced throughout
West Lindsey District Council (EIA Scoping March 2022)	It is suggested that assessment of sea level rise in the climate change resilience review should remain in the scope of the ES.	Included as assessment within this ES Chapter	CCR assessment (Section 7.9)
West Lindsey District Council (EIA Scoping March 2022)	Specific reference to use of the IEMA guidance. (IEMA EIA Guide to: Climate Change Resilience and Adaptation (2020))	This has been considered and referenced throughout this chapter.	Included as Ref 7.21
Bassetlaw District Council (EIA Scoping March 2022)	It is considered that a full climate change chapter should be scoped into the ES rather than a proportionate one to allow a full assessment to be undertaken in this regard.	Climate Change scoped into the ES	n/a

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
Lincolnshire County Council (EIA Scoping March 2022)	The potential for a microclimate to be created by battery storage.	The design of the battery storage will allow for natural ventilation in order to prevent a microclimate from being generated.	Scheme Design
Lincolnshire County Council (EIA Scoping March 2022)	What is the energy consumption and associated carbon emissions of the battery system?	Assessed as part of GHG assessment	GHG assessment (Section 7.8)
Lincolnshire County Council (EIA Scoping March 2022)	What are the carbon emissions associated with the solar PV panels themselves –separated into manufacture, operation, and maintenance (and which panels are to be used – poly, multi, single crystal silicon)? Is the embedded carbon associated with the panel manufacture included in any payback of carbon (bearing in mind that the panels are likely to be imported)?	Solar Panel Types are Bifacial monocrystalline panels. Embodied carbon assessed as part of GHG assessment	GHG assessment (Section 7.8)
Lincolnshire County Council (EIA Scoping March 2022)	Power losses and associated carbon footprint of connecting cables to the grid need estimating	Details on cabling are included and assessed as part of the GHG assessment	GHG assessment (Section 7.8)
Lincolnshire County Council (EIA Scoping March 2022)	With regard to greenhouse Gas Emissions this should be directly compared to the number of years it will take for development to be carbon neutral. However, to get a true reflective understanding of the benefits/harm to the environment it should be compared to a least one fossil fuel, nuclear and at least one alternative renewable energy. It is considered that by doing this the clear environmental benefits should be highlighted and allow	Assessed as part of GHG assessment	GHG assessment (Section 7.8)

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
	for careful consideration against the impacts of the development.		
Natural England (EIA Scoping March 2022)	The ES should identify how the development affects the ability of the natural Environment to adapt to climate change, including, its ability to provide adaption for people.	CCR assessment included	CCR assessment (Section 7.9)
Natural England (EIA Scoping March 2022)	Consideration of net zero by 2050.	Calculation of Carbon Neutrality included	Assessment of Likely Significant Effects (Section 7.8)
Gringley on the Hill Parish Council (EIA Scoping March 2022)	We would support the use of a quantitative approach to life cycle GHG emissions assessment. This is to provide a balanced representation of the current land use vs the proposed development and to ensure due consideration is given to the potential carbon emissions during construction i.e., from the level of ground disturbance required to construct the foundations, drainage, and soil handling on site.	Included as part of GHG assessment	GHG assessment (Section 7.8)
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	The plant sits on 1,300ha of land with an expected output power of 480MW. Land allocated fits the requirement of 2ha for every 1 MW of PV size.	No response required	No response required
University of Derby on behalf of Lincolnshire County Council	Energy output in the 1st year is estimated at 583,500MWh. Estimates from other solar resource assessment tools put the yearly energy output at 452,000MWh. See Figure 2 for a	Updated figures within ES Chapter	Section 7.5

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
(PEIR Response July 2022)	comparison with energy output from the Global Solar Atlas platform (GSA).		
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	What type of tracking is considered in the design, and how much of an increase in efficiency and energy yield is expected?	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	Battery capacity has also not been stated in the PIER document, however, definite land size of 0.8ha has been allocated. Allocation of land size does not equate to the number of battery cabins that can be installed and the capacity of the BESS unit. For instance, a 2 MW BESS unit occupying 48m2 could accommodate 25 BESS units (400MWh of storage capacity) if only 15% of the land area allocated in the PIER is used , see Fig 3. Batteries carry a lot of weight in the overall GHGs calculations due to their embodied carbon and decommissioning methods. Figure 3 shows the total embodied emissions (assuming an intensity of 150kgCO2/kWh) from different estimations of BESS capacity.	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire County Council	How are the batteries going to be decommissioned considering they will be replaced several times over the plant's lifespan?	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
(PEIR Response July 2022)			
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	What is the total battery capacity? Especially knowing that a given land area can accommodate well 25 BESS units (conservative estimate).	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	Analysis of GHG emissions GHG emissions in PV plants are typically categorised into Construction, Operation and Decommissioning stages. A wholesome value from the construction stage is taken as the representative emissions from the plant over its entire life in the scheme. The emissions source highlighted during the construction stage does not fully state other possible emissions sources: water use, fuel use, switch gears, fencing, module structure, cables and batteries. The operational and decommissioning stages have not been provided with an estimate of the associated GHGs.	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	Although the total GHGs from the construction stage are mentioned as the worst case scenario in the PIER (7.8.13), what other sources of emissions (aside from table 7.12) have been considered in the 'worst-case' estimate?	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	What are the possible emissions during the operation stage? What is the replacement rate for the sources of emissions identified in the operations stage?	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	What are the emissions sources and total carbon emissions in the decommissioning stage?	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	What is the replacement rate of the batteries during the operational stage? Analysis of Grid decarbonization The UK's grid has been witnessing gradual decarbonisation over the years, with 60% decarbonisation achieved in 10 years (between 2009 and 2109). The Future Energy Scenarios (FES 2022) sets out credible ways that the UK can achieve Net Zero by 2050, as well as the UK Government's commitment to a decarbonised electricity system by 2035. Based on extensive stakeholder engagement, research and modelling, each scenario considers how much energy we might need; where it could come from; and how we maintain a system that is reliable.	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	**Without grid decarbonisation** considered in the scheme GHG savings calculation, offset of construction emissions is achieved in the 6th year, and a net savings of about 3.5 million tonnes of CO2 can be achieved over the project's lifespan.	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	When 'Falling Short' projections from FES are considered, the net savings from the plant is calculated to be about 250,000tCO2 and offset now pushed to the 12th year for the bifacial and tracking PV system (Figure 6). Please note Figure 6 also considers operation GHGs emissions and battery replacements.	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	Is grid decarbonisation considered in the GHG emissions estimations and what is the total net savings from the plant with a decarbonising grid?	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	What are projections of grid decarbonisation over the lifespan of the project?	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9
University of Derby on behalf of Lincolnshire	GHG Intensity comparison with other forms of Energy Generation Technologies is broad. Can an estimate of the net GHG savings	Meeting with Lanpro, BV, UoD and LCC on	Refer to paragraphs 7.2.4-7.2.9

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
County Council (PEIR Response July 2022)	of an equally rated power plant (as West Burton) be made?	13/9/22 and included within this ES Chapter.	
University of Derby on behalf of Lincolnshire County Council (PEIR Response July 2022)	Climate change (including the impact of the development itself) has been scoped into the PEIR which is welcomed by the Local Planning Authority. The chapter within the PEIR itself appears comprehensive and assesses key baselines. Although the development itself will inevitably produce some carbon emissions, especially during the construction and decommissioning phases, it is clear that these will be more than mitigated for by the provision of 480 MW of clean energy per annum. Nevertheless, efforts to reduce carbon emissions produced by the project should be carried forward.	Meeting with Lanpro, BV, UoD and LCC on 13/9/22 and included within this ES Chapter.	Refer to paragraphs 7.2.4-7.2.9

7.2.4 The following information is provided in response to queries raised on behalf of Lincolnshire County Council during the Statutory Consultation stage (July 2022).

7.2.5 The yearly production number for periods between 1994 -2018 of 1,100 kWh/kWp is based on fixed mounting structures and monofacial solar modules. The DCO Application will retain the option to build either fixed mounting structures; or tracking mounting structures. Tracking mounting structures present a worst case scenario from a Climate Change perspective as additional materials are required compared to a fixed structure and therefore have been assessed in the ES. The current design is based on tracking mounting structures with backtracking technology, bifacial high efficiency modules. All these updated components will increase the energy output of the PV projects.

7.2.6 Single-axis tracking technology will be used as part of the design – axis oriented N-S with modules rotating E-W tracking with backtracking strategy for tracking arrays: when the mutual shadings begin, the tracking angle does not follow the sun anymore, but it instead goes back (decreases) so that no shading occurs. Generally, a solar panel system with a single-axis solar tracker installed sees a performance gain of anywhere between 10 to 30 percent compared to a fixed mounting system.

7.2.7 The proposed Energy Storage Facility (or BESS) will be located at West Burton 3. Following consultation with typical battery suppliers, for the purpose of the calculation of Greenhouse Gas Emissions, the batteries have been assessed as being replaced once over the anticipated 40 year lifespan of the project. The batteries will be recycled insofar as practical and with the technology available at the time of replacement.

7.2.8 A description of the Energy Storage Facility is provided in Chapter 4 of the ES 'Scheme Description' **[EN010132/APP/WB6.2.4]**.

7.2.9 In response to queries raised by Derby University, acting on behalf of Lincolnshire County Council, during the consultation process, reference is made to National Grid's document on Future Energy Scenarios (Ref 7.35). As part of this, one of the key recommendations is to increase Wind and Solar energy generation to 66% of all energy generated of Britain's energy supply by 2030.

7.3 Policy Context

7.3.1 The following legislation, planning policy and guidance relating to climate change is relevant to the Scheme:

- Climate Change Act 2008 (Ref 7.2)
- Climate Change Act 2008 (2050 target amendment) (Ref 7.3)
- Carbon Budgets Order (2009) (Ref 7.4) Carbon Budget Order (2011) (Ref 7.5), Carbon Budget Order (2016) (Ref 7.6), Carbon Budget Order (2021) (Ref 7.7)
- National Policy Statement (NPS) EN-1 (Ref 7.8), with particular reference to paragraphs 2.2.9 and 4.8.2 in relation to climate impacts and adaptation; paragraphs 4.1.3 to 4.1.4 in relation to adverse effects and benefits; paragraphs 4.2.1, 4.2.3, 4.2.4, 4.2.8 to 4.2.10 in relation to Environmental Statement assessment methodology; 4.5.3 and 4.8.1 to 4.8.12 in relation to adaptation measures in response to climate projections; and paragraphs 5.7.1 to 5.7.2 in relation to climate projections, flood risk and the importance of relevant mitigation.
- The Revised (Draft) National Policy Statements for Energy; Business, Energy and Industrial Strategy Committee (Ref 7.10) has also been reviewed for relevant emerging policy;
- NPS EN-5 (Ref 7.11) – paragraph 2.4.1 regarding NPS EN-1 and the importance of climate change resilience, and paragraph 2.4.2 in relation to ES requirements regarding climate change resilience. Draft update to NPS EN-5 (Ref 7.12) paragraph 2.6 in relation to Climate Change resilience.

- National Planning Policy Framework (NPPF) (Ref 7.13) – paragraphs 8, 20 and 149 in relation to adaptation, mitigation and climate change resilience; paragraphs 148 and 157 in relation to flood risk and damage to property and people; paragraphs 150 and 153 in relation to reduction of CO2 emissions through design and reduced energy consumption; and paragraphs 155 to 165 in relation to climate projections, associated flood risk and adaptation.
- Planning Practice Guidance, Climate Change (March 2019) (Ref 7.14)
- Lincolnshire County Council Carbon Management Plan (2019) (Ref 7.15)
- Nottinghamshire County Council Carbon Management Plan (2007) (Ref 7.16)
- West Lindsey District Council Sustainability, Climate Change and Environment Strategy (2021) (Ref 7.17)
- Central Lincolnshire draft Local Plan- in relation to Climate Change (Ref 7.18)
- Bassetlaw District Council Renewable and Low carbon study (2010) (Ref 7.19)
- Bassetlaw draft Local Plan (Ref 7.20), specifically policy ST50: Climate Change Mitigation and Adaptation

Climate Change Act 2008

7.3.2 The Climate Change Act 2008 sets a target year of 2050 for the reduction of targeted greenhouse gas emissions.

Carbon Budgets Order

7.3.3 As set out by the UK Government, under a system of carbon budgets, every tonne of greenhouse gases emitted between now and 2050 will count. Where emissions rise in one sector, the UK will have to achieve corresponding falls in another.

7.3.4 The Carbon Budgets have been used within this assessment to inform whether development emissions would be significant.

National Policy Statement

7.3.5 National Planning Policy Statement (NPS) EN-1 is the overarching policy statement for Energy. NPS EN-3 is focused on Renewable Energy and NPS EN-5 is focused on Electricity Network Infrastructure.

7.3.6 Section 1.7.5 of NPS EN-1 states that

"*As required by the SEA Directive, Part 3 of the AoS of EN-1 also includes an assessment of reasonable alternatives to the policies set out in EN-1 at a strategic level. In particular, this involved a generic assessment of alternatives which placed more emphasis on three key drivers of policy which are highly relevant to the planning context: securing low cost energy (Alternative A1); reducing greenhouse gas emissions (Alternative A3); and reducing other environmental impacts of energy infrastructure development (Alternative A4).*"

7.3.7 Section 4.8 of EN-1 advises that the resilience of the project to climate change should be assessed in the Environmental Statement (ES) accompanying an application.

National Planning Policy Framework (2021)

7.3.8 Paragraph 153 of the National Planning Policy Framework (NPPF) states that:

"153. Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for the possible future relocation of vulnerable development and infrastructure."

Planning Practice Guidance

7.3.9 The planning practice guidance supplements the NPPF states and states:

"*In addition to supporting the delivery of appropriately sited green energy, effective spatial planning is an important part of a successful response to climate change as it can influence the emission of greenhouse gases. In doing so, local planning authorities should ensure that protecting the local environment is properly considered alongside the broader issues of protecting the global environment. Planning can also help increase resilience to climate change impact through the location, mix and design of development."*

Lincolnshire County Council Carbon Management Plan (2019)

7.3.10 This document sets out the County Council's 5-year Carbon Management Plan. It seeks to "*Ensure local and structural development plans are updated with latest climate projections. Some of the measures that could build resilience to weather and climate-related hazards, such as building codes and zoning regulations, may be less effective if they are not regularly updated to incorporate the latest climate change projections, as well as other changes including shifts to societal structures, demography, environmental degradation, poverty and inequality. Policy tools for urban and country planning should incorporate climate change mitigation, climate change adaptation and disaster risk management considerations and good practice."*

Central Lincolnshire draft Local Plan

7.3.11 The Central Lincolnshire Draft Local Plan has been reviewed for relevant policies to this ES Chapter.

7.3.12 *"Policy S15: Wider Energy Infrastructure The Joint Committee is committed to supporting the transition to net zero carbon future and, in doing so, recognises and supports, in principle, the need for significant investment in new and upgraded energy infrastructure. Where planning permission is needed from a Central Lincolnshire authority, support will be given to proposals which are necessary for, or form part of, the transition to a net zero carbon sub-region, which could include:*

energy storage facilities (such as battery storage or thermal storage); and upgraded or new electricity facilities (such as transmission facilities, sub-stations or other electricity infrastructure. However, such proposals should take all reasonable opportunities to mitigate any harm arising from such proposals, and take care to select appropriate locations for such facilities thereby minimising harm arising."

Bassetlaw draft Local Plan

7.3.13 The Bassetlaw draft Local Plan has been reviewed for policies relevant to this ES Chapter and the following considered relevant and referenced for the production of this assessment.

7.3.14 *"POLICY ST50: Reducing Carbon Emissions, Climate Change Mitigation and Adaptation 1. All proposals, including the change of use of existing buildings and spaces, should seek to reduce carbon and energy impacts in their design and construction in accordance with Policy ST35. Proposals should incorporate measures that address issues of climate change mitigation through:*

a) ensuring no adverse impact on local air quality;

b) directing development towards locations that minimise the need to travel and maximise the ability to make trips by sustainable modes of transport; Bassetlaw Local Plan 2020-2037: Publication Version August 2021 175

c) incorporating passive and energy efficient materials and/or technologies where appropriate;

d) requiring compliance with relevant national building standards such as meeting BREEAM very good-excellent standards;

e) promoting the retrofitting of existing buildings, including incorporating measures to reduce energy consumption;

f) providing for electric vehicle charging capability and charging infrastructure in new development, and/or providing infrastructure that supports car-free living, particularly in town centres;

g) ensuring that major development makes an appropriate financial contribution to the Bassetlaw carbon offsetting fund;

h) making best use of available opportunities to reduce the impact of climate change on biodiversity and the natural environment by providing space for habitats and species to move through the landscape and for the operation of natural processes;

i) minimising the use of natural resources over the development's lifetime, such as minerals and consumable products, by reuse or recycling of materials in construction, and by making the best use of existing buildings and infrastructure;

2. *All new development should be designed to improve resilience to the anticipated effects of climate change. Proposals should incorporate measures that address issues of adaptation to climate change through:*

a) *designing layouts so that the orientation of buildings and spaces take the opportunity to maximise solar gain;*

b) *using appropriate materials that enable buildings to ventilate efficiently by day and night;*

c) *adapting surface materials and drainage design to reduce the risk of flooding to land, property and people as a result of more extreme rainfall in accordance with Policy ST52;*

d) *promoting water efficiency by residential development meeting the tighter Building Regulations optional requirement of 110 litres per person/per day;*

e) *using integrated water management systems to manage runoff and provide a nonpotable water supply;*

f) *providing green/blue infrastructure, and where possible, retaining existing trees and woodlands to reduce the 'urban heating effect' during warmer summers; and*

g) *using urban greening methods within the design of new buildings."*

7.4 Assessment Methodology and Significance Criteria

7.4.1 The methodologies described in the following section have been developed in line with the relevant planning policy and appropriate industry guidance for assessing GHGs and climate change resilience and adaptation in EIA (Ref 7.22).

7.4.2 While the lifecycle GHG impact assessment assesses the significance of the GHG impact of the Scheme, the CCR review does not assess the significance as only a review of the impacts is required in line with the Institute of Environmental Management and Assessment (IEMA) guidance.

GHG Impact Assessment

7.4.3 All GHG emissions arising over the course of the Scheme will be assessed through the Lifecycle GHG impact Assessment. Direct emissions from activities taking place within the parcels, indirect emissions from activities outside the Site and embodied carbon within construction materials are all considered as part of the study area for the GHG impact assessment.

7.4.4 The Applicant has provided data and information that underpins the lifecycle GHG impact assessment, which has been evaluated using the methodology set out below.

7.4.5 In line with the GHG Protocol, the potential effects of the Scheme on the climate as a result of the development have been assessed. It has been identified that materials and activities will likely produce the greatest amount of GHG emissions and mitigation efforts will concentrate on these priority areas. The IEMA document

'Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance' has been used to inform the methodology for the GHG impact assessment (Ref 7.22).

7.4.6 The approach to assessing emissions follows the different stages of the scheme including construction, operation and maintenance and decommissioning.

7.4.7 The Department for Business, Energy and Industrial Strategy (BEIS) (replaced by ESNZ) 2021 emissions factors guidance (as shown below) has been used as a calculation-based methodology for estimating the anticipated GHG emissions arising during the construction, operation and maintenance and decommissioning activities of the Scheme (Ref 7.24):

Activity data x GHG emissions factor = GHG emissions value

7.4.8 The seven Kyoto Protocol GHGs have been considered in this assessment, which are in-line with the 'GHG protocol' (Ref 7.23):

- 1. Carbon dioxide (CO_2);
- 2. Methane (CH_4);
- 3. Nitrous oxide (N_2O);
- 4. Sulphur hexafluoride (SF_6);
- 5. Hydrofluorocarbons (HFCs);
- 6. Perfluorocarbons (PFCs); and
- 7. Nitrogen trifluoride (NF_3).

7.4.9 It should be noted that within this assessment, 'GHG emissions' represent all seven Kyoto Protocol GHGs. The unit of $kgCO_2e$, (kilograms CO_2 equivalent) tCO_2e (tonnes CO_2 equivalent) or $MtCO_2e$ (Megatonnes of CO_2 equivalent) captures CO_2 as well as the other greenhouse gases of concern and has been used as the unit to quantify greenhouse gases within this assessment.

Significance criteria

7.4.10 The sensitivity of the receptor (global climate) to increases in GHG emissions is always defined as 'high' as any additional GHG impacts could compromise the UK's ability to reduce its GHG emissions and therefore meet its future 5-year carbon budgets and Net Zero by 2050 target. The extreme importance of limiting global warming to below 2°C this century is broadly asserted by the International Paris Agreement, the United Nations Climate Change Conferences (COP27) and the climate science community.

7.4.11 Standard GHG accounting and reporting practices have been followed to assess the effect of the Scheme. The IEMA guidance states that 'it is up to the GHG practitioner's professional judgement to decide which tool is most appropriate for the project at hand with regards for assessing the magnitude of GHG impacts'. The GHG accounting method is deemed most appropriate for this part of the assessment.

7.4.12 With reference to national carbon budgets, these can be used to investigate the significance of the Scheme's GHG emissions and potential impact to the climate.

7.4.13 Emission sources that are <1% of a given emissions inventory can be excluded through the concept of 'de minimis' contribution. This has been supported by both BEIS and Publicly Available Specification PAS:2050 (2011) (Ref 7.25).

7.4.14 For this assessment, future emissions inventory scenarios have been supported by UK national carbon budgets. At present, the sixth carbon budget (2033 – 2037) has been set and detailed by the Government and formally adopted into legislation before parliament under the Carbon Budget Order 2021 (Ref 7.7). The amount of GHGs that the UK can emit over the 5-year period (2033 – 2037) is 965 million tonnes of carbon dioxide equivalent.

7.4.15 Developments that have emissions <1% of the current carbon budget would unlikely impact the UK's capacity to reach its net zero by 2050 target, as set out in the Climate Change Act 2008 (2050 Target Amendment). Developments which would result in reduction in emissions would also have a positive contribution towards meeting the 2050 target.

7.4.16 The following criteria summarized in Table 7.2 will be used to assess the magnitude of the GHG impact associated with the Scheme, as it is applicable for this type of assessment.

Table 7.2 – GHG Impact Assessment magnitude criteria

Magnitude	Magnitude Criteria
High	GHG emissions >1% of the applicable annual National carbon budget
Low	GHG emissions <1% of the applicable annual National carbon budget

7.4.17 The purpose of the UK national carbon budgets is to the reduce the amount of GHG emissions that the UK can release over the 5-year period (Ref 7.26). At the time of writing, the UK is in the 3rd carbon budget period with the 4th carbon budget commencing in 2023.

7.4.18 It is expected that the construction stage of the Scheme will occur during the 4th national carbon budget (2023 – 2027). The operational stages of the Scheme will occur during the 4th (2023 – 2027), 5th (2028 – 2032) and 6th (2033 – 2037) carbon budgets. As the current carbon budgets are only available up to 2037 and the Scheme is expected to be operational past this; all assumptions past 2037 will use the 6th Carbon Budget. Using professional judgement; the significance of the impacts associated with GHG emissions produced by the Scheme will be determined.

7.4.19 As shown in Table 7.3, the UK national carbon budgets up to 2037 show the future amount of GHG emissions that the UK will be able to emit.

Table 7.3 – National Carbon Budgets

Carbon Budget	Total budget (MtCO2e)
3rd (2018 – 2022)	2,544
4th (2023 – 2027)	1,950
5th (2028 – 2032)	1,725
6th (2033 – 2037)	965

7.4.20 Any amount of increase or reduction in GHG emission is considered significant in relation to the impact on the sensitivity of the global climate. The traditional EIA Criteria is not considered a suitable method for climate change mitigation, as highlighted by IEMA guidance on Assessing GHG emissions and Evaluating their Significance (Ref 7.22). Therefore, for this assessment, the following criteria (Table 7.4) will be used to determine the magnitude of significance.

Table 7.4 – Matrix for the significance of Effects for GHG Impact Assessment

Magnitude	Significance
Low (<1% of carbon budget)	Minor significance
High (>1% of carbon budget)	Major significance

7.4.21 For the purpose of this assessment, 'minor' is not considered a significant effect in EIA terms and 'Major' is considered a significant effect in EIA terms.

7.4.22 As set out in the Climate Change Act 2008 (2050 target amendment); it is mandatory for the UK to reach net zero by 2050 by reducing and offsetting its emissions. Carbon budgets have only been established up to 2037 and budgets beyond 2037 are presently not known. Although it is anticipated that the total budget of emissions will decrease over time; any emissions that are released are likely to be significant as it would impact the UK's ability to achieve future carbon budgets and reach the net zero target by 2050.

Climate Change Resilience Review

7.4.23 For the CCR Review, the Scheme itself; during construction, operation and decommissioning, is considered the receptor. The climate resilience review will provide a description of how the Scheme will be impacted by climate change impacts and how it will be designed to be more resilient to the impacts identified during the review of the UK Climate Projections 2018 (UKCP18) data (Ref 7.26).

7.4.24 UKCP18 data and historic climate data from the Met Office have been acquired to establish the future and historic baseline climate conditions (Ref 7.27).

7.4.25 The Scheme's design has been adapted to include CCR measures as set out within the Hydrology, Flood Risk and Drainage Chapter of the ES **[EN010132/APP/WB6.2.10]**.

7.4.26 EIA regulations require information regarding the vulnerability of the Scheme to climate change. An assessment has been developed based on the IEMA 'Environmental Impact Assessment Guide to: Climate Change Resilience and Adaption' document (Ref 7.22), which assesses the Scheme's resilience to potential impacts caused by climate change.

7.4.27 As part of the review, the Scheme's associated infrastructure and assets will be incorporated. This includes the risks associated with an increased frequency of extreme weather events, as highlighted by UKCP18 projects and the Scheme's resilience against gradual climatic changes.

7.4.28 Vulnerable and sensitive receptors will be identified and the sensitivity of the receptors determined using quantifiable data, where available. The susceptibility and vulnerability of the receptor will be considered alongside its value and importance.

7.4.29 The susceptibility of the receptor will be determined using the following scale:

- **High susceptibility** = receptor has no ability to withstand/not be substantially altered by the projected changes to the existing/prevailing climatic factors (e.g. lose much of its original function and form).
- **Moderate susceptibility** = receptor has some limited ability to withstand/not be altered by the projected changes to the existing/prevailing climatic conditions (e.g. retain elements of its original function and form).
- **Low susceptibility** = receptor has the ability to withstand/not be altered much by the projected changes to the existing/prevailing climatic factors (e.g. retain much of its original function and form).

7.4.30 The vulnerability of the receptor will be determined using the following scale:

- **High vulnerability** = receptor is directly dependent on existing/prevailing climatic factors and reliant on these specific existing climate conditions continuing in future (e.g. river flows and groundwater level) or only able to tolerate a very limited variation in climate conditions.
- **Moderate vulnerability** = receptor is dependent on some climatic factors but able to tolerate a range of conditions (e.g. a species which has a wide geographic range across the entire UK but is not found in southern Spain).
- **Low vulnerability** = climatic factors have little influence on the receptors.

7.4.31 The importance of the receptor is associated with the economic value the receptor represents. Due to the scale of the Scheme this is considered to be high for all receptors.

7.4.32 The likely effects of climate change on the development will be evaluated to identify the magnitude i.e., the degree of change from the relevant baseline conditions. Magnitude is based on a combination of likelihood and consequence.

7.4.33 The criteria to assess the likelihood of climate change impact is defined in Table 7.5. The consequence of the climate risk will be determined using professional judgement and supporting evidence.

Table 7.5 – Criteria to Assess Likelihood of Climate Change Impact

Level of Likelihood	Definition of Likelihood
Very unlikely	It is highly improbable that the impact will occur during the operational phase or the construction phase of the assets or systems.
Unlikely	Impact is not expected to occur during the operational phase or the construction phase of the assets or systems
As likely as not	Impact may occur during the operational phases or the construction phase of the assets or systems
Likely	Impact is expected to occur during the lifespan of the assets or systems or the construction phase.
Very likely	It is highly probable that the impact will occur during the lifetime of assets or systems including the construction phase.

7.4.34 The receptor sensitivity and magnitude of effect will be combined to reach an overall judgement on the significance of the likely environmental effect. As there is no legislative definition of 'significance' the conclusion of whether an effect is significant will be based on the outcomes of the CCR review.

7.4.35 Mitigation measures which have been incorporated into the Scheme will be considered as part of the review of potential impacts. Existing resilience measures that are already present or planned will also be identified by the review.

In Combination Climate Change Impacts

7.4.36 The ICCI assessment methodology has been developed in line with the IEMA 'Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation' guidance document (Ref 7.22).

7.4.37 The guidance defines an ICCI effect as 'When a projected future climate impact (e.g. increase in temperatures) interacts with an effect identified by another topic and exacerbates its impact. For example, if the biodiversity topic identifies an effect on a habitat or species receptor due to a project/scheme, such as loss of habitat, and in addition projected future higher temperatures will increase the vulnerability of this habitat to fragmentation, this is an ICCI.'

7.5 Assessment Assumptions and Limitations

7.5.1 Assumptions in calculation of GHGs from each source are provided when discussing the methodology used to calculate the total CO2e for each different source including for construction worker movements. Some more overarching assumptions are included within this section.

Assumptions for Construction Plant

7.5.2 Fuel use for construction plant is not known. It is not expected that emissions from construction plant would be significant and best practice measures are included in the draft Outline Construction and Environmental Management Plan (OCEMP) **[EN010132/APP/WB7.1]** to limit emissions during the construction phase.

Assumptions for Embodied Carbon in Production of Materials

7.5.3 All assumptions made within the calculations for estimating the embodied carbon of the materials used for the Scheme have been set out within the individual sections detailed in Section 7.8.

Assumptions for Transport of Materials

7.5.4 As it is anticipated that the PV panels will be sourced from China or a country of similar distance from the UK, there will be an increase in embodied carbon and transport emissions, which would otherwise be lower if sourced from Europe1. Therefore, the manufacture and transport of products will likely be the largest sources of GHG emissions from the Scheme.

7.5.5 HGV and sea freight distances assumed for transportation of materials and waste are outlined below. The country of origin for materials have been chosen as Europe and China, and assumptions have been made around the specific ports used based on proximity to relevant manufacturing facilities within each country.

- HGV transport of materials within China prior to sea freight transportation – 450km (based on the average distance of a number of major manufacturing centres in and around Shanghai to the nearest port);
- HGV transport of materials within Europe, including distance prior to, and following, sea freight transportation – 1,750km (based on half of the reasonable maximum distance equipment might be transported within Europe, plus the distance between Dover and the Site);
- Sea freight distance from China to England –21,880km (based on the sea freight distance between Shanghai and Dover);
- Sea freight distance from Europe to England –50km (based on the sea freight distance between Calais and Dover);

[1] A Outline Skills, Supply Chain and Employment Plan (PINS Document Reference EN010132) forms part of the DCO Application and is in accordance with the statement made on Solar Energy UK (**Error! Reference source not found.**)

7.5.6 For HGV transportation of materials, the UK Government GHG 2021 Conversion Factors for 'Rigid HGV >7.5-17t' and 'Articulated HGV >3.5 – 33t' has been applied, including well-to-tank (WTT) emissions2. It has been assumed that HGVs are 50% laden.

7.5.7 For sea freight transportation, the UK Government GHG 2022 Conversion Factors for 'General Cargo –Average' has been applied, including WTT emissions.

Assumptions for Climate Change Resilience

7.5.8 Climate change projections are subject to uncertainties due to the complexity of the climate system and uncertainty over future greenhouse gas emission levels and modelling uncertainties used to develop the Met Offices predictions.

7.5.9 To address these uncertainties, UKCP18 provides a range of likely climate changes to give a lower and upper estimates. This allows for provision of a greater level of confidence for the magnitude and impact of climate change effects.

7.6 Baseline Conditions

7.6.1 The baseline environmental conditions of the Scheme are described in this section. Additionally, reference to the surrounding area in relation to GHG emissions and climatic conditions is discussed.

GHG Impact Assessment

Current Baseline

7.6.2 Due to the nature of the Sites, which comprises mainly arable land – current baseline GHG emissions are largely derived from agricultural practice. However, this is dependent on the soil, vegetation type present and the fuel use of vehicles and other agricultural machinery.

7.6.3 The current land use is considered to have minor levels of associated GHG emissions. For the purposes of the GHG assessment, a conservative approach assuming the existing site has zero baseline emissions has been used.

Future Baseline

7.6.4 For the lifecycle GHG impact assessment, the baseline is a 'business as usual' scenario whereby the Scheme is not implemented. The baseline comprises existing carbon stock and sources of GHG emissions within the Sites from the existing activities on-site. In this case the future baseline is also based on a zero emissions scenario.

Climate Change Resilience Review

Current Baseline

[2] Well-to-tank emissions, also known as upstream or indirect emissions, are the GHG emissions released into the atmosphere from the production, processing, and delivery of a fuel to the point of use.

7.6.5 Historic climate data acquired by the Met Office from the closest Met Office Station to the Scheme (Waddington) for the 30-year climate period of 1981 – 2010 will provide the current baseline for the CCR Review (Ref 7. 22) . This is summarised in Table 7.6 below.

Table 7.6 Historic Climate data

Climatic Factor	Month	Figure
Average annual maximum daily temperature (°C)	-	13.6
Warmest month on average (°C)	July	21.5
Coldest Month on average (°C)	February	1.3
Mean annual rainfall levels (mm)	-	614.1
Wettest month on average (mm)	July	59.5
Driest month on average (mm)	February	36.1

7.6.6 Historic 10-year averages for the East and Northeast of England obtained from the Met Office have identified gradual warming and increased rainfall between 1969 – 2018. The table below summarizes these findings.

Table 7.7 Historic climate data for 10-year averages for temperature and rainfall for the East and Northeast of England region.

Climate period	Climate variables	
	Mean Maximum annual temperatures (°C)	Mean annual rainfall (mm)
1969 - 1978	12.0	709.2
1979 - 1988	11.8	792.5
1989 - 1998	12.7	713.5
1999 - 2008	13.2	829.8
2009 - 2018	13.1	785.2

Future Baseline

7.6.7 It is anticipated that the future baseline will be different from the current present-day baseline, due to changes in climate. For this assessment, UKCP18 probabilistic projections have been provided for 20-year periods from 2020 - 2079 and obtained for the following climate variables which includes annual and seasonal changes in climatic conditions over the land area of the Scheme.

- Mean annual air temperature;

- Mean summer air temperature;
- Mean winter air temperature;
- Maximum summer air temperature;
- Minimum winter air temperature;
- Mean annual precipitation;
- Mean summer precipitation;
- Mean winter precipitation;
- Mean annual cloud cover;
- Mean summer cloud cover; and,
- Mean winter cloud cover.

7.6.8 A 25 km^2 grid square that encompasses the Scheme's location have been used to analyse the UKCP18 probabilistic projections. Temperature, precipitation, and cloud anomalies are considered relative to the 1981 – 2000 baseline. These variables are illustrated in Table 7.8, Table 7.9 and Table 7.10.

7.6.9 There are a range of different climate scenarios also known as Representative Concentration Pathways (RCPs) used in UKCP18 that help inform future trends in emissions (Ref 7.22). For this assessment RCP 8.5 has been used, which assumes a 'business as usual' pathway for climate change as recommended by the IEMA guidance.

7.6.10 The impact of climate change will be determined over the course of the Scheme's design life. The operational life of the Scheme is anticipated to be 40 years. Once the Scheme ceases to operate, it will be decommissioned. A 40-year period for the operational phase of the Scheme has been assessed in the EIA and reported in this ES. For the assessment, the climatic impacts of GHG emissions at the 10%, 50% and 90% probability levels up to 2079 for are included.

Table 7.8 Predicted Changes in temperature variables (°C)

Climate Variable	Time Period		
	2020 – 2039	2040 - 2059	2060 - 2079
Mean annual air temperature anomaly at 1.5 m (°C)	+ 0.99 (+0.33 to +1.66)	+1.75 (+0.83 to +2.73)	+2.70 (+1.23 to +4.25)
Mean summer air temperature anomaly at 1.5 m (°C)	+1.18 (+0.35 to +2.03)	+2.17 (+0.83 to +3.55)	+3.29 (+1.09 to +5.57)
Mean winter air temperature anomaly at 1.5 m (°C)	+0.94 (-0.02 to +1.92)	+1.60 (+0.40 to +2.90)	+2.43 (+0.70 to +4.17)

Climate Variable	Time Period		
	2020 – 2039	2040 - 2059	2060 - 2079
Maximum summer air temperature anomaly at 1.5 m (°C)	+1.27 +(0.19 to +2.43)	+2.43 (+0.76 to +4.22)	+3.67 (+1.03 to +6.44)
Minimum winter air temperature anomaly at 1.5 m (°C)	+0.86 (-0.11 to +1.89)	+1.56 (+0.29 to +3.00)	+2.36 (+0.65 to +4.28)

Table 7.9 - Predicted changes in Precipitation Variables (%)

Climate Variable	Time Period		
	2020 – 2039	2040 - 2059	2060 - 2079
Annual precipitation rate anomaly (%)	+1.57 (-3.15 to 6.59)	-1.20 (-8.4 to +6.23)	-1.18 (-6.64 to +4.42)
Summer precipitation rate anomaly (%)	-5.44 (-25.22 to +15.00)	-17.27 (-37.91 to +3.84)	-23.85 (-51.34 to +4.07)
Winter precipitation rate anomaly (%)	+3.79 (-5.13 to +13.38	+7.68 (-4.46 to +20.39)	+12.86 (-3.06 to +29.0)

Table 7.10 - Predicted changes in Cloud Anomaly variables (%)

Climate Variable	Time Period		
	2020 – 2039	2040 - 2059	2060 - 2079
Annual total cloud anomaly (%)	-1.66 (-4.74 to +1.14)	-1.20 (-8.4 to +6.23)	-1.18 (-6.64 to +4.42)
Summer total cloud anomaly (%)	-3.64 (-10.34 to +2.69)	-8.21 (-18.51 to +1.88)	-23.85 (-51.34 to +4.07)
Winter total cloud anomaly (%)	-0.19 (-2.15 to +1.62)	+0.13 (-2.01 to +2.06)	+5.22 (-1.65 to +2.68)

7.6.11 For the Climate Change Resilience Review, the Scheme and all associated infrastructure and assets are considered as a sensitive receptor.

7.7 Embedded Mitigation

7.7.1 Various GHG mitigation measures are embedded within the Scheme and are included within the Outline Construction Environmental Management Plan **[EN010132/APP/WB7.1]** and Outline Construction Traffic Management Plan **[EN010132/APP/WB6.3.14.2]** accompanying the DCO Application and these measures are secured by a Requirement in the draft DCO.

7.7.2 This embedded mitigation will be implemented to reduce the GHG impact of the Scheme. Specific embedded mitigation measures include:

- Increasing recyclability by segregating construction waste to be re-used and recycled where reasonably practicable;
- Adopting the Considerate Constructors Scheme (CCS) to assist in reducing pollution, including GHGs, from the Scheme by employing good industry practice measures;
- Designing, constructing and implementing the Scheme in such a way as to minimise the creation of waste and maximise the use of alternative materials with lower embodied carbon, such as locally sourced products and materials with a higher recycled content where feasible;
- Reusing suitable infrastructure and resources already available within the Sites where possible to minimise the use of natural resources and unnecessary materials (e.g. reusing excavated soil for fill requirements);
- Encouraging the use of lower carbon modes of transport by identifying and communicating local bus connections and pedestrian and cycle access routes to/ from the Scheme to all construction staff, and providing appropriate facilities for the safe storage of cycles;
- Liaising with construction personnel for the potential to implement staff minibuses and car sharing options;
- Implementing a Travel Plan to reduce the volume of construction staff and employee trips to the Scheme;
- Switching vehicles and plant off when not in use and ensuring construction vehicles conform to current EU emissions standards; and
- Conducting regular planned maintenance of the construction plant and machinery to optimise efficiency.

7.7.3 Regular planned maintenance of the Scheme will also be conducted during operation to optimise efficiency.

7.7.4 An Outline Decommissioning Statement **[EN010132/APP/WB7.2]** has been included with the DCO Application. Similar measures to the CEMP will be developed prior to the decommissioning phase to encourage the use of lower-carbon and more climate change resilient methods. It would not be appropriate to specify such requirements now as the decommissioning environment beyond 2065 is likely to be considerably different to today.

7.7.5 Further climate change resilience measures embedded within the Scheme, particularly in relation to flood risk, are outlined below. The specific flood risk impacts and associated mitigation measures are discussed in more detail in Chapter 10: Hydrology, Flood Risk and Drainage, of the ES **[EN010132/APP/WB6.2.10]** and include:

- Access to the Sites during construction and operation will be taken from permeable and existing farm tracks accessed from the local highway network. This limits the potential for increased surface water runoff rates and sedimentation effects during construction.
- 8m easements have been established around all watercourses, including Main Rivers and Ordinary Watercourses and 9m from IDB assets.
- Whilst it is likely that the Scheme will utilise tracker solar panels, optionality is included within the application to be able to utilise fixed panels. Considerations for either option with regards to Climate Change are set out below:

Fixed Panels

- The minimum height of the lowest part of the fixed solar panel units will be 0.6 m above ground level.
- Fixed panels will be located within areas of the Site which are located in Flood Zone 1 whereas tracker panels can be located in areas that are within Flood Zones 2 and 3 on the basis of the additional flood protection offered by their potential to be stowed horizontally.
- Fixed panels would have a maximum height of up to 3.5 metres.

Tracker Panels

- The tracker solar panel units will be mounted on raised frames (usually raised a minimum of 0.4 m) when on maximum rotation angle) and will therefore be raised above surrounding ground levels and fitted with a tracking system. During times of flooding, solar panels may be stowed by the tracking system algorithm onto a horizontal plane, to the minimum post height of 2.3 m above ground level. This ensures that all sensitive and electrical equipment on the solar panel is raised to a minimum of 2.3 m above ground level in the horizontal position.
- Tracker Panels would have a maximum height of 4.5m.
- Electrical infrastructure associated with the panels can be adequately waterproofed to withstand the effect of flooding. Where possible sensitive electrical equipment has been located in parts of the Site that are within Flood Zone 1. Where this hasn't been possible the sensitive electrical equipment will

be raised 600mm above the 0.1% AEP flood level or where this is not possible as high as practicable.

7.7.6 Health and safety plans and risk assessments developed for construction and decommissioning activities will be required to account for potential climate change impacts on workers, such as flooding and heatwaves. This will include for the provision of flood defence equipment (e.g. sandbags) on site and best practice health management measures for construction staff working in heat such as wearing loose clothing, staying hydrated and applying sun protection.

7.8 Assessment of Likely Impacts and Effects

GHG Impact Assessment

7.8.1 For each lifecycle stage of the Scheme (production, construction, operation and maintenance, and decommissioning), the associated GHG emissions are identified and assessed.

7.8.2 A summary of the anticipated GHG emissions arising from the Scheme are shown below:

Table 7.11: Possible sources of GHG emissions

Lifecycle Stage	Activity	Primary emission sources
Construction Stage	The extraction of raw materials and manufacturing of products necessary to make equipment.	GHG emissions that are embodied within the product.
	This stage is anticipated to create a significant input to GHG emissions, due to the materials that contain high levels of embodied carbon, complex manufacturing processes and equipment design.	GHGs that are produced during manufacturing
	Construction activity on-site.	Energy consumption on-site. Commuting construction workers.
	Construction materials that are transported and not integrated in embodied GHG emission. Equipment required is likely to require shipment, due to overseas origin.	Transportation of materials to the sites and the amount of fuel consumed.
	Construction workers that would need transportation to the site.	Transportation of workers to the sites and resulting GHG emissions.

Lifecycle Stage	Activity	Primary emission sources
	Waste produced during the construction process that need to be disposed.	GHG emissions produced from the transportation and removal of waste materials
	Water use	Treatment of wastewater and supply of potable water
Operation Stage	Scheme operation	GHG emissions from maintenance. The operational aspects are expected to be negligible in the context of overall GHG emissions.
	Scheme maintenance Replacement materials (i.e. batteries and replacement panels) Water use on site for fire suppression and cleaning panels	Emissions from routine maintenance are expected to be negligible. However, the periodic replacement of components has the potential to have significant impacts given the complexity of the equipment involved.
Decommissioning Stage	Decommissioning activity occurring on-site	Energy consumption of on-site vehicles and generators.
	Removal and transportation of any waste materials	GHG emissions generated from the transportation and disposal of waste materials. This has the potential to be significant given the complexity of the design of the equipment, and the use of materials with high associated waste treatment emissions.
	Workers that would need to be transported to the site	Transportation of workers to site and resulting GHG emissions

7.8.3 For the purposes of this assessment, it has been considered that any increase in GHG emissions compared to the baseline has the potential to have an impact, due to the high sensitivity of the receptor (global climate) to increases in GHG emissions. This is in line with the IEMA guidance (Ref 7.21), which states that all GHG emissions have the potential to be significant. The application of the standard EIA significance criteria is not considered to be appropriate for climate change mitigation assessments. GHG impacts will be put into context in terms of their impact on the UK's 5-year carbon budgets, including sub-sectoral budgets for energy generation, which set legally binding targets for GHG emissions.

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

7.8.5 Therefore, the net impact of the Scheme is also identified and assessed, taking into account the renewable energy generation and the benefit of this in the context of the wider energy generation sector and the National Grid average GHG intensity. This overall assessment, which accounts for all GHG emissions over the assessed lifetime of the Scheme, compares the Scheme's GHG intensity to the National Grid average GHG intensity to quantify the net GHG impact of the Scheme compared with other predicted grid energy generation sources.

Construction (2024 - 2026)

7.8.6 The construction period is anticipated to take approximately 24 months. Construction activities will be carried out Monday to Friday 07:00-18:00 and between 08:00 and 13:30 on Saturdays.

7.8.7 The construction phase for the Scheme includes the preparation of the Sites, installing the access tracks, erection of security fencing, assembly and erection of the Solar PV arrays, installation of the inverters/transformers and grid connection.

7.8.8 The construction of the energy storage system element of the Scheme will include the preparation of the Sites, installation of the access roads, erection of security fencing, assembly of the battery system, and installation of the switch-room and grid connection.

7.8.9 Calculations for the embodied carbon within the various products to be used on site and the sources for each are set out below.

Solar PV Modules

7.8.10 The total number of modules for at West Burton in the indicative design is 1,001,808.

7.8.11 The total weight of an individual panel is anticipated to be 33.4kg and have approximately 156 individual solar cells as set out in the product details as supplied by the Applicant. The primary materials which go into construction of a solar panel are silicon, steel and glass.

7.8.12 The Global Silicon Council have produced a document, "Silicon-Chemistry Carbon Balance: An assessment of Greenhouse Gas Emissions and Reductions" (Ref 7.34) which states that each cell contains approximately 11g of silicon. Silicon has an embodied carbon value of 6kgCO_2e/kg. Based on these figures, it is calculated that each panel has 1.584kg silicon and an embodied carbon value of 9.504kgCO_2e. The total embodied silicon from panels at the development is 10,315 tCO_2e

7.8.13 The surface area for the panel is anticipated to be 2.80m^2. A value of 2.5kg per mm thickness per m^2 as derived from Ref 7.34 and glass thickness of 3.2mm. The glass weight per panel is therefore 22.36kg. An embodied carbon value of 1.437kgCO_2e has been taken from Ref 7.24 for glass. This gives a total of 32,192 tCO_2e for glass used across the development.

7.8.14 It has been assumed that the remaining weight of the panel which is not silicon or glass is steel. This gives a weight of 9.32kg steel per module. Using a value of 3.03$kgCO_2e$/kg this gives a total of 28.2$kgCO_2e$ per module. The steel at all solar panels at the development is 28,295 tCO_2e.

7.8.15 Through consultation with Solarport, a supplier of solar panel mounting equipment, it is understood that each MW of electricity generated requires around 30 tonnes of mounting equipment. It has been assumed that all mounting equipment will be primarily steel.

7.8.16 A value of 3.03$kgCO_2e$/kg has been used as derived from Ref 7.24. Based on the above and knowing that the development will generate around 480MW, a value of 43,632 tCO_2e has been derived for the mountings.

7.8.17 The total embodied carbon for all panels and mounting associated with all parcels (i.e. West Burton 1, 2 and 3), accounting for the materials used in development is:

70,802 tCO_2e

Transformers, Inverters and Switchgear

7.8.18 To calculate the embodied carbon associated with the production of the transformers to be used on site, the material breakdown of a typical transformer as reported in a lifecycle assessment produced by Hegedic et al (2016) (Ref 7.29) was used as a benchmark to estimate material quantities associated with the transformers required for the Scheme.

7.8.19 For the purpose of this assessment, a total of 4 x 400/33kV transformers with inverters and switchgear will be installed at West Burton 3. At West Burton 1 and 2 a total of 3 x 132/33kV transformers with inverters and switchgear will be installed.

7.8.20 Information has been provided for the amount of oil to be used with the 400/33kV transformer (77.7 tons). The same ratio has been assumed to be used for the 133/33kV transformers.

7.8.21 The materials used in transformers are oil, steel, copper and plasterboard as set out in Ref 7.29. The proportions of typical material are also shown in Ref 7.29. As the weight of oil is known, the remaining materials have been proportioned out appropriately.

Table 7.12: Materials of $kgCO_2e$ in Transformers Inverters and Switchgear

Material	Total Weight (tonnes)	$kgCO_2e$/kg	tCO_2e
Steel	843	2.364	1,994
Copper	221	2.710	600
Plasterboard	55	0.390	22

Material	Total Weight (tonnes)	$kgCO_2e/kg$	tCO_2e
Oil	425	1.401	595
Total			3,210

High Voltage Cables

7.8.22 Indicative cable lengths were provided by the Applicant for the whole of the Scheme and these were used to set out an indicative total cable length of 80,600m based on multiple cables being required per circuit.

7.8.23 Total weight per meter was provided for the two main materials used within the cables: copper and aluminium.

Table 7.13: Materials of $kgCO_2e$ in High Voltage Cables

Material	kg/m	total kg	$kgCO_2e/kg$*	tCO_2e
Copper	21	1,693,062	2.71	4588
Aluminium	10.7	862,655	6.67	5753
Total				10,341

**Ref 7.24*

Low Voltage Cables

7.8.24 Indicative cable lengths were provided for:

- Low Voltage DC Electrical Cabling (string to combiner box)
- Low Voltage DC Electrical Cabling (combiner box to inverter)
- Medium Voltage Electrical Cabling (from Power Station to Sub Station)

7.8.25 A breakdown of materials was not provided but total weights have been. It has been assumed that the material split will be the same as the high voltage cables.

Table 7.14: Materials of $kgCO_2e$ in Low/Medium Voltage Cables

Material	kg/m	total kg	kgCO2e/kg*	tCO2e
Copper	21	346,438	2.71	939
Aluminium	10.7	176,518	6.67	1,177
Total				2,116

**Ref 7.28*

Batteries

7.8.26 Following consultation with LeClanché battery suppliers, a value of 100kgCO_2e per kwh was provided as a realistic worst case for the purposes of this assessment. The assessed MWh battery storage has been assumed to be:

159MWh

7.8.27 Based on the above assumptions the total CO_2e from batteries is:

15,984tCO_2e

Shipping of Materials

7.8.28 Based on the above calculations of material weights and making the precautionary assumption that half of products would come from China and half from Europe the below calculations are made. Shipping distance from Shanghai to Dover is 21,880km and Calais to Dover is 50km.

Table 7.15 –Shipping GHG Emissions

Source	Shipping Weight (tonnes)	Distance (km)	kgCO_2e/tonne/km*	kgCO_2e	tCO_2e
Shipping from China	30,521	21,880	0.01323	8,836,265	8,836
Shipping from Europe	30,521	50	0.01323	20,193	20
Total					**8,856**

**General Average Cargo Ship from Ref 7.24*

Vehicle Movements

7.8.29 A 1-way distance of 30km per journey has been assumed for the worker transportation calculations, which is a conservative estimate as, where possible, staff will be located within 30km of the Sites according to currently available data. The UK Government 2022 emissions factors for 'Average car' and 'Average Diesel van', including WTT emissions, have been applied to this distance and total worker numbers to calculate GHG emissions associated with worker transport.

7.8.30 The intention is for any non-local workers to use local accommodation and use minibuses to transport them to the Sites which will reduce the overall vehicle construction worker vehicle trips as set out in the Transport and Access Chapter (Chapter 14) of the ES **[EN010132/APP/WB6.2.14]**.

7.8.31 There are 505 forecast daily construction worker movements (two way trips) and an estimated construction period of 520 days. Assuming that 27 two-way trips will be by shuttlebus, 336 two way trips will be by car and the same for diesel LGV.

Table 7.16 – Construction Worker GHG Emissions

Vehicles	Number of Trips	Average Distance	kgCO2e/km	$kgCO_2e$	tCO_2e
Bus	13,130	30	0.09650	38011	38
Diesel LGV	87,533	30	0.23156	608,077	608
Cars	87,533	30	0.17048	447,680	448
Total					**1,094**

7.8.32 The total HGV trips for the Sites have been provided as 13,860 two way trips and are set out below. This assessment has assumed that half of the HGV trips will be from Europe with a total journey distance on road of 1,750km and half will be from China with a total journey distance on road of 500km. The distance from Europe is assuming travel from Eastern Europe to Calais and then Dover to the Sites and from China from industrial areas around Shanghai, travelling by ship to Dover and then to the Sites. It is assumed that half of delivery vehicles will be articulated HGVs and half will be Rigid HGVs. To account for delivery to and from the Sites, it is assumed that vehicles will be 50% laden.

Table 7.17 – Construction HGV GHG Emissions

Vehicles	Number Trips	Distance	kgco2e/km	kgCO2e	tCO2e
HGV artic (China to site)	3,465	500	0.80322	1,391,579	1,392
HGV rigid (China to site)	3,465	500	0.63623	1,102,268	1,102
HGV artic (Europe to site)	3,465	1,750	0.80322	4,870,525	4,871
HGV rigid (Europe to site)	3,465	1,750	0.63623	3,857,940	3,858
Total	13,860				11,222

7.8.33 The total emissions from vehicle movements associated with the development during construction has been estimated as **12,316 tCO_2e**

Waste

7.8.34 Waste streams during the construction phase which have been assessed for their Greenhouse Gas Emissions include:

- Sewage Waste; and
- Excavated Ground material.

7.8.35 Sewage waste generated during construction has been estimated at 20,080.35m^3. Using the emissions from Ref 7.28 of 0.727$kgCO_2e/m^3$ for Water Treatment, the total estimated emissions from sewage waste have been calculated at **5.46tCO_2e.**

7.8.36 The estimated ground material expected to be excavated which will not be suitable for refill or compaction has been calculated at 88,754m^3. Using a typical value for mixed construction and demolition weight by cubic metre of 1.2 tonnes per m^3, the total estimated emissions from excavation material waste have been calculated at **87.40tCO_2e.**

7.8.37 The total Waste generated during construction results in an estimated **93tCO_2e.**

Water Use

7.8.38 Water use has been provided for:

- Water consumed for Construction and cleaning of HGV, modules & equipment in litres; and
- Potable and non-potable water for drinking and sanitary purpose in litres.

Table 7.18: Construction Water Use Emissions

Scenario	Water use during construction/ annum (million litres)	Water Supply emissions (kgCO2e/ million litres	$kgCO_2e$/ annum	tCO_2e/ construction phase
West Burton 1, 2 and 3	15.4	149	2,293	**2.29**

**Ref 7.28*

Energy Use

7.8.39 Electricity for temporary site security during construction tenure and Electricity for office cabin and welfare centres is provided during the construction phase.

Table 7.19 – Energy usage during Construction Phase GHG Emissions

Total Energy usage (kwh)	Total kg CO_2e per kwh	tCO_2e over construction phase
786,828	0.19338	**152**

Packaging of Materials

7.8.40 Packaging for the solar modules and mounting system information has been provided as set out below. As the volume has been provided but not the weight, typical conversion factors have been used to calculate the total weight and the total emissions from the packaging materials to be used.

Table 7.20: Packaging Materials Embedded GHG Emissions

Packaging Item	Total Volume (m^3)	Assumed Ratio of Volume to Weight for Material	Total Weight (tonnes)	$kgCO_2e$/ tonne for material *	Total tCO_2e
Pallet Wood	12,400	0.700	8,680	313	2,714
Polyurethane Foam pad for cushioning between modules	9,897	0.024	238	2,601	618
Paper and Board	7,218	0.600	4,331	829	3,590
Corner pieces and edge spacers made of HDPE	180	0.024	4	3,270	14
Pallet Nails	n/a	n/a	2	3,030	6
Total					**6,941**

** Ref 7.24*

Summary of Construction GHG

7.8.41 During the construction stage, the greatest impact of GHGs is the result of embodied carbon in the materials used for construction. As mentioned previously; the PV panels are expected to be sourced from China or a country of similar distance. The manufacture and supply of PV panels and Batteries will be the largest source of GHG emissions. The summary of GHG emissions during the construction phase is shown below.

Table 7.21 – Construction GHG Emissions

Emissions Source	Emissions (tCO_2e)	% Construction Emissions
Products (PV arrays including mounting)	70,802	54.1
Products (Transformers)	3,210	2.5

Emissions Source	Emissions (tCO_2e)	% Construction Emissions
Products (High voltage cables)	10,341	7.9
Products (Low voltage cables)	2,116	1.6
Products (Batteries)	15,984	12.2
Shipping of Materials	8,856	6.8
Worker Transportation & Delivery Vehicles	12,316	9.4
Waste	93	0.1
Water Usage	2	0.0
Energy Usage for Construction Period	152	0.1
Packaging	6,941	5.3
Total	130,815	100.0

Significance of Effect (Construction)

7.8.42 Worst case total GHG emissions from the construction phase are estimated to equate to around 130,815 tCO2e.

7.8.43 GHG emissions from construction activities will be limited to the duration of the construction programme (anticipated to be 2 years). When annualised, the total annual construction emissions equate to around 65,407 tCO2e.

7.8.44 Table 7.22 presents the estimated construction emissions against the carbon budget period during which they arise. Construction emissions will fall under the 4th UK carbon budget.

7.8.45 As the construction phase and the first three years of the operation phase both fall within the 4th carbon budget, the annual emissions of each phase have been compared to the relevant annualised carbon budgets to enable assessment of the phases individually.

Table 7.22 – Construction GHG Emissions

Relevant UK Carbon Budget	Annualised UK Carbon Budget (tCO_2e)	Annual Construction Emissions for the Scheme During Carbon Budget Period (tCO_2e)	Construction Emissions for the Scheme as a Proportion of Carbon Budget
4th Carbon Budget (2023 to 2027)	390,000,000	65,407	0.017%

7.8.46 Annual emissions from the construction of the Scheme do not contribute to equal to or more than 1% of the annualised 4th carbon budget. The magnitude of effect is therefore considered low. GHG emissions from the construction of the Scheme are considered to have a **minor adverse significant effect** on the climate. A negligible significant effect is not possible where any GHG emissions are released to the atmosphere. The overall effect from Construction is considered **not significant** in EIA terms.

Operation (2026–2066)

7.8.47 GHG emissions will be generated as a result of operational activities such as the transportation of operational workers to and from the Sites, water consumption, and replacement of on-site materials.

Maintenance Travel

7.8.48 Assuming a 30km distance of travel, the operational phase of the project would generate approximately **10 tCO_2e** as a result of operational workers travelling to and from the Sites twice a month for maintenance.

7.8.49 As shown from the GHG emissions associated with worker transportation, it is likely the GHG emissions associated with the additional operational activities will be small compared to emissions from energy consumption.

7.8.50 The operational GHG emissions calculated reflect a worst-case as the calculations for worker transportation and maintenance will have been carried out using current emissions factors to estimate emissions over the operational lifetime of the Scheme. However, carbon and emissions associated with energy and fuel use throughout the supply chain are anticipated to be lower in the future as a result of grid decarbonisation and machinery and vehicle electrification in line with the UK's net zero carbon emissions target for 2050.

Replacement Parts

7.8.51 Through consultation with a battery supplier, it is understood that the lifespan for the proposed battery units are expected to require replacing as part of the development. While technology may have improved and some of the assumptions used which underpin the embodied carbon values, as a conservative approach, it has been assumed that the embodied carbon at replacement will be the same as during the construction phase, equivalent to **15,984tCO_2e**.

7.8.52 It has been assumed that 0.04% of panels will require replacement each year based on supplier input. This has been calculated based on the embodied carbon of the products as set out in the construction phase and applied to the estimated 40 year development lifespan. This results in a total estimated **18,309tCO_2e** over the project lifespan.

Water Consumption

7.8.53 228,000 litres of water is required on site for fire suppression. Ref 7.24 gives a value of 149kgCO^2e per million litres of water. This accounts for 32.93 kgCO_2e of water use during operation or 0.03 tCO_2e.

7.8.54 This is assuming the water is never replaced. If it does need to be replaced, the associated emissions are considered negligible.

7.8.55 Over the lifespan of the project, water will be used for cleaning of the panels and for some supply of drinking water on site as set out below:

5.3 million litres

7.8.56 Based on a water supply 149kgCO_2e/million litres gives a total of **32tCO_2e** water use during lifespan of operation of the project.

Operational Waste

7.8.57 There is anticipated to be 450m^3 of sewage waste from the Scheme per annum. Using the wastewater value methodology as per the construction phase this gives a total of **4.90tCO_2e** over the Scheme's 40 year lifespan.

Energy Usage

7.8.58 There will be some required energy use for operation of the Sites from for the surveillance and monitoring system and for the office and O&M room. While it is anticipated that greenhouse gas emissions from energy will reduce over the lifespan of the Scheme, in part due to the nature of the Scheme itself which will result in energy generation creating fewer greenhouse gases, as a worst case assumption the baseline year greenhouse gas emissions have been assumed over the estimated 40 year project lifespan.

Table 7.23 – Operational GHG Emissions from Energy Usage

Total Energy usage (kwh)	Total kg CO_2e per kwh	tCO_2e over project lifespan
51,823,600	0.19338	**10,022**

Summary of Operational Effects

7.8.59 The below summary provides estimated GHG emissions over the whole operational period. As shown, the production of replacement batteries at the midpoint of the project's lifespan is the greatest contribution to GHG emissions during operation.

Table 7.24 – Operation GHG Emissions Summary

Emissions Source	Emissions (tCO2e)	% Operational Emissions
Maintenance trips	10	0.03
Replacement batteries	15,984	42.76
Replacement PV modules	11,328	30.31
Water Usage	32	0.08
Operational Waste	5	0.01
Energy Usage for Operational Period	10,022	26.81
Total	**37,380**	100.0

Future Climate Change

7.8.60 Future climate change impacts, as identified in Section 7.6, may affect the lifetime energy generation modelled. For example, cloud cover is projected to decrease, which is expected to increase solar resource and have a positive impact on the productivity of the solar PV modules. This benefit, however, is assumed to be counterbalanced by temperature increases projected, which are anticipated to have a negative impact on the efficiency of the solar PV modules and on energy transmission losses (Ref 7.24). Any overall positive or negative effect is not anticipated to have a material impact on the outcome of the assessment.

7.8.61 Energy generation from the Scheme during the first year of operation is estimated to be 583,000 MWh. A 0.4% degradation factor has been used for each subsequent year with a 1% reduction in the first year based on typical products to be used with the proposed mountings, resulting in an estimated energy generation figure of 493,649MWh in the final year of operation, and a total energy generation figure of around 21,956,988 MWh over the estimated 40-year assessed lifetime.

7.8.62 Based on the total energy generation of the Scheme and the estimate of GHG emissions for the total lifespan considering construction and operational emissions of 169,532 tCO2e, the intensity of the Scheme is estimated to be 7.72 gCO2e/kWh. This compares favourably with fossil fuel electricity generation and is comparable with other low carbon energy generation as shown in Table 7.25. It is considered that, of the below renewable energy types, the only other viable use for the land would be for onshore Wind which would have a slightly lower but comparable GHG intensity.

Table 7.25 – Comparison of energy intensities of various forms of energy generation Energy Generation

Energy Generation Type	GHG Intensity (gCO_2e/kWh)
Combined Cycle Gas Turbine (CCGT)	380 to 500

Energy Generation Type	GHG Intensity (gCO_2e/kWh)
Nuclear	5 to 55
Offshore Wind	5 to 24
Onshore Wind	7 to 20
West Burton Solar Project	7.66

7.8.63 A further calculation has been completed to understand at what point the GHG reductions from National Grid through the use of renewable energy at the scheme would offset the calculated worst-case emissions generated from the products and the construction phase. It also accounts for annual emissions generated by the scheme from water use, replacement products and energy consumption on site.

7.8.64 The calculation has used the UK Government Conversion factor for UK Electricity from 2022 (54) to calculate the tCO2e saved by the scheme year on year compared with a scenario using existing UK grid. The calculations accounts for 0.4% reduction in efficiency per year with a 1% reduction in the first year.

7.8.65 It is acknowledged that the emissions from energy usage is expected to be reduced in future years as the UK becomes less reliant on fossil fuels but this is not reflected within the calculations in Table 7.26 which shows the expected year for the operation of the scheme to offset the construction emissions.

Table 7.26 – Calculation of Savings to Offset Construction GHG Emissions

Year of Operation	GHG Savings as a Result of Scheme (tCO_2e)	Offset from Development Emissions (tCO2e)
Construction Phase	-	132,152
Year 1	111,806	20,346
Year 2	110,679	-89,399
Year 3	110,232	-198,696
Year 4	109,788	-307,549
Year 5	109,345	-415,959

7.8.66 As shown above, it is expected that the savings from the scheme would result in offsetting the construction emissions within 3 years of operation. Assuming baseline values for emissions from the Scheme, over the estimated 40 year lifespan there would be a reduction of **3,981,049 tCO2e** from the Scheme compared to a scenario where the Scheme does not go ahead.

Other Greenhouse Gas Considerations

7.8.67 While sulphur hexafluoride (SF6) is a potential source of GHG emissions over the lifetime of the Scheme (i.e. derived from certain electric items such as gas-insulated switchgear and gas-insulated transformers during production, operation through leakage, and dismantling), it has not been possible to quantify fugitive emissions from the leakage of SF6 due to insufficient research data being available on this topic. SF6 is one of the seven GHGs identified by the Kyoto Protocol (Ref 7.23) due to its high Global Warming Potential (GWP) of 23,900 for the 100-year time horizon as set out in the protocol. GWP is defined as the heat absorbed by any greenhouse gas in the atmosphere, as a multiple of the heat that would be absorbed by the same mass of carbon dioxide (CO2). CO2 has a GWP of 1.

7.8.68 It is not anticipated that SF6 emissions will significantly affect the overall outcome of this assessment, however. For example, total annual SF6 emissions from the National Grid Transmission Network in 2015-2016 equated to 216,645 tCO2e (Widger and Haddad, 2018; Ref 7.30) and are assumed to be similar each year. As the Scheme will provide less than 1% of total generation capacity to the National Grid Transmission Network, and as switchgear and transformers are not limited to power generation facilities but can be found all across the network, it is anticipated that the Scheme's contribution to this total will be minimal.

Significance of Effect (Operation)

7.8.69 As previously stated, the operational stage of the Scheme will encompass the 4th 2023 – 2027), 5th (2028 – 2032) and 6th (2033 – 2037) national carbon budgets, however, budgets beyond this have not been published yet. Due to the nature of the Scheme; it is unlikely that any emissions derived from the operational stage will produce GHG emissions >1% of the 4th, 5^{th,} and 6th carbon budgets. It is anticipated that the magnitude of effect is likely to be low.

7.8.70 Compared to other types of electricity generation; the Scheme is expected to have a **major beneficial significant effect** on the climate.

Decommissioning (2066 - 2067)

7.8.71 During the decommissioning stage, total GHG emissions will be supplied; including the source of emissions, any related emissions and the contribution of each emission source (as a percentage) to the overall GHG emissions produced.

7.8.72 As the decommissioning activities associated with the Scheme will occur far into the future; there is uncertainty over the total estimate of GHG emissions that will be produced. Therefore, prior to decommissioning, a Decommissioning Plan will be prepared. It is assumed that GHG emissions during decommissioning will be broadly the same as construction without the added production GHG emissions associated with creating the materials to go on site. The below is assumed for decommissioning which shows that emissions will be far lower than construction and the main source of emissions will be from worker transportation.

7.8.73 Removal of the parts has assumed the total weight of materials will be recycled as average construction and demolition waste in line with Ref 7.24.

Table 7.27 – Summary of Decommissioning GHGs

Emissions Source	Emissions (tCO_2e)	% Construction Emissions
Worker Transportation	12,316	98.29
Removal of onsite materials	60	0.48
Water Usage	2	0.02
Energy Usage for Decommissioning Period	152	1.21
Total	**12,531**	**100.00**

Significance of Effect (Decommissioning)

7.8.74 The projected lifespan of the Scheme is estimated to be 40 years so it is unknown at this stage what the effects will be in the future. However, based on the above of the development, it is expected that the magnitude of effect will be low.

7.8.75 It should be noted that the embodied carbon within the products would not require consideration within the decommissioning process as they would not need to be produced again or shipped as a result of decommissioning of the scheme. It is therefore likely that decommissioning effects would be lower than construction. The assumption is for a closed loop disposal within the UK.

Overall GHG Impact

7.8.76 It is anticipated that the construction and decommissioning stages of the Scheme will result in a minor adverse impact on the climate which is not significant in EIA terms. Conversely, the overall operational stage will likely have a major significant beneficial effect.

Climate Change Resilience Review

7.8.77 In the sections below; associated impacts and effects of climate change during the construction, operation and decommissioning stages of the Scheme are discussed.

7.8.78 The receptor for the review of climate change resilience is the Scheme itself, including all infrastructure, assets, and workers on-site during construction, operation, and decommissioning. The sensitivity of the receptors has been evaluated based on their vulnerability, susceptibility to climate change associated impacts and their overall importance.

Table 7.28 – Sensitivity of Receptors

Receptors	Vulnerability	Susceptibility	Importance	Overall Sensitivity
Buildings and infrastructure	Moderate	Moderate	High	Medium

Receptors	Vulnerability	Susceptibility	Importance	Overall Sensitivity
including equipment and building operations				
Human Health including construction workers and site users	Moderate	Moderate	High	Medium

Construction (2024-2026)

7.8.79 Due to projected changes in climate and increased environmental extremes; sensitive receptors during the construction process may be vulnerable. The climate risks are summarised in the table below.

Table 7.29 – Construction Phase Climate Risks

Climate Risk	Receptor	Consequence	Likelihood of Impact	Magnitude of Effect
Increased probability of extreme weather events	Buildings and Infrastructure	Restriction to site access and working hours causing delay to construction	As likely as not	Medium
Increased heatwaves	Human Health	Poor working conditions impacting specific construction activities	Likely	High
Increase rainfall events	Human Health	Poor working conditions impacting specific construction activities	Likely	High
Increased risk of flooding from River Trent	Buildings and Infrastructure & Human Health	Danger to site workers, damage to site equipment	Unlikely	Medium

7.8.80 The climatic changes expected to take place during the construction phase have the potential to cause delays to the construction schedule due to the occurrence of severe weather events. The extreme weather conditions may also impact the health and safety of the workers on site. Nonetheless, the construction phase takes place within the early stages of the 2020 – 2039 range of climate scenarios as detailed in Table 7.8, 7.8.81 Table 7.9 and Table 7.10. As a consequence, the expected climate changes are not as severe and will likely be able to be mitigated against through best working practices such as working in heat risk assessment (e.g. staying hydrated, wearing sun protection).

Operation (2026 - 2065)

7.8.82 Climate change risks may increase the Scheme's vulnerability to damage during its operational stage.

7.8.83 The receptor for the review of climate change resilience is the Scheme itself, including all infrastructure, assets, and workers on-site during construction, operation, and decommissioning. The sensitivity of the receptors has been evaluated based on their vulnerability, susceptibility to climate change associated impacts and their overall importance.

7.8.84 The projected changes in climate and increased environmental extremes are likely to be more severe during the 40 years life span of the Scheme. The climate risks are summarised in the table below.

Table 7.30 – Operation Phase Climate Risks

Climate Risk	Receptor	Impact	Likelihood of Impact	Magnitude of Effect
Increased frequency of severe weather events	Buildings and Infrastructure	Damage to infrastructure/assets due to heat stress or storm/flood damage	As likely as not	High
Increased summer and winter temperatures	Buildings and Infrastructure	Increase in the ambient temperature of BESS units, resulting in higher ventilation and cooling requirements	As likely as not	High
Increased summer temperatures	Human Health	Health and safety risk due to increased risk of fire	As likely as not	High
Increased winter precipitation	Human Health	Health and safety risk due to increase in surface water flooding and standing water leading to land subsidence	As likely as not	High
Increased risk of flooding from River Trent	Buildings and Infrastructure & Human Health	Danger to site workers, damage to site equipment	Unlikely	Medium

Decommissioning (2065-2067)

7.8.85 During the decommissioning stage, the impacts of climate change are expected to worsen and increase. This may increase the likelihood of sensitive receptors being impacted when compared with the construction process.

Overall CCR Impact

7.8.86 Embedded mitigation measures to increase the resilience of the Scheme to Climatic changes are outlined in previous sections. This includes raising panels above the ground and stowing solar panels on a horizontal plane in the event of any significant flooding.

7.8.87 The CCR review has considered the measures which are integrated into the design (see Section 7.9). These are considered an adequate response to the projected climate change impacts to which the Scheme would be exposed.

7.9 In Combination Assessment

7.9.1 The greatest risk of in combination affects are of increased flooding events from extreme weather arising from a changing climate.

7.9.2 The risk of flooding from the River Trent and from increased rainfall has been determined to be unlikely through the Hydrology assessment work and consultation with the Environment Agency and use of EA models, though there are cumulative risks of increased flooding as a result of Climate Change. The below is summarised from the Hydrology ES Chapter.

Table 7.31 – Flood Risks from Climate Change

Area	Flood Risk Summary	Likelihood of Impact
Cable Route	The EA 'Flood Map for Planning' map shows that the Cable Route is located within Flood Zones 1, 2 and 3. The risk of flooding from all sources has been assessed and the flood risk to the Site is considered to be Negligible to Low and therefore does not require Site-specific mitigation measures. The solar panels will be mounted on raised frames for both fixed and tracker panel options and therefore raised above surrounding ground level allowing flood water to flow freely underneath. Therefore, there will be no loss of floodplain volume as a result of the proposed development. The Scheme is free draining through perimeter gaps around all panels, allowing for infiltration as existing within the grassland/vegetation surrounding and beneath the panels. There will be minimal increase in impermeable area meaning the proposals will not increase surface water flood risk elsewhere. Any surface water exceeding the infiltration capacity of the surrounding strata will naturally drain to the surrounding Land Drains and the River Till in line with the existing scenario. The heavily managed agricultural land will be replaced with grassland. This will help to reduce run off rates by increasing the roughness of the ground,	Negligible to low

Area	Flood Risk Summary	Likelihood of Impact
	help to increase infiltration by reducing compaction, and improve water quality by reducing erosion and mobilisation of pollutants. As a result, runoff rates may be reduced following development when compared to the existing greenfield scenario.	
West Burton 1	The EA provided data inclusive of Climate Change predictions from the Upper Witham Lincoln 2015 model. The majority of the Site is shown to remain flood-free. The vast majority of the Site remains flood free during the 1% annual exceedance probability (AEP) + 20% Climate Change event with only minor flooding within the Till Flood Storage Area in the north-west of the Site. The proposed solar panels will be raised above surrounding ground levels with associated power infrastructure appropriately waterproofed whether fixed or tracked.	Negligible to Low
West Burton 2	The EA provided data inclusive of Climate Change predictions from the Upper Witham Lincoln 2015 model. The majority of the Site is expected to remain flood free during the 1% AEP + 20% CC event with only the eastern extent of the Site which acts as a Flood Storage Area for the River Till shown to be impacted by flooding. Development has been sequentially located away from the area of the Site located within the Flood Storage Area. The proposed solar panels will be raised above surrounding ground levels with associated power infrastructure appropriately waterproofed.	Negligible to Low
West Burton 3	The western and eastern extents of the Site are expected to remain flood free across all flood risk scenarios. The central portion of the Site is shown to	Low

Area	Flood Risk Summary	Likelihood of Impact
	flood during the 1% AEP + 20% CC event, the vast majority of flooding is expected to remain below 1 m in depth. Deeper flooding in excess of 2 m is expected during the 0.1% + 20% CC event however the likelihood of this event occurring during the Site's 40 year tenancy operational phase is very low, and is therefore considered a residual risk. The solar panels will be mounted on raised frames and therefore raised above surrounding ground level allowing flood water to flow freely underneath. Therefore, there will be no loss of floodplain volume as a result of the proposed development. The proposed substation and battery storage area will introduce impermeable drainage area in the form of battery storage, substation infrastructure and access. This will result in an increase in surface water runoff. In order to ensure the increase in surface water runoff will not increase flood risk elsewhere, flow control will be used, and attenuation provided on Site to accommodate storm events up to and including the 1 in 100 plus 20% CC event.	

7.9.3 While there is potential for some of West Burton 1 and 2 to have increased chance of flooding as a result of the effects of Climate Change, the layout of the scheme has been designed in such a way as to minimise development of areas which are more at risk of flooding.

7.10 Mitigation Measures

7.10.1 The GHG assessment has identified that the greatest source of tCO_2e during the construction phase is from embodied carbon from products.

7.10.2 While worst case assumptions have been made for the purpose of the GHG vehicle type around use of HGVs for transport of construction materials, wherever possible vehicles with lower carbon emissions should be used.

7.10.3 Climate Change mitigation forms part of the embedded mitigation as part of the scheme as its primary purpose is to deliver clean renewable energy. The scheme will contribute to the UK's Carbon Target of Net Zero by 2050.

7.10.4 The assessment has not identified the need for any additional mitigation or enhancement measures.

7.11 Cumulative Effects

7.11.1 Cumulative GHG emissions are likely to arise due to the prevalence of other planned developments considered as part of the cumulative effects off the Scheme. With three of these planned developments being Nationally Significant Infrastructure Projects (NSIPs); consideration has been given to these within the ES. Specific consideration has been given to the following solar projects:

- Cottam
- Gate Burton
- Tillbridge

7.11.2 Although the Scheme will provide major beneficial impacts; it is important to consider other developments as the GHG emissions produced in conjunction may exceed >1% of the applicable carbon budget.

7.11.3 The Scheme is being developed in tandem alongside the nearby Cottam Solar Project. It is considered that there would be positive cumulative effects should both developments construction periods overlap as this could allow for consolidation of vehicle trips which would lead to less GHG emissions than if the construction periods were staggered. Any of these savings have not been explicitly accounted for within this assessment as at this stage, it is unknown what these potential savings would be therefore the cumulative effect is based on both schemes operating in isolation.

7.11.4 The total construction emissions have been calculated inclusive of embodied carbon from products which allows for a cumulative assessment of the effect of both construction phases on the UK carbon budget.

Table 7. 32 Cumulative Construction Phase Greenhouse Gas Emissions

Cottam Construction Emissions (tCO_2e)	West Burton Construction Emissions (tCO_2e)	Cumulative Emissions (tCO_2e)	Annualised UK Carbon Budget (tCO_2e)	% of Carbon Budget
444,475	130,815	575,289	390,000,000	0.15

7.11.5 As shown, the cumulative emissions from both projects is below 1% of the 4th UK carbon budget and so not expected to result in a significant effect.

7.11.6 The cumulative effect of both schemes in operation is determined to be major beneficial with regards to climate change

7.11.7 The Gate Burton Energy Park has also been considered as part of the cumulative assessment. The cumulative effect of the construction phases of this scheme is not likely to be >1% of the 4th Carbon Budget. While there may be some cumulative effects from combined GHG emissions during the construction phase, it is considered that, as with the Scheme, the offset from reduced emissions over the operational phase of the development would ultimately result in a beneficial cumulative effect with regards to Climate Change.

7.11.8 The GHG assessment has included for the cumulative effect of emissions. There are potential savings for joint working practices with the West Burton, Gate Burton and Tillbridge project ducts and cables being constructed at the same time. The specific embodied emissions for cables associated with Cottam are separated out in the GHG assessment above. Sharing a joint cable corridor would result in a net saving of GHG emissions compared to approaching each project separately.

7.11.9 The overall increase in renewables offered by the increase in solar capacity as a result of each of these schemes would lead to further reduced Greenhouse Gas Emissions and would have a net cumulative positive effect.

7.11.10 In summary, there are not anticipated to be any significant cumulative effects as a result of all three developments with regards to Climate Change in either the construction or operational scenarios.

7.11.11 The cumulative effect of the solar developments will be major beneficial in terms of Climate Change Resilience given that the combined effect of the renewable energy will serve to counter the effects of Climate Change.

7.12 Residual Effects

7.12.1 During the different stages of the Scheme (construction, operation, and decommissioning), inevitable GHG emissions will be generated with associated transport, energy, and fuel-use.

7.12.2 Overall, the Scheme itself will provide major beneficial impacts and a net reduction in GHG.

7.12.3 The design has accounted for Climate Resilience through accommodating embedded design mitigation within flood risk zones, though there remains uncertainty to the extent of which severe weather events will affect the UK. While some panels may be placed in flood risk zones, tracker solar panel units will be mounted on raised frames (usually raised a minimum of 0.4 m) when on maximum rotation angle) and will therefore be raised above surrounding ground levels and fitted with a tracking system. During times of flooding, solar panels may be stowed by the tracking system algorithm onto a horizontal plane, to the minimum post height of 2.3 m above ground level. This ensures that all sensitive and electrical equipment on the solar panel is raised to a minimum of 2.3 m above ground level in the horizontal position.

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