POWER FOR GOOD

Steeple Renewables Project

Chapter 12: Climate Change

Environmental Statement - Volume 1

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Chapter 12: Climate Change

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12.1 Introduction

12.1.1 This chapter of the Environmental Statement (ES) considers potential effects with respect to climate change, in accordance with the Project Description provided in **Chapter 4: Proposed Development [EN010163/APP/6.2.4]** of this ES.

12.1.2 In line with the EIA Regulations, this ES assessment considers the following:

- **Emissions reduction**[1]: potential effects of the Proposed Development on emissions of greenhouse gases (GHGs); and
- **Climate change adaptation**: both the vulnerability of the Proposed Development to climate change and also the implications of climate change for the predicted effects of the Proposed Development, as assessed by the other topic specialists ('in-combination climate effects').

12.1.3 To ensure that both emissions reduction and climate change adaptation are fully and consistently considered, this chapter sets out the assessment for these two elements separately.

12.1.4 The assessment draws on recognised climate change projections, existing guidance, and emerging good practice, as well as being informed by relevant information presented in other chapters of the ES and further documents which will form part of the application.

12.1.5 Details of the lead author of this Chapter are set out in **Appendix 1.4 -EIA Statement of Competence [EN010163/APP/6.3.1]**.

Part A: Emissions Reduction

12.1.6 This section of the ES considers the potential impact of the Proposed Development on the global climate by considering all major sources of GHG emissions arising over the lifecycle of the Proposed Development and includes direct GHG emissions arising from activities within the Site as well as indirect emissions from activities outside the Site (for example, the transportation of materials to the Site, and embodied carbon within construction materials).

[1] Also known as 'climate change mitigation' and this is not to be confused with EIA mitigation. Climate change mitigation seeks to specifically reduce a development's greenhouse gas emissions. EIA mitigation is measures that aim to avoid, prevent, reduce or offset any identified significant adverse effects of a development.

12.1.7 The findings of the lifecycle assessment are presented in this ES chapter. Key assumptions underpinning the assessment are also outlined under '12.3 Assessment Methodology' below.

12.2 Legislation and Planning Policy

UK Legislation, Policy and Strategy

12.2.1 This assessment has been carried out in accordance with the following legislation and relevant national policy objectives:

- The Climate Change Act 2008[2]: this sets legally binding targets for reducing emissions of greenhouse gases by 2050. The net UK carbon account for 2050 must be at least 100% lower than the 1990 baseline. Under the Act, a series of sequential carbon budgets have been developed. Each budget provides a five-year statutory cap on total GHG emissions, which should not be exceeded to meet the UK's emission reduction commitments. These legally binding targets are currently available to the 6th carbon budget period (2033-2037) which became legislation under the Carbon Budget Order 2021, and which came into force on 24 June 2021. The Climate Change Committee (CCC) has subsequently published a statutory advisory report on the Seventh Carbon Budget (2038-2042) in February 2025, which is yet to become legislation.
- Part 2 of the Overarching National Policy Statement for Energy (NPS EN-1)[3]: this sets out the central government policy context for major energy infrastructure. This includes the need to meet legally binding targets to cut greenhouse gas emissions, transition to a low-carbon economy and decarbonise the power sector.
- Paragraphs 1.1.1 and 1.1.2 of the National Policy Statement for Renewable Energy Infrastructure (NPS EN-3)[4]: this states that there is an urgent need for new electricity generating capacity and underlines the importance of the generation of electricity from renewable sources. It states that electricity generation from renewable sources of energy is essential for the Government to meet their statutory targets for the sixth carbon budget

[2] UK Government (2008) The Climate Change Act 2008.
[3] UK Government (2023) Overarching National Policy Statement for Energy (EN-1).
[4] UK Government (2023) National Policy Statement for Renewable Energy Infrastructure (EN-3).

(CB6). It stresses that demand for electricity could more than double by 2050 and that this would require a fourfold increase in electricity generation that will most likely come from renewables.

- The UK Net Zero Strategy[5]: this sets out policies and proposals for decarbonising all sectors of the economy to meet the UK's net zero target by 2050. This includes that by 2035, all the UK's electricity should come from low carbon sources. The British Energy Security Strategy[6], published in April 2022, and the Growth Plan of 23 September 2022[7] further reinforced ambitions and the importance of addressing our underlying vulnerability to international oil and gas prices and reducing our dependence on imported oil and gas. Powering Up Britain[8], published in March 2023, set out how the government will enhance our country's energy security, seize the economic opportunities of the transition, and deliver on our net zero commitments.

Local Policy and Strategy

12.2.2 The Site is located within the administrative authority of Bassetlaw District Council ('BDC'). The Bassetlaw Local Plan[9] was adopted in May 2024. Policy ST49: Renewable Energy Generation states that "*development that generates, shares, transmits and/or stores zero carbon and/or low carbon renewable energy including community energy schemes will be supported subject to the satisfactory resolution of all relevant site specific and cumulative impacts".* Furthermore, *"all renewable energy development will be expected to provide details of the expected power generation based upon expected yield or local self-consumption to enable effective monitoring of the district's contribution to the national zero carbon targets".*

12.2.3 The assessment has also taken account of the following policy objectives:

- Bassetlaw District Council Climate Change Strategy[10]: The principal goal is to decarbonise the Council's operations by 2030 and District-wide emissions by 2045. This includes the decarbonisation of various sectors, such as

[5] UK Government (2021) Net Zero Strategy: Build Back Greener.
[6] UK Government (2022) British Energy Security Strategy.
[7] UK Government (2022) The Growth Plan 2022.
[8] UK Government (2023) Powering Up Britain.
[9] Bassetlaw District Council (2024) Bassetlaw Local Plan.
[10] Bassetlaw District Council (2024) Bassetlaw District Council Climate Change Strategy.

heating and transport, along with an expansion of renewable energy initiatives.

- Nottinghamshire County Council Net Zero Framework (2024)[11]: this outlines a commitment to reducing local carbon emissions by 13.8% annually, aligning with the Paris Agreement's 1.5°C global target. Nottinghamshire has achieved a 34% reduction in CO_2 emissions per capita from 2005 to 2021, below the UK average of 45%, and swift and substantial cuts are still needed to meet the ambitious annual target. The Framework also focuses on expanding access to affordable, clean energy for all residents, promoting renewable energy generation, and delivering cost-effective strategies to decarbonise the county's energy system.
- Ambition 9 'Protecting the Environment and Reducing our Carbon Footprint' of The Nottinghamshire Plan 2021-2031[12]: This highlights the commitment to make the Council's activities net carbon neutral by 2030. One of the actions to achieve this is reducing reliance on purchased energy and grid capacity and instead, developing renewable energy capacity across the Council's estate.
- The Carbon Reduction Plan for Nottinghamshire County Council 2022-2032[13]: this sets out a framework for action and scope for the activities for which GHG emissions will be measured and reported in pursuit of the goal to be carbon neutral for its activities by 2030. These activities fall into the three broad areas of energy use in buildings; energy use in highways assets (mainly street lighting); and energy use in work-related travel and transport.

12.3 Assessment Methodology

12.3.1 The assessment has adopted a 'whole life' approach to calculating GHG emissions[14]. This considers all major lifecycle sources of GHG emissions and includes both direct

[11] Nottinghamshire County Council (2024) Net Zero Framework.
[12] Nottinghamshire County Council, 2021. Nottinghamshire Plan 2021-2031.
[13] Nottinghamshire County Council, 2022. Carbon Reduction Plan for Nottinghamshire County Council 2022-2032.
[14] It is not considered that the 'Finch Case' (*R (on the application of Finch on behalf of the Weald Action Group) v Surrey County Council and others* [2024] UKSC 20) has implications for the Proposed Development in terms of any requirement to consider 'downstream effects' which were not previously assessed in that case. No significant adverse downstream effects are anticipated as a result of the Proposed Development with respect to GHG emissions, due to the nature of the Proposed Development providing renewable energy, thereby avoiding and/or reducing GHG gases associated with the use of fossil fuels.

GHG emissions as well as indirect emissions from activities such as the transportation of materials and embodied carbon within construction materials.

12.3.2 As the calculated GHG emissions represent estimates, all numerical values have been rounded according to either three significant figures for larger values, or to at least one decimal place for smaller values. To maintain accuracy, all values have been rounded direct from the calculated value, and therefore, this may occasionally cause slight discrepancies where presented total figures may not add up exactly from other rounded values.

Study Area

12.3.3 Following the latest Institute of Environmental Management (IEMA) guidance (see paragraph 12.3.4 below), the study area for the assessment of GHG emissions is considered to be the global climate. The assessed receptor is the global atmosphere since GHG emissions are not geographically limited, having a global effect rather than directly affecting any specific local receptor(s).

Guidance

12.3.4 This assessment has been carried out in accordance with the principles contained within the following documents:

- IEMA (2022): Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance. Second Edition.[15]
- Department for Business, Energy and Industrial Strategy (BEIS) (2023): Green Book Supplementary Guidance: Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal.[16]
- British Standards Institute (BSI) (2016) PAS 2050:2016 Specification for the Assessment of the Life Cycle Greenhouse Gas Emissions of Goods and Services.[17]

[15] Institute of Environmental Management and Assessment (IEMA). (2022) *IEMA Environmental Impact Assessment Guide: Assessing Greenhouse Gas Emissions and Evaluating their Significance*.
[16] Department for Energy Security and Net Zero. (2023) *Valuation of energy use and greenhouse gas emissions for appraisal*.
[17] British Standards Institution (BSI). (2011) *PAS 2050: Specification for the assessment of the life cycle greenhouse gas emissions of goods and services*.

- World Business Council for Sustainable Development (WBCSD) (2015) The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard.[18]

Desk Based Research and Data Sources

Introduction

12.3.5 A desk-based assessment has been completed to determine the potential effects of the Proposed Development on the climate. This has been calculated in line with the GHG Protocol (WBCSD, 2015), and GHG 'hot spots' (i.e. materials and activities likely to generate the largest amount of GHG emissions) have been identified. This enables priority areas for mitigation to be identified. This approach is consistent with the principles set out in IEMA's 'Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance'.

12.3.6 Based on the description within **Chapter 4: Proposed Development [EN010163/APP/6.2.4]** of the ES, a 24-month construction programme has been assumed for the purposes of this assessment, commencing in 2027, followed by a maximum 40-year operational lifetime (2029-2069). It is anticipated that decommissioning will begin in 2069. (2029-2069). It is anticipated that decommissioning will begin in 2069.

12.3.7 Estimated GHG emissions arising from various activities during the construction, operational and decommissioning phases of the Proposed Development have been quantified using a calculation-based methodology as stated in the Department for Energy Security and Net Zero (DESNZ) 2024 emissions factors guidance[19].

12.3.8 Where activity data allows, expected GHG emissions arising from the construction, operational and decommissioning phases of the Proposed Development have been quantified using a calculation-based methodology as per the following equation, as stated in the DESNZ 2024 emissions factors guidance:

- Activity data *x* GHG emissions factor = GHG emissions value

12.3.9 Where data is not available, a qualitative approach to addressing GHG impacts has been followed, in line with the IEMA guidance on assessing GHG emissions in EIA.

[18] World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). (2004) *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*.
[19] Department for Energy Security and Net Zero (2024) Greenhouse Gas Reporting: Conversion Factors 2024.

Identifying Construction Effects

12.3.10 An overview of methodologies for identifying effects related to the construction phase is presented below. GHG emissions sources within the scope of the construction emissions include energy and fuel use for construction activities including fuel consumed by construction plant and machinery, the embodied carbon of products and equipment, the transportation of these materials to the Site boundary, the emissions associated with construction workers' transport to the Site, and disposal of waste materials, including emissions from the waste treatment process (recycling, landfill, incineration).

12.3.11 The construction worker employment generation is aligned with the average number of people likely to be working on-site during the construction period. A one-way distance of 50km per journey has been assumed for the worker transportation calculations, which is a conservative (worst case) estimate, as, where possible, staff will reside much closer to the Site, and employees not from the local area would stay in local accommodation. Lift sharing will also be encouraged.

12.3.12 The DESNZ 2024 emissions factors for 'Vans – Average (up to 3.5 tonnes) & Diesel', including well-to-tank (WTT) emissions, has been applied to this distance and total worker numbers to calculate GHG emissions associated with worker transport during construction and decommissioning.

12.3.13 Products and equipment considered in this assessment include the solar panels, solar inverters, transformers, substation and Battery Energy Storage System (BESS) enclosures. Whilst the specific manufacturer and model of the PV modules has not yet been confirmed, indicative information on the number and size of modules likely to be installed is available. A likely worst-case furthest distance country of origin of China has been assumed as a conservative estimate for products and equipment, with distances estimated from manufacturing facilities in Shanghai. Corresponding HGV and sea freight distances of 350km and 21,880km, respectively, have been assumed for transportation of materials.

12.3.14 For HGV transportation of materials, the DESNZ 2024 emissions factor for 'Rigid HGV – 7.5-17t' has been applied, including WTT emissions. It has been assumed that HGVs are 100% laden. Emissions per unit distance have been multiplied by the assumed distance above.

12.3.15 For sea freight transportation, the DESNZ 2024 emissions factor for 'Products tanker – Average' have been applied, including WTT emissions. Emissions per unit distance have been multiplied by the assumed distance above.

12.3.16 GHG emissions associated with energy and fuel use for construction activities, including fuel consumed by construction plant and machinery, have been calculated by multiplying the emissions factors per unit of fuel used by the fuel consumption. These include the DESNZ 2024 emissions factor for 'Diesel (100% mineral diesel)' and 'Electricity', and the associated WTT and T&D emissions factors.

12.3.17 The embodied carbon of the solar panel modules to be installed within the Proposed Development has been estimated by taking their indicative size and weight data from comparable supplier product information (Trina Solar, 2019 – see Table 12.1 for full ref), and using the embodied carbon benchmark (Life Cycle Analysis stages A1-A5, B1-B7, C1-2) from the Environmental Product Declaration (EPD) for a comparably sized module manufactured in China (Trina Solar, 2020).

12.3.18 To calculate the embodied carbon within the inverters, typical manufacturer information about material composition breakdown (Willmott Dixon, 2022) and unit weights (Solar Edge, 2018) has been used as a benchmark to estimate material quantities associated with the inverters required for the Proposed Development. Embodied carbon factors for each of these materials from the Inventory of Carbon and Energy version 3 database (University of Bath and Circular Ecology, 2019) have been applied.

12.3.19 For the embodied carbon of the BESS energy storage cells, embodied carbon benchmarks have been applied using data from the Life Cycle Analysis (LCA) of lithium-ion batteries (Dai et al., 2019) and have been multiplied by the indicative energy generation specifications.

12.3.20 To calculate the embodied carbon of the Proposed Development's substation, the material composition breakdown (Harrison et. al., 2010) has been used as a benchmark to estimate material quantities. Embodied carbon factors for each of these materials from the Inventory of Carbon and Energy version 3 database (University of Bath and Circular Ecology, 2019) have been applied.

12.3.21 The GHG emissions associated with construction waste disposal have been calculated by multiplying the emissions factors per waste treatment type by the weight of waste in tons. These include the DESNZ 2024 emissions factor for 'Metals',

'Batteries' and 'Average construction', each for respective disposal methods of 'Closed-loop', 'Open-loop', 'Combustion' and 'Landfill'.

12.3.22 Assumed reference values for the construction phase calculations can be seen below in full in **Table 12.1.**

Table 12.1: Construction phase assessment assumptions

Type	Description	Value	Unit	Source
Transport Emission Factor	HGV Rigid (>7.5 tonnes-17 tonnes)	0.691	kgCO2e/km	DESNZ (2024)[20]
	HGV Rigid (>7.5 tonnes-17 tonnes) – WTT	0.170	kgCO2e/km	
	Products tanker average	0.00902	kgCO2e/ tonne.km	
	Products tanker average – WTT	0.00205	kgCO2e/ tonne.km	
	Vans – Average (up to 3.5 tonnes) & Diesel	0.250	kgCO2e/km	
	Vans – Average (up to 3.5 tonnes) & Diesel – WTT	0.0613	kgCO2e/km	
Energy and Fuel Use Emissions Factors	Diesel (100% mineral diesel)	2.66155	kgCO2e/litre	DESNZ (2024)[6]
	Electricity generated	0.2075	kgCO2e/kWh	DESNZ (2024)[6]

[20] Department for Energy Security and Net Zero (2024) Greenhouse Gas Reporting: Conversion Factors 2024.

Type	Description	Value	Unit	Source
	Diesel (100% mineral diesel) – WTT	0.62409	kgCO2e/litre	DESNZ (2024)[6]
	T&D- UK electricity	0.01830	kgCO2e/kWh	DESNZ (2024)[6]
	WTT- UK electricity (generation)	0.04590	kgCO2e/kWh	DESNZ (2024)[6]
	WTT- UK electricity (T&D)	0.00397	kgCO2e/kWh	DESNZ (2024)[6]
Waste Disposal Emissions Factors	Construction – Metals (Closed-loop)	0.98485	kgCO2e/tonne	DESNZ (2024)[6]
	Construction – Metals (Landfill)	1.26435	kgCO2e/tonne	DESNZ (2024)[6]
	Average construction (Open-loop)	0.98485	kgCO2e/tonne	DESNZ (2024)[6]
	Average construction (Combustion)	6.41061	kgCO2e/tonne	DESNZ (2024)[6]
	Batteries (Open-loop)	6.41061	kgCO2e/tonne	DESNZ (2024)[6]
	Batteries (Landfill)	8.88386	kgCO2e/tonne	DESNZ (2024)[6]
Product Weight	Battery unit	18,000	kg per unit	Sungrow (2021)[21]

[21] Sungrow (2021) Energy Storage System, Product Catalogue.

Type	Description	Value	Unit	Source
	Solar Panel	38.7	kg per unit	Trina Solar (2019)[22]
	Solar Inverter unit	48	kg per unit	Solar Edge (2018)[23]
	Battery Power Conversion System Unit	1,500	kg per unit	Solar Edge (2018)[24]
Material Compositions	Inverter unit	0.3% stainless steel, 13.4% steel, 4.6% zinc, 12.2% copper, 7.7% aluminium, 14.6% electronics, 3.1% ceramic and 44.1% epoxide resin	%	Willmott Dixon (2022)[25]
	Cable	18.3% copper wire, 2.6% copper, tin 0.3%, 2.6% polyethylene, 3.4% polypropylene, other plastics 60.6%	%	

[22] Trina Solar (2019) The Duomax Half-Cell Dual Glass 72 Layout Module Product Sheet.
[23] Solar Edge (2018) Three Phase Inverter with Synergy Technology Product Sheet.
[24] Solar Edge (2018) Three Phase Inverter with Synergy Technology Product Sheet.
[25] Wilmott Dixon (2022) Whole life carbon of photovoltaic installations: Technical Report.

Type	Description	Value	Unit	Source
	Substations	0.002% aluminium, 0.5% copper, 1.7% steel, 0.4% other, 19.3% concrete, 77.0% limestone chipping, 0.4% fencing, 0.7% oil	%	Harrison et. al. (2010)[26]
Embodied Carbon	Battery unit	73	kgCO2e/kWh	Dai et. al. (2019)[27]
	Solar panel – Upstream (A1 – A2)	0.00557	kgCO2e/kWh	EPD Trina Solar (2020)[28]
	Solar panel – Core Stage (A3 – A5, B1 – B7, C1 – C2)	0.00673	kgCO2e/kWh	
	Polyethylene	2.54	kgCO2e/kg	University of Bath and Circular
	Polypropylene	4.49	kgCO2e/kg	
	Other Plastics	3.31	kgCO2e/kg	
	Steel	3.02	kgCO2e/kg	
	Zinc	4.18	kgCO2e/kg	

[26] Harrison, GP, Maclean, EJ, Karamanlis, S & Ochoa, LF 2010, 'Life cycle assessment of the transmission network in Great Britain', Energy Policy, vol. 38, no. 7, pp. 3622-3631.
[27] Dai, Q.; Kelly, J.C.; Gaines, L.; Wang, M. Life Cycle Analysis of Lithium-Ion Batteries for Automotive Applications. Batteries 2019, 5, 48.
[28] Trina Solar (2020) Environmental Product Declaration.

Type	Description	Value	Unit	Source
	Aluminium	13.10	kgCO2e/kg	Ecology (2019)[29]
	Ceramics	0.70	kgCO2e/kg	
	Epoxide Resin	5.70	kgCO2e/kg	
	Electronics	5.30	kgCO2e/kg	
	Copper	2.71	kgCO2e/kg	
	Tin	14.47	kgCO2e/kg	

Identifying Operational Effects

12.3.23 An overview of methodologies for identifying effects related to the operational phase is presented below. GHG emissions sources within the scope of the operational emissions include operational energy use (i.e. for auxiliary services and standby power), fuel used for the transportation of workers to the Proposed Development and maintenance activities (including embodied carbon in replacement parts, plant and machinery requirements).

12.3.24 Operational energy generation data has been estimated by applying an industry standard capacity factor for solar PV to the indicative capacity specifications for the first year of operation. Efficiency losses of the PV modules over time have been accounted for based on an industry standard degradation factor 0.4% for each subsequent year (and confirmed with RES).

12.3.25 Operational energy use (i.e. for auxiliary services and standby power) for the Proposed Development during the night has been estimated from recent comparable schemes. Whilst corresponding energy requirements could also be supplied from the BESS, to be consistent with the conservative approach taken, it has been assumed that this will be met by energy imported from the National Grid. Therefore, the night-time energy use will result in GHG emissions as a result of the

[29] University of Bath and Circular Economy (2019) Embodied Carbon ICE Database.

production of grid electricity, using current 2024 and projected grid GHG intensities (DESNZ, 2023)[30] over the operational phase of the Proposed Development.

12.3.26 GHG emissions associated with operational maintenance have been represented by the embodied carbon emissions resulting from the replacement of product components. To calculate the associated GHG emissions for the embodied carbon and transportation of replaced products, estimated emissions from the equivalent activities during construction have been scaled on a pro rata basis to the proportion of embodied and transportation emissions for the construction phase.

12.3.27 Assumed reference values for the operational phase calculations can be seen below in full in Table 12.2.

[30] Department for Energy Security and Net Zero, (2023); Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal.

Table 12.2: Operational phase assessment assumptions

Type	Description	Value	Unit	Source
Energy Generation	Capacity Factor	11%	%	BEIS (2016)[31]
	Annual Degradation Factor	0.4%	%	RES[32]
Operation and Maintenance	Night-time energy demand	0.01	kWh/kWh generation	Sunnica Energy Farm Project Team (2021)[33]
	Replacement rate of solar panels	0.2	% per year	
	Replacement rate of solar inverters	4.4	% per year	
	Replacement rate of battery inverters	3.1	% per year	
	Replacement rate of substations	10.0	% per year	Harrison et. al. (2010)[34]
	Replacement rate of battery units	8 – 9	Years	Heckington Fen Solar Park Project Team (2023)[35]

Identifying Decommissioning Effects

12.3.28 An overview of methodologies for identifying effects related to the decommissioning phase is presented below. GHG emissions sources within the scope of the decommissioning emissions include energy and fuel use for decommissioning activities including fuel consumed by plant and machinery, the transportation of products and equipment from the Proposed Development boundary, emissions associated with worker transport, and disposal of waste

[31] Department for Business, Energy and Industrial Strategy (2016) Electricity Generation Costs.
[32] Email correspondence, March 2025.
[33] Sunnica Energy Farm Project Team. Environmental Statement Chapter 6: Climate Change. 18 November 2021.
[34] Harrison, GP, Maclean, EJ, Karamanlis, S & Ochoa, LF 2010, 'Life cycle assessment of the transmission network in Great Britain', Energy Policy, vol. 38, no. 7, pp. 3622-3631.
[35] Heckington Fen Solar Park Project Team. Environmental Statement Chapter 13: Climate Change. August 2023.

materials, including emissions from the waste treatment process (recycling, landfill, incineration).

12.3.29 GHG emissions associated with energy and fuel use for decommissioning activities, including fuel consumed by plant and machinery, have been calculated by multiplying the emissions factors per unit of fuel used by the fuel consumption. These include the DESNZ 2024 emissions factor for 'Diesel (100% mineral diesel)' and 'Electricity', and the associated WTT and T&D emissions factors.

12.3.30 For HGV transportation of materials and waste to their disposal point, an average distance of 50km has been assumed to reflect a conservative estimate. Correspondingly, the DESNZ 2024 emissions factor for 'Rigid HGV–7.5-17t' have been applied, including WTT emissions. It has been assumed that HGVs are 100% laden. Emissions per unit distance have been multiplied by the assumed distance above.

12.3.31 For worker transportation, it has been assumed that an equivalent number of workers will be required on site at decommissioning as per the construction stage. Correspondingly, a 1-way distance of 50km per journey has been assumed for the worker transportation calculations, which is a conservative estimate as, where possible, staff will reside much closer to the site limits, and employees not from the local area would stay in local accommodation. The DESNZ 2024 emissions factors for 'Vans – Average (up to 3.5 tonnes) & Diesel', including WTT emissions, have been applied to this distance and total worker numbers to calculate GHG emissions.

12.3.32 The GHG emissions associated with decommissioning waste disposal have been calculated by multiplying the emissions factors per waste treatment type by the weight of waste in tons. These include the DESNZ 2024 emissions factor for 'Metals', 'Batteries' and 'Average construction', each for respective disposal methods of 'Closed-loop', 'Open-loop', 'Combustion' and 'Landfill'.

12.3.33 To reduce the lifetime impact associated with the embodied carbon of all products and equipment, recycling of reclaimed materials would be required at end of life decommissioning, adhering to UK government WEE guidelines (Environment Agency, 2023)[36].

[36] Environment Agency (2023) Electrical and Electronic Equipment: Producer Responsibilities.

12.3.34 Solar panel infrastructure is highly recyclable, with current rates approximately at 96% of the material.[37] Furthermore by the estimated end of the Proposed Development's operational lifetime in the late-2060s, recycling technologies and efficiencies are likely to have significantly improved, and any remaining decommissioning GHG emissions associated with energy generation, transportation, operation of plant and waste disposal throughout the supply chain are anticipated to be much lower as a result of grid decarbonisation of machinery and vehicle electrification in line with the UK's net zero carbon emissions target for 2050.

12.3.35 Assumed reference values for the decommissioning phase calculations can be seen below in full in Table 12.3.

Table 12.3: Decommissioning phase assessment assumptions

Type	Description	Value	Unit	Source
Transport Emission Factor	HGV Rigid (>7.5 tonnes-17 tonnes)	0.691	$kgCO_2e/km$	DESNZ (2024)[38]
	HGV Rigid (>7.5 tonnes-17 tonnes) – WTT	0.170	$kgCO_2e/km$	
	Products tanker average	0.00902	$kgCO_2e$/ tonne.km	
	Products tanker average – WTT	0.00205	$kgCO_2e$/ tonne.km	
	Vans – Average (up to 3.5 tonnes) & Diesel	0.250	$kgCO_2e/km$	
	Vans – Average (up to 3.5 tonnes) & Diesel – WTT	0.0613	$kgCO_2e/km$	

[37] CSG (2023) Waste specialist to launch solar panel recycling service.
[38] Department for Energy Security and Net Zero (2024) Greenhouse Gas Reporting: Conversion Factors 2024.

Type	Description	Value	Unit	Source
Energy and Fuel Use Emissions Factors	Diesel (100% mineral diesel)	2.66155	$kgCO_2e$/litre	DESNZ (2024)[18]
	Electricity generated	0.2075	$kgCO_2e$/kWh	DESNZ (2024)[18]
	Diesel (100% mineral diesel) – WTT	0.62409	kgCO2e/litre	DESNZ (2024)[18]
	T&D- UK electricity	0.01830	kgCO2e/kWh	DESNZ (2024)[18]
	WTT- UK electricity (generation)	0.04590	kgCO2e/kWh	DESNZ (2024)[18]
	WTT- UK electricity (T&D)	0.00397	kgCO2e/kWh	DESNZ (2024)[18]
Waste Disposal Emissions Factors	Construction – Metals (Closed-loop)	0.98485	$kgCO_2e$/tonne	DESNZ (2024)[18]
	Construction – Metals (Landfill)	1.26435	kgCO2e/tonne	DESNZ (2024)[18]
	Average construction (Open-loop)	0.98485	$kgCO_2e$/tonne	DESNZ (2024)[18]
	Average construction (Combustion)	6.41061	$kgCO_2e$/tonne	DESNZ (2024)[18]
	Batteries (Open-loop)	6.41061	$kgCO_2e$/tonne	DESNZ (2024)[18]
	Batteries (Landfill)	8.88386	$kgCO_2e$/tonne	DESNZ (2024)[18]

Assessment of Significance

Sensitivity

12.3.36 The sensitivity of the receptor (global atmosphere) to increases in GHG emissions is always considered 'High', following IEMA Guidance (IEMA, 2022). This reflects the severe consequences of global climate change and the cumulative contributions of all GHG emission sources.

Magnitude

12.3.37 With respect to the generation of GHG emissions, the magnitude of change to the climate has been assessed as the change in mass of GHG emissions, in units of tonnes of carbon dioxide equivalent (tCO_2e) [39] relative to relevant national carbon budgets, in accordance with the IEMA guidance (IEMA, 2022).

12.3.38 This guidance emphasises that impact may not be determined by whether a project emits GHG emissions, or even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050.

12.3.39 The UK has national carbon budgets which present future emissions inventory scenarios and outline the total amount of GHGs that the UK can emit over a five-year period. These are currently available to the 7th carbon budget period (2038 – 2042). The national carbon budgets, which have been determined by the Climate Change Committee as compatible with the required magnitude and rate of GHG emissions reductions required to meet the goals of the Paris Agreement, have the advantage of being clearly defined and based on robust scientific evidence. The starting point for context is, therefore, the Proposed Development's percentage contribution to the national carbon budget.

12.3.40 Since the effects of GHG emissions cannot be geographically constrained, more localised budgets or targets can be less meaningful, especially since it is unclear as to whether emerging local authority or regional budgets will add up coherently to the UK budget. In addition, national carbon budgets have the advantage of being clearly defined and based on robust scientific evidence.

[39] A carbon dioxide equivalent is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential. For example, methane has a GWP of 25, meaning that 1 tonne of methane has the same warming effect as 25 tonnes of CO2.

12.3.41 As shown in Table 12.4 below, the appropriate UK national carbon budgets that span the construction programme of the Proposed Development are the 4th carbon budget (2023 to 2027) and the 5th carbon budget (2028 to 2032). With regards to the operational phase and decommissioning, it is noted that whilst the corresponding carbon budgets are not fully available yet, the UK has set an ambitious target to achieve net zero greenhouse gas emissions by 2050.

Table 12.4: Relevant carbon budgets for this assessment

Carbon Budget	Total budget (MtCO2e)	Reduction below 1990 levels
4th (2023-2027)	1,950	51% by 2025
5th (2028-2032)	1,725	57% by 2030
6th (2033-2037)	965	78% by 3035
7th (2038 – 2042)	535	87% by 2040
Beyond 7th Carbon Budget	Not yet published	Not yet published

12.3.42 Table 12.5 presents the criteria for assessing the magnitude of change.

Table 12.5: Criteria for determining magnitude of change

Magnitude	Description
High/Medium	Net annual GHG emissions represent equal to or more than 1% of the relevant annual National Carbon Budget (professional judgement made depending on extent of exceedance).
Low	Net annual GHG emissions represent less than 1% of the relevant annual National Carbon Budget.
Negligible	Net annual GHG emissions are net zero.

12.3.43 No differentiating thresholds have been defined for the net reduction in GHG emissions, as in accordance with IEMA guidance (2022), all beneficial effects are considered significant (see Table 12.7 below).

Significance

12.3.44 The updated IEMA guidance (IEMA, 2022)[40] has been adopted for assessing the significance of GHG effects for EIA. The guidance describes five distinct levels of

[40] Institute of Environmental Management and Assessment (IEMA). (2022) *IEMA Environmental Impact Assessment Guide: Assessing Greenhouse Gas Emissions and Evaluating their Significance*.

significance *"which are not solely based on whether a project emits GHG emissions alone, but how the project makes a relative contribution towards achieving a science-based 1.5°C aligned transition towards net zero"* (see Table 12.7 below). Major and moderate adverse effects are considered significant in the context of the EIA Regulations, as are all beneficial effects. .

12.3.45 In GHG accounting, it is common practice to consider the exclusion of emission sources that are <1% of a given emissions inventory, on the basis of a 'de minimis' contribution. Both GHG Protocol - Corporate Standard (2004)[41] and PAS 2050 Specification (BSI, 2011)[42] allow emissions sources of <1% contribution to be excluded from emission inventories, and for these inventories to still be considered complete for verification purposes. The IEMA guidance (2022) also states that projects with any non-significant adverse effects should be considered in terms of their compatibility with the budgeted, science based 1.5°C trajectory (in terms of rate of emissions reduction) and in terms of compliance with up-to-date policy and 'good practice' reduction measures.

12.3.46 Therefore, the GHG intensity of the Proposed Development (defined as the operational emissions divided by the energy generation) has been compared with the forecasted 2024 grid GHG intensity of the electricity grid as published by DESNZ (DESNZ, 2023)[43] over the operational phase of the Proposed Development, considering both the Proposed Development a whole, as well as excluding the BESS.

12.3.47 This assesses the relative contribution of the Proposed Development to the UK's trajectory towards net zero, since the projected grid intensity takes into account key variables related to climate change policies where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made.

12.3.48 This approach to assessing the significance of construction, operational and decommissioning effects is summarised in Table 12.6 below.

[41] World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). (2004) *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*.
[42] British Standards Institution (BSI). (2011) *PAS 2050: Specification for the assessment of the life cycle greenhouse gas emissions of goods and services*.
[43] Department for Energy Security and Net Zero, (2023); Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal.

Table 12.6: Significance criteria

Significance of Effect	IEMA Guidance	Construction / Decommissioning	Operational
Major Adverse	*"..not compatible with the UK's net zero trajectory"*	Net annual GHG emissions represent more than or equal to 1% of the relevant annual National Carbon Budget.	Annual operational GHG intensity of Proposed Development (excluding Energy Storage) greater or equal to the DESNZ 2024 grid GHG intensity.
Moderate Adverse	*"..does not fully contribute to decarbonisation"*		
Minor Adverse	*"…compatible with the budgeted, science based 1.5°C trajectory"*	Net annual GHG emissions represent less than 1% of the relevant annual National Carbon Budget.	Annual operational GHG intensity of Proposed Development (excluding Energy Storage) less than the DESNZ 2024 grid GHG intensity but greater than the relevant annual decarbonised grid GHG intensity.
Negligible	*"…goes substantially beyond the reduction trajectory"*	Net annual GHG emissions are net zero.	Annual operational GHG intensity of Proposed Development (excluding Energy Storage) less than the relevant annual

Significance of Effect	IEMA Guidance	Construction / Decommissioning	Operational
			decarbonised grid GHG intensity.
Beneficial	*"…GHG emissions to be avoided or removed from the atmosphere"*	Net annual GHG emissions are negative (i.e., net sequestration of GHG emissions).	Annual operational GHG intensity of Proposed Development (excluding Energy Storage) is at least less than the relevant annual decarbonised grid GHG intensity.

12.4 Assessment Assumptions and Limitations

12.4.1 Whilst some information gaps, such as the detailed energy generation modelling, have been identified, it is considered that there is sufficient information to enable an informed decision to be taken in relation to the identification and assessment of likely significant environmental effects of the Proposed Development on the climate.

12.4.1 Where available, product or design data specific to the Proposed Development required to undertake the lifecycle GHG impact assessment has been provided by the Applicant. Where data is unavailable, reasonable assumptions have been made based on professional judgement and analysed using methodologies and data sources previously outlined in this Section.

12.5 Stakeholder Engagement

12.5.1 No comments were raised in the Scoping Opinion provided by PINS (**see Appendix 1.2 – EIA Scoping Opinion [EN010163/APP/6.3.1]**) with respect to the methodology for assessing emissions reductions. No comments were received on the climate change chapter (Part A: Emissions Reduction) of the Preliminary

Environmental Information Report (PEIR) as part of the Statutory Consultation process.

12.6 Baseline Conditions

Site Description and Context

12.6.1 The baseline for the lifecycle GHG impact assessment reflects the existing Site conditions described below and is a 'do nothing' scenario whereby the Proposed Development is not implemented.

12.6.2 The Site comprises primarily agricultural land, with generally relatively large, regular shaped arable fields, with some dividing hedgerows and individual trees. Small woodland plantations are located within some of the fields.

12.6.3 The baseline conditions include the existing carbon stock (e.g. carbon sequestered within vegetation present) and sources of GHG emissions (e.g. from agricultural vehicles and machinery) within the Site from the existing activities on-site. As the land use within the Site is largely agricultural, it is estimated that the baseline conditions of the land will have minor levels of associated GHG emissions.

12.6.4 Whilst the growing of crops will sequester carbon in the short term for the duration of a growing cycle, this carbon would be subsequently released in a relatively short cycle during the agricultural practices of management, harvesting and consumption.

12.6.5 The resulting net GHG emissions of the baseline conditions are therefore dependent on soil and vegetation types present, and fuel use for the operation of agricultural vehicles and machinery. However, it is anticipated that these emissions will not be material in the context of the overall Proposed Development.

12.6.6 Therefore, for the purposes of the lifecycle GHG impact assessment, a conservative GHG emissions baseline of zero is applied, which due to the likely existing minor levels of associated GHG emissions, represents a robust worst-case approach.

Future Baseline in Absence of Development

12.6.7 The future baseline in the absence of the Proposed Development is assumed to be the same as that of the baseline conditions previously outlined in this Section, representing a 'do nothing' scenario whereby the Proposed Development is not implemented.

12.7 Assessment of Likely Significant Effects

Construction

12.7.1 The greatest GHG emissions during the construction phase are as a result of the embodied carbon in construction materials which accounts for 88% of the construction phase emissions.

12.7.2 Total GHG emissions from the construction phase are estimated to equate to 273,000 tCO2e. A breakdown of estimated GHG emissions from the construction of the Proposed Development is presented in Table 12.7 below.

12.7.3 GHG emissions from construction activities will be limited to the duration of the construction programme (24 months). When annualised, the total annual construction emissions equate to 136,000 tCO2e.

Table 12.7: Summary of Construction GHG Emissions

Emissions Source	Emissions (tCO2e)	% of Construction Emissions
Products (Embodied)	239,000	87.6
Transportation of materials & waste	10,900	4.0
Worker transportation	1,620	0.6
Waste treatment	34	<0.1
Fuel use	21,300	7.8
Total	**273,000**	**100.0**

12.7.4 GHG emissions from construction have been assessed to identify the significance of the effect. Table 12.8 presents the estimated construction emissions against the carbon budget period during which they arise. Construction emissions will fall under the 4th UK carbon budget and 5th UK carbon budget.

Table 12.8: Summary of Construction GHG Emissions against carbon budgets

Relevant UK Carbon Budget	Annualised UK Carbon Budget (tCO2e)	Annual Construction Emissions During Carbon Budget Period (tCO2e)	Construction Emissions as a Proportion of Annual Carbon Budget
4th Carbon Budget (2023-2027)	390,000,000	137,000	0.035%
5th Carbon Budget (2028-2032)	345,000,000	137,000	0.040%

12.7.5 Annual emissions from the construction of the Proposed Development represent less than 1% of the annualised 4th carbon budget and 5th carbon budget. The magnitude of change is therefore considered to be low. GHG emissions from the construction of the Proposed Development are therefore considered to have a **minor adverse (not significant)** effect on the climate.

Operation

12.7.6 The greatest GHG emissions during the operational phase are estimated to result from maintenance activities, associated with the embodied carbon of replacement parts and equipment, which account for 98% of the operational phase.

12.7.7 Total operational GHG emissions are estimated to equate to 174,000 tCO2e over the 40-year design life, as presented in Table 12.9 below. On an average annualised basis, this is equivalent to 4,350 tCO2e per year of operation.

Table 12.9: Summary of Operational GHG Emissions

Emissions Source	Emissions (tCO2e)	% of Operational Emissions
Worker transportation	1,100	0.6
Maintenance	171,000	98.1
Operation	2,180	1.3
Total	**174,000**	**100.0**

12.7.8 The operational GHG emissions presented in Table 12.10 are considered to reflect the conservative approach as the calculations for worker transportation and maintenance have been carried out using current emissions factors to estimate emissions over the operational lifetime of the Proposed Development. 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.

12.7.9 The average operational GHG intensity of both the Proposed Development (including BESS) and just the solar generation in isolation (excluding BESS) have been calculated by dividing the corresponding total operational GHG emissions (outlined above) by the total energy generation of the Proposed Development.

12.7.10 When considering the Proposed Development as a whole, this gives an average operational GHG intensity of 10.7 grams of CO2 equivalent per kWh (gCO2e/kWh). This operational GHG intensity is well below the 2025 GHG intensity of the grid (114 gCO2e/kWh), as published by BEIS (BEIS, 2021).

12.7.11 When considering only the aspects relating to the solar energy generation from the Proposed Development, this gives an average operational GHG intensity of 4.6 grams of CO2 equivalent per kWh (gCO2e/kWh). In addition to being well below the 2025 GHG intensity of the grid, this also remains below the projected decarbonised grid GHG intensity (BEIS, 2021) over the operational phase of the Proposed Development, which is not projected to fall lower than 6.7 gCO2e/kWh. These comparisons can be seen in Figure 12.1 below.

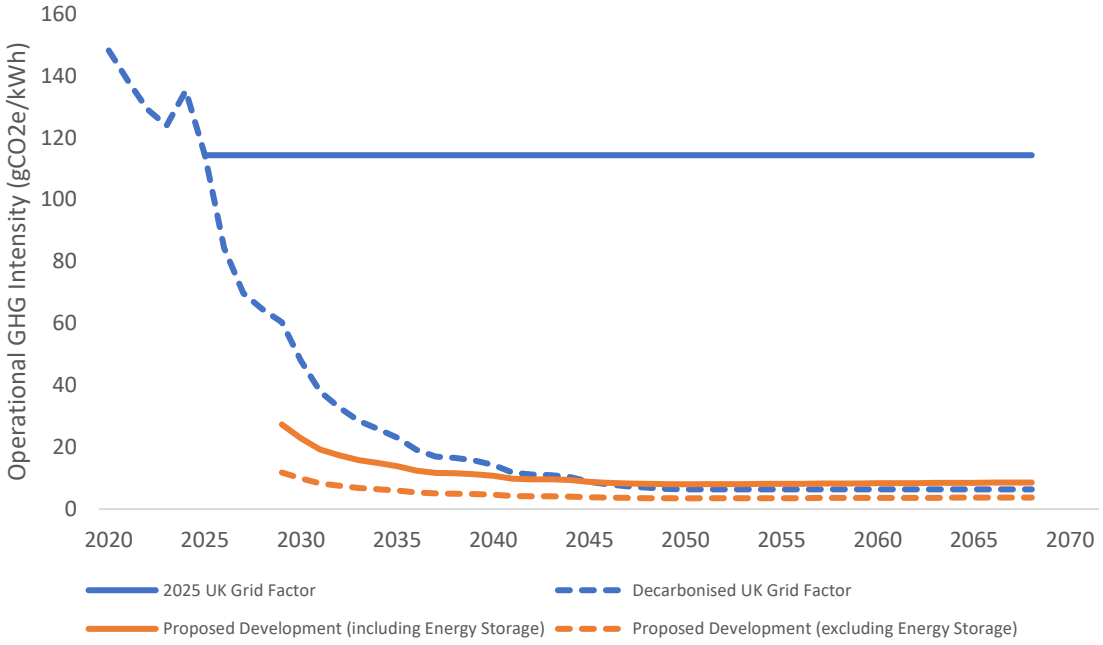

Figure 12.1: Operational GHG intensity of UK grid projections and estimated operational Proposed Development emissions (with and without energy storage)

12.7.12 These decarbonised projections assume a significant extent and rate of grid decarbonisation assumed by BEIS. In fact, current BEIS forecasts indicate a required newly installed energy capacity of over 150,000MW (130% the current energy generation capacity in 2022) by 2040 to be net zero strategy compliant. Over half this increase, nearly 100,000MW, is projected to be met by newly installed renewable capacity (BEIS, 2021).

12.7.13 Projects such as the Proposed Development will contribute towards the UK achieving the forecasted decarbonised grid mix by contributing to the projected rapid increase of required new renewable capacity as indicated above.

12.7.14 Over the maximum 40 year operational lifetime, the Proposed Development is estimated to produce a cumulative energy generation of 16,100,000 MWh. To contextualise the effects of the Proposed Development's GHG emissions during the operational phase, a counterfactual scenario has been assumed where the corresponding energy generation would otherwise be supplied by the National Grid, in the absence of the Proposed Development.

12.7.15 Using the 2025 Grid Factor as the GHG emission intensity for the generation of this energy supply, as shown above in Figure 12.1, it has been estimated that 1,840,000 tCO2e would be emitted to generate the equivalent amount of electricity over the

operational lifetime of the Proposed Development from the projected grid energy mix.

12.7.16 Based on the difference between the operational GHG emissions of the Proposed Development, 174,000 tCO2e as shown above in Table 12.10 (and represented by the solid orange line as shown above in Figure 12.1), and the estimated emissions that would result from sourcing the equivalent energy supply from the grid, 1,840,000 tCO2e (and represented by the solid blue line as shown above in Figure 12.1), (BEIS, 2021), it is therefore estimated that the Proposed Development would result in avoided GHG emissions of 1,660,000 tCO2e.

12.7.17 In addition, it should be recognised when comparing the two operational intensities, that unlike the estimate for the Proposed Development, the BEIS Grid Factor GHG intensities do not account for maintenance (including embodied carbon associated with replacement) or worker transport requirements, and thus the GHG emission saving from the operational phase of the Proposed Development is even greater.

12.7.18 Even when taking into account the conservative approach taken, Figure 12.1 clearly shows that that the estimated annual operational GHG intensity of the Proposed Development is considerably less than the relevant annual projected decarbonised grid GHG intensity. Therefore, the operational phase of the Proposed Development on GHG emissions is considered to have a **beneficial (significant) effect**.

Decommissioning

12.7.19 Total GHG emissions from the decommissioning phase are estimated to equate to 14,300 tCO2e. A breakdown of estimated GHG emissions from the decommissioning of the Proposed Development is presented in Table 12.10 below.

12.7.20 GHG emissions from decommissioning activities will be limited to the duration of the decommissioning programme (12months).

Table 12.10: Summary of Decommissioning GHG Emissions

Emissions Source	Emissions (tCO2e)	% of Decommissioning Emissions
Transportation of materials & waste	1,940	13.6

Emissions Source	Emissions (tCO2e)	% of Decommissioning Emissions
Worker transportation	1,620	11.3
Fuel use	10,600	73.9
Waste treatment	182	1.3
Total	**14,300**	**100.0**

12.7.21 To contextualise the emissions associated with the decommissioning phase of the Proposed Development, these are presented alongside the total emissions from the construction phase in Table 12.12 below.

Table 12.11: Construction and Decommissioning GHG Emissions

Emissions Source	Emissions (tCO2e)
Construction	273,000
Decommissioning	14,300

12.7.22 As shown in Table 12.12 above, the GHG emissions associated with the decommissioning phase are considerably less than those during the construction phase, with the value of 14,300 tCO2e representing approximately 5.2% of the construction phase emissions.

12.7.23 To assess the significance of effect of the construction phase, the GHG emissions were compared to the relevant UK national carbon budgets. Using this approach, the residual effects from the construction phase were considered to be minor adverse (not significant). However, this approach is not possible for the timescale of the decommissioning phase (indicative decommissioning period likely to commence 2069), as the current UK national carbon budgets only span up to the year 2042.

12.7.24 Although the magnitude of GHG emissions from the decommissioning phase of the Proposed Development cannot be compared against a known carbon budget, emissions are considerably less than those for the construction phase. It is therefore considered that the magnitude of change is also low with a **minor adverse (not significant) effect** on the climate.

Whole Life

12.7.25 As shown in Figure 12.1 above, the estimated operational GHG intensities of the Proposed Development (including and excluding energy storage) are considerably lower than that of the current grid energy mix, and remain well below the projected decarbonised grid factors over its lifetime.

12.7.26 Whilst the national BEIS Energy Grid Mix is currently only projected to 2040, this shows a clear trend and assumption of increasing contribution of renewable energy sources such as solar power, such as the Proposed Development, to the UK supply (BEIS, 2021). This long-term trend is also expected to continue beyond 2040 and over the lifetime of the Proposed Development.

12.7.27 Therefore, without low-carbon energy generation projects such as the Proposed Development, the average grid GHG intensity will not fully decrease as shown projected in Figure 12.1 above, which would also adversely affect the UK's ability to meet its carbon reduction targets.

12.7.28 When considering likely effects across all phases of the Proposed Development, the total lifetime GHG emissions are presented in Table 12.13 below.

Table 12.12: Whole Life GHG Emissions of Proposed Development

Emissions Source	Emissions (tCO2e)
Construction	273,000
Operational	174,000
Decommissioning	14,300
Total	**461,000**

12.7.29 Based on the total energy generation of the Proposed Development and the lifecycle GHG emissions of 461,000 tCO2e, the lifetime GHG intensity of the Proposed Development is 28.7 gCO2e/kWh. When considering only the aspects relating to the solar energy generation (i.e. excluding battery storage), and corresponding lifecycle GHG emissions of 174,000 tCO2e, this gives a lifetime GHG intensity of 10.7 gCO2e/kWh. This compares extremely favourably with fossil fuel electricity generation and is comparable with other low carbon energy generation (Pehl et. al., 2017[44]), as shown below in Figure 12.2.

[44] Pehl, M., Arvesen, A., Humpenöder, F. *et al.* Understanding future emissions from low-carbon power systems by integration of life-cycle assessment and integrated energy modelling. *Nat Energy* 2, 939–945 (2017).

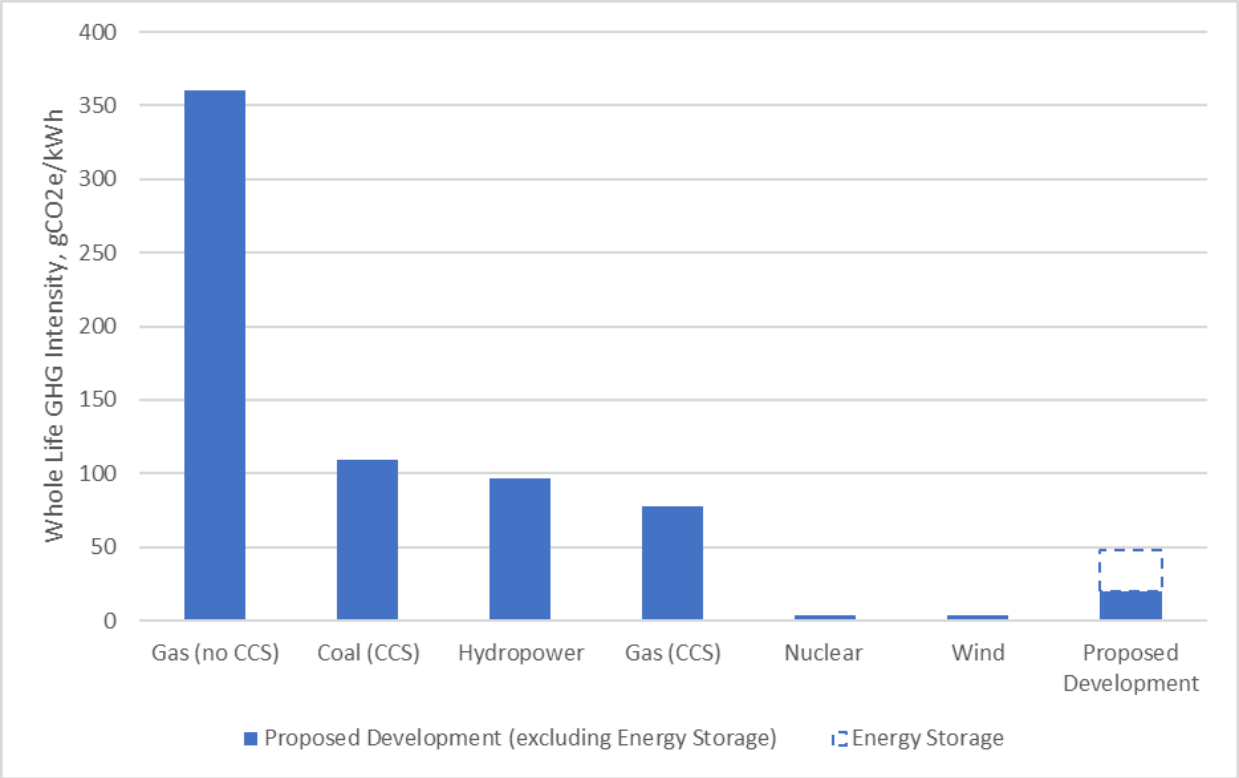

Figure 12.2: Whole Life Cycle GHG intensities of the Proposed Development and Alternative forms of Energy Generation (Pehl et. al., 2017)

12.7.30 In addition, the lifecycle GHG emissions of the Proposed Development of 483,000 tCO2e can be put into further context when compared against the previously estimated emissions (see paragraph 12.7.15) that would result from sourcing the equivalent energy supply from the grid, 1,840,000 tCO2e (and represented by the solid blue line as shown above in Figure 12.1). Over the lifecycle of the Proposed Development, this would therefore result in total GHG emissions saving of 1,380,000 tCO2e, as shown by the green line below in Figure 12.3.

12.7.31 As also shown by the green line below in Figure 12.3, whilst the total lifecycle ('cumulative') GHG emissions for the Proposed Development (only) initially increase, representing the initial required 'investment' in GHG emissions during the construction phase, once operational, the avoided GHG emissions of the Proposed Development compared to the UK Grid Factors quickly offset this initial 'investment' in GHG emissions, eventually falling below zero and estimated to reach a 'carbon payback' in the year 2035, or approximately 7 years after the start of construction (i.e., 5 years into the Proposed Development's operational phase).

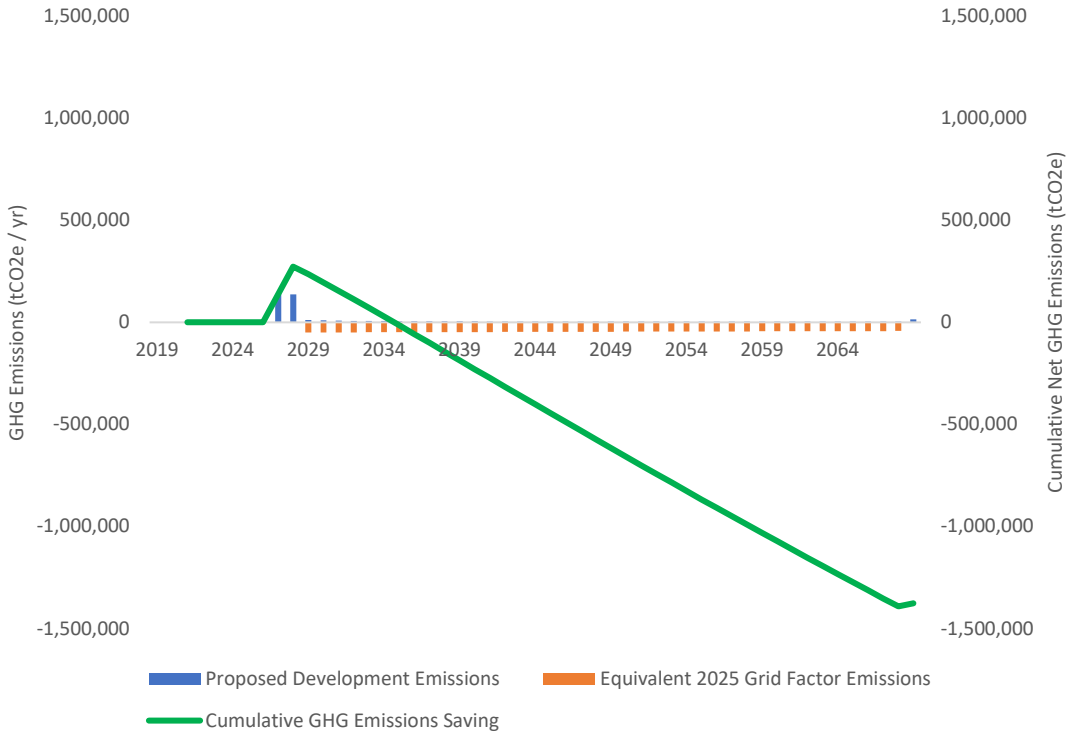

Figure 12.3: Total Lifetime GHG Emissions of the Proposed Development

12.8 Mitigation and Enhancement

12.8.1 There will be unavoidable GHG emissions resulting from the construction phase of the Proposed Development as materials, energy and fuel use, and transport will be required. The following additional mitigation measures will be assumed to apply to the construction, operational and decommissioning phases. This is because the key activities assessed during the operational phase include the maintenance requirements for product and equipment replacement and associated transport to the Site, requiring similar mitigation measures to the initial construction activities

12.8.2 Specific mitigation measures will include the following, which will be incorporated into the **outline Construction Environmental Management Plan (oCEMP)** (see **Appendix 4.1, [EN010163/APP/6.3.1]**) and the **outline Construction Traffic Management Plan (oCTMP)** (see **Appendix 13.2, [EN010163/APP/6.3.13]**), detailed versions of which are secured by DCO requirement:

(a) Designing, constructing, and implementing the Proposed Development 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;

i. Reusing suitable infrastructure and resources already available within the Proposed Development where possible to minimise the use of natural resources and unnecessary materials (e.g., reusing excavated soil for fill requirements);
ii. Increasing recyclability by segregating construction waste to be re-used and recycled where reasonably practicable;
iii. Adopting the Considerate Constructors Scheme (CCS) to assist in reducing pollution, including GHGs, from the Proposed Development by employing good industry practice measures;
iv. Implementing staff minibuses to transport construction personnel to the Site or using car sharing options where possible;
v. Switching vehicles and plant off when not in use and ensuring construction vehicles conform to current UK emissions standards; and
vi. Conducting regular planned maintenance of the construction plant and machinery to optimise efficiency.

12.9 Residual Effects

12.9.1 Residual effects remain as stated above, namely:

- construction: **minor adverse (not significant)**;
- operation: **beneficial (significant)**;
- decommissioning: **minor adverse (not significant)**.

12.10 Cumulative and In-combination Effects

Cumulative Effects

12.10.1 Table 12.12 presents a list of other planned renewable energy generation projects included in the shortlist of developments for potential inclusion in the cumulative assessment (see Table 2.9 of **Chapter 2: EIA Methodology and Public Consultation [EN010163/APP/6.2.2])**, alongside their corresponding generation capacities. This has been used to assess cumulative beneficial effects. Other developments in the short list have been excluded as they will not contribute to meeting the UK's requirement for renewable energy capacity.

12.10.2 Collectively, the other developments included in Table 12.2 represent an estimated 4,220MW of renewable energy generation, including 2,920MW within Bassetlaw District Council.

12.10.3 The assessment for both the construction and decommissioning phases presented in this chapter has concluded that the sensitivity of the receptor is high, and the magnitude of change is low, which means that effects would be **minor adverse (not significant)**. Effects are **beneficial (significant)** for the operational phase as the estimated annual operational GHG intensity of the Proposed Development is considerably less than the relevant annual projected decarbonised grid GHG intensity. The same effects are anticipated for the other sites, utilising the same assessment methodology.

12.10.1 To further demonstrate the cumulative climate change benefits of these other developments and the additional contribution of the Proposed Development, this generating capacity has been contextualised to the UK's national targets for newly installed energy generation capacity. This data has been published by BEIS to show the projected requirements of newly installed electricity generating capacity for different types of generation in order to meet the national UK Net Zero Strategy (BEIS, 2021).

12.10.2 Whilst this data does not specify a projected capacity of solar projects specifically, it does project a newly installed capacity of 107,000MW across all types of renewable energy generation (including solar, onshore and offshore wind, geothermal etc.) by 2040.

12.10.3 Table 12.12 below shows that the contribution of the currently planned solar projects which have been considered is estimated to represent 3.9% of the total national projections by 2040 (2.7% within BDC), and with the additional generating capacity of the Proposed Development, this would increase further to represent 4.4% of the total national capacity (3.1% within BDC).

Table 12.13: Planned Renewable Energy Projects, including breakdown by within or outside Bassetlaw District Council

Project Name and Reference	Solar Capacity (MW)	Contribution to projected UK Renewable Capacity within BDC	Contribution to projecte UK Renewable Capacity outside BDC
ID 1 Cottam Solar Project (EN010133)	600	0.6%	-

Project Name and Reference	Solar Capacity (MW)	Contribution to projected UK Renewable Capacity within BDC	Contribution to projected UK Renewable Capacity outside BDC
ID 2 Gate Burton Energy Park (EN010131)	500	0.5%	-
ID 3 Tillbridge Solar Project (EN010142)	500	0.5%	-
ID 5 West Burton Solar Project (EN010132)	480	0.4%	-
ID 7 Bumblebee Solar Farm (BDC ref: 22/00358/FUL)	49.9	0.0%	-
ID 8 Wood Lane Solar Farm (BDC ref: 20/00117/FUL)	49.9	0.0%	-
ID 16 One Earth Solar Farm (EN010159)	740	0.7%	-
ID 6 Heckington Fen Energy Park (EN010123)	500	-	0.5%
ID 15 Great North Road Solar and Biodiversity Park (EN010162)	800	-	0.7%
Sub-Total	4,220	2.7%	**1.2%**
Steeple Renewables Project	450	0.4%	
Total	4,670	3.1%	**1.2%**

12.10.4 This shows the beneficial effects of the Proposed Development and its contribution towards meeting the UK's net zero targets, and the importance of the local area to contributing to these targets on a national scale. On this basis, cumulative operational effects are considered to be **beneficial (significant)**.

In-Combination Effects

12.10.5 In-combination effects are given further consideration below (as a core component of Part B).

Part B: Climate Change Adaptation

12.10.6 This section of the ES considers both the vulnerability of the Proposed Development to climate change and also the implications of climate change for the predicted effects of the Proposed Development, as assessed by the other topic specialists ('in-combination climate effects'). It presents a summary of the baseline, mitigation and assessment of likely significant effects.

12.11 Legislation and Planning Policy

UK Legislation, Policy and Strategy

12.11.1 The Climate Change Act 2008[45]: this requires the Government, on a five-year cycle, to compile an assessment of the risks for the UK arising from climate change, and then to develop an adaptation programme to address those risks and deliver resilience to climate change on the ground. Key strategies include constructing flood defences against rising sea levels, increasing green spaces in urban areas, planting drought-resistant crops, and developing resilient infrastructure to withstand extreme heat and flooding.

12.11.2 National Policy Statement for Energy (NPS EN-1)[46]: this details the UK Government's energy and climate change strategy. Part 4.10, Climate Change Adaptation and Resilience, includes policies for adapting to climate change emphasising the need for new energy infrastructure to be sufficiently resilient to the possible impacts of a changing climate. It highlights the potential of nature-based solutions, with paragraph 4.10.5 advising *"applicants should take reasonable steps to maximise the use of nature-based solutions alongside other conventional techniques"* and paragraph 4.10.6 and 4.10.7 emphasising the additional benefits these have, such as carbon sequestration benefits, biodiversity benefits and net gain.

12.11.3 Paragraph 4.10.8 of NPS EN-1 states that *"applicants must consider the direct (e.g. site flooding, limited water availability, storms, heatwave and wildfire threats to infrastructure and operations) and indirect (e.g. access roads or other critical dependencies impacted by flooding, storms, heatwaves or wildfires) impacts of climate change when planning the location, design, build, operation and, where*

[45] UK Government (2008) The Climate Change Act 2008.
[46] UK Government (2023) Overarching National Policy Statement for Energy (EN-1).

appropriate, decommissioning of new energy infrastructure." Paragraph 4.10.9 advises that the "*ES should set out how the proposal will take account of the projected impacts of climate change, using government guidance and industry standard benchmarks such as the Climate Change Allowances for Flood Risk Assessments, Climate Impacts Tool, and British Standards for climate change adaptation, in accordance with the EIA Regulations.*" In addition, paragraph 4.10.11 notes that applicants "*should also demonstrate how proposals can be adapted over their predicted lifetimes to remain resilient to a credible maximum climate change scenario.*"

12.11.4 Section 2.4 of National Policy Statement for Renewable Energy Infrastructure (NPS EN-3)[47] also refers to climate change adaptation and resilience. Paragraph 2.4.11 'Solar Photovoltaic' states that as solar PV sites may be proposed in low lying exposed sites, applicants should consider, in particular, the increased risk of flooding and the impact of higher temperatures. This policy document reinstates Section 4.10 of NPS EN-1 that notes that renewable energy infrastructure must be *"safe and resilient to climate change, and that necessary action can be taken to ensure the operation of the infrastructure over its estimated lifetime."* Additionally, it highlights section 5.6 and 5.8 of NPS EN-1 on Coastal Change and Flood Risk, which sets out *"generic considerations that applicants and the Secretary of State should take into account in order to manage coastal change and flood risks."* Section 2.10 of NPS EN-3 'Solar Photovoltaic Generation', mentions the importance of drainage systems and watercourses to prevent contributing to flood risks.

12.11.5 **Chapter 8: Hydrology, Hydrogeology, Flood Risk and Drainage [EN010163/APP/6.2.8]** of the ES considers the likely effects arising from the construction, operation (including maintenance) and decommissioning phases of the Proposed Development in the context of the surface water and groundwater environment, including consideration of flood risk.

Local Planning Policy

12.11.6 The Bassetlaw Local Plan 2020-2038[48] outlines the Council's approach to climate change adaptation, ensuring that the development and use of land in the District will contribute to the 'mitigation' of, and 'adaptation' to, climate change during the

[47] UK Government, (2023) National Policy Statement for Renewable Energy Infrastructure (EN-3).

[48] Bassetlaw District Council, (2024). Bassetlaw Local Plan 2020-2038.

design, construction and occupation of any new development. The local plan provides consideration for climate change adaptation in Policy ST48: Reducing Carbon Emissions, Climate Change Mitigation and Adaptation, including flood risk and watercourse management, the protection of existing trees, woodland and hedgerows and securing additional planting that increases canopy cover in the interests of biodiversity, amenity and climate change adaptation.

12.11.7 Ambition 9 'Protecting the Environment and Reducing our Carbon Footprint' of The Nottinghamshire Plan 2021-203149 highlights the commitment to managing the impact of climate change on Nottinghamshire's environment, including working with partners to reduce the risk of flooding to homes and businesses.

12.11.8 Nottinghamshire County Council's Net Zero Framework (2024)[50] states that adaptation is essential to ensure Nottinghamshire remains resilient, allowing communities to live sustainably and recover swiftly from the impacts of climate change. By incorporating adaptation measures within its net zero goals, Nottinghamshire aims to protect residents, businesses, and the natural environment. Key efforts include collaborating with stakeholders to develop flood adaptation projects and prioritising green infrastructure solutions in planning and development to enhance long-term resilience.

12.12 Assessment Methodology

Guidance

12.12.1 A Climate Change Adaptation (CCA) assessment has been undertaken in accordance with the principles and information contained within the following document:

- IEMA (2020) Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation[51].

12.12.2 The IEMA Guidance (2020) defines the two key elements of assessing climate change adaptation in EIA as follows:

- Project resilience: the risks of changes in the climate to the project, i.e., the resilience or conversely the vulnerability of a project to future climate change, both to changes in average conditions and in extreme events. This

[49] Nottinghamshire County Council, (2021). The Nottinghamshire Plan 2021-2031.
[50] Nottinghamshire County Council, (2024). 2024 Nottinghamshire County Council Net Zero Framework.
[51] IEMA (2020) Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation.

considers if the Proposed Development can withstand the projected climate changes (e.g., through design features and choice of construction materials) and can be future-proofed, enabling resilience modifications to be added in the future if necessary.

- In-combination effects: the extent to which climate exacerbates or ameliorates the effects of the project on the environment.

12.12.3 Therefore, in line with this guidance, the project resilience assessment assesses the effects of a changing climate on the Proposed Development. The project resilience assessment differs from many other EIA topics in that it considers how the resilience of a development is affected by an external factor (climate change) and not how environmental receptors are affected by a development's impacts. Consequently, the project resilience impacts cannot be assigned significance with respect to the severity of impacts in the same way as for the other environmental topics. Instead, a risk-analysis-based approach has been used for the project resilience assessment, included in this ES chapter.

12.12.4 The in-combination assessment considers the extent to which the climate worsens or improves the effects of the Proposed Development on the environment, on a topic-by-topic basis. Topics that have been judged to have a lower sensitivity to climate change have been scoped out and are not considered further, whilst a more detailed assessment is provided for those topics that have been judged to have a higher sensitivity to climate change and are therefore scoped into the in-combination assessment. This is set out in the 'Assessment of Likely Significant Effects' section.

Study Area

12.12.5 The study areas used for the in-combination assessment are as the study areas defined in each of the topic chapters of the ES. The assessment aims to determine the influence of climate change and project-related impacts on the identified receptors in each of the assessments in the scoped in topic chapters. The study area for the project resilience assessment is the Proposed Development within the Site itself.

Desk-Based Research and Data Sources

12.12.6 To establish the current climate of the Site, data was sourced from the Met Office[52] for the closest climate station located to the Proposed Development. This was Scampton Climate Station, 16.7 km from the Proposed Development.

12.12.7 As recommended in the IEMA guidance (IEMA, 2020), the UK Climate Projections 2018 (UKCP18) have been used to establish future climate change projections for the Proposed Development. The UKCP18 Projections are considered to be the most up-to-date assessment of how the UK's climate may change over the 21st century. Whilst they provide a valid assessment of the UK's future climate over land for a range of variables including temperature, precipitation and sea level rise, wind speed and storm frequency/intensity are considered separately as global modelling information is currently more limited.

12.12.8 The UKCP18 projections for temperature and precipitation are presented for the UK as a whole and also on a regional basis. The UK projections consider three variables:

- Timeframe: the projections are presented between the years of 2010 and 2099. These are broken down into a series of time periods including 2020-2039, 2040-2059, 2060-2079 and 2080-2099.
- Probability: The projections are provided as probability distributions rather than single values, with figures provided for 5, 10, 50, 90 and 95% probability.
- Representative Concentration Pathways (RCP): Four pathways have been adopted; RCP2.6, RCP4.5, RCP6.0 and RCP8.5. These pathways describe different GHG and air pollutant emissions as well as their atmospheric concentrations and land use, with each one resulting in a different range of global mean temperature increases over the 21st century. RCP2.6 represents a scenario which aims to keep global warming likely below 2°C compared to pre-industrial temperatures. It is noted, however, that the IPCC reported in 2021 that "*global surface temperature was already 1.09°C higher in 2011–2020 than 1850–1900*"[53], and that in 2023, the UN Environment Programme (UNEP) reported that there is "*no credible*

[52] Met Office, (not dated). UK Climate Averages.
[53] IPCC (2021) Summary for Policymakers: Climate change 2021: The Physical Science Basis.

pathway to 1.5°C"[54]. RCP4.5 and RCP6.0 represent intermediate scenarios while RCP8.5 describes a very high GHG emission scenario, where minimal efforts are implemented to reduce emissions, often referred to as 'business as usual'. All scenarios are considered to be equally plausible.

12.12.9 This assessment uses projections for the time period 2060-2079 and RCP8.5 and utilises the figures relating to the 10, 50 and 90% probability projections. As the most far-reaching projection, the 2060-2079 scenario is considered to be appropriate for the design life of the Proposed Development. RCP8.5 is selected as a suitably precautionary approach as recommended as best practice in the IEMA guidance (2020). This RCP has been used to indicate the projected temperature and precipitation for the East Midlands which encompasses the Proposed Development.

12.12.10 Information on wind speed and storms has also been considered, however, changes in wind speeds are not currently available at the regional level and there remains considerable uncertainty in the projections, with respect to wind speed and storms.

Field Survey

12.12.11 The assessment has been desk-based, drawing largely from published guidance and data.

Assessment of Significance

12.12.12 This assessment considers both the vulnerability of the Proposed Development to climate change and the implications of climate change for the predicted effects of the Proposed Development ('in-combination climate effects'). Potential receptors therefore include the following:

- Solar infrastructure receptors (including building materials, equipment and construction operations/processes);
- Socio-economic receptors (e.g. construction workers, permanent employees and users of the public right of ways (PRoWs) crossing the Site); and,
- Environmental receptors (e.g. habitats and species).

[54] UNEP (2022) Emissions Gap Report 2022.

12.12.13 When determining the likelihood of a climate hazard occurring, a conservative scenario has been assumed, whereby all climate hazards are considered likely to occur.

12.12.14 With respect to climate change adaptation and effect significance, Section 7 of the IEMA Guidance (IEMA, 2022) explains that in determining significance, account should be taken of the susceptibility of the receptor (e.g. ability to be affected by a change and the opposite of climate resilience) and the vulnerability of the receptor (e.g. potential exposure to a change).

12.12.15 A receptor with high susceptibility has no ability to withstand/not be substantially altered by the projected changes to the climate. A receptor with low susceptibility has the ability to withstand/not be altered much by the projected change to climate. A receptor with high vulnerability 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. Climatic factors have little influence on receptors with low vulnerability (and these receptors require limited consideration through the EIA process).

12.12.16 Using professional judgement, a combination of susceptibility and vulnerability, in addition to the value/importance of the receptor is used to reach a reasoned conclusion on sensitivity. The greater the susceptibility and/or vulnerability of the receptor, the greater the probability that receptor is also of higher sensitivity.

12.12.17 Magnitude of change is based on a combination of likelihood, which takes into account the chance of the effect occurring over the relevant time period and also the consequence of the effect occurring , which reflects the geographical extent of the effect, or the number of receptors affected (e.g. scale), the complexity of the effect, degree of harm to those affected and the duration, frequency and reversibility of effect. Table 12.13 defines the likelihood of a climate effect occurring, after taking into account the mitigation measures that have been proposed.

Table 12.13: Defining the likelihood of effect

Likelihood of climate effect occurring	Description of likelihood
Likely	66-100% probability that the impact will occur during the life of the Proposed Development
Possible	33-65% probability that the impact will occur during the life of the Proposed Development
Unlikely	0-32% probability that the impact will occur during the life of the Proposed Development

12.12.18 The approach to defining the consequence for the in-combination climate effects assessment is set out in Table 12.14, whilst Table 12.15 sets out the consequence criteria for climate change resilience. To assess the consequence of an in-combination climate change effect, for each environmental topic scoped into the assessment, a level of consequence is assigned to an effect based on the approach outlined in Table 12.14 and Table 12.15 and their respective assessment methodology. For climate change resilience, professional judgement has been adopted when assigning a consequence criterion to a potential effect.

Table 12.14: Defining consequence for in-combination climate effects

Consequence	Description of consequence
High	The climate change factors in-combination with the effect of the Proposed Development causes the significance of the effect of the Proposed Development on the receptor, defined by the topic, to increase to major
Medium	The climate change factors in-combination with the effects of the Proposed Development causes the significance of the effect of the Proposed Development on the receptor, as defined by the topic, to increase to moderate

Consequence	Description of consequence
Low	The climate change factors in-combination with the effects of the Proposed Development causes the significance of the effect of the Proposed Development on the receptor, as defined by the topic, to increase to minor
Negligible	The climate change factors in-combination with the effect of the Proposed Development causes no change to the significance of the effect of the Proposed Development on the receptor, as defined by the topic

Table 12.15: Defining consequence for project resilience

Consequence	Description of consequence
High	Major damage to infrastructure and complete loss of service; and/or Major financial loss; and/or Major health and environmental effects
Medium	Partial infrastructure damages and some loss of service; and/or Moderate financial impact; and/or Adverse effect on health and the environment
Low	Localised infrastructure disruption; and/or No permanent damage, minor restoration work required; and/or Minor financial losses; and/or slight adverse health or environmental effects
Negligible	No damage to infrastructure; and/ or No adverse financial effect, and/or No effects on health or the environment

12.12.19 The significance of potential effects is then determined using the significance criteria matrix in Table 12.16 as a guide, informed by professional judgement as necessary. Where an effect has been determined to be either moderate or major, this has been deemed a significant environmental effect in the context of the EIA Regulations. For project resilience, significance should reflect the aims/purpose of the project. For example, as a solar project has the purpose of generating renewable electricity, an effect which temporarily removes this should be considered significant.

Table 12.16 Significance criteria

Consequence / Likelihood	Likely	Possible	Unlikely
High	Major	Major	Minor
Medium	Major	Moderate	Minor
Low	Moderate	Minor	Negligible
Negligible	Minor	Negligible	Negligible

12.13 Assessment Assumptions and Limitations

12.13.1 The assessment has been carried out using the UKCP18 projections. These are not climate change predictions as they include a degree of uncertainty. As stated in the UKCP18 Science Overview Report:

"While the global and regional projections of future climate use the latest climate models and are diverse, they cannot cover all potential future climate outcomes out to 2100 (or beyond in the case of sea level)….The probabilities represent the relative strength of evidence supporting different plausible outcomes for UK climate, based on the climate models, physical insight, observational evidence and statistical methodology used to produce them. However, they may not capture all possible future outcomes, because, for example, some potential influences on future climate are not yet understood well enough to be included in climate models."

12.14 Stakeholder Engagement

12.14.1 The information below presents the comments and responses received on the Scoping Report (see **Appendix 1.1 – Steeple Renewables Project EIA Scoping Report [EN010163/APP/6.3.1]**) following formal submission to the Planning Inspectorate (PINS) including the PINS EIA Scoping Opinion (see **Appendix 1.2 – EIA Scoping Opinion [EN010163/APP/6.3.1]**).

12.14.2 Table 12.17 provides a summary of matters raised within the Scoping Opinion and how these have been addressed in this ES chapter in relation to climate change adaptation.

Table 12.17 Summary of Scoping Opinion Responses

Consultee	Summary of Consultation Response	How is matter addressed in the ES	Location of response
PINS EIA Scoping Opinion [EN010163/APP/6.3.1]	The Inspectorate agrees that alterations in air quality conditions as a consequence of climate change can be scoped out of the assessment on this basis.	No action necessary	N/A
PINS EIA Scoping Opinion [EN010163/APP/6.3.1]	The Inspectorate agrees that increases in noise from cooling equipment due to higher temperatures can be scoped out of the climate change impact assessment on the basis that this will be addressed within the Noise and Vibration chapter of the ES.	No action necessary	N/A
	The Inspectorate agrees that an additional assessment of increases in rainfall which could lead to flooding	No action necessary	N/A

Consultee	Summary of Consultation Response	How is matter addressed in the ES	Location of response
	episodes on the development Site is not required in the Climate Change chapter as it will be considered in the assessment of flood risk in the Hydrology, Hydrogeology, Flood Risk and Drainage section of the ES.		
PINS EIA Scoping Opinion [EN010163/APP/6.3.1]	The Inspectorate agrees that 'Transport and access – disruption' can be scoped out of the assessment with respect to in-combination climate effects.	No action necessary	N/A
PINS EIA Scoping Opinion [EN010163/APP/6.3.1]	Due to the historical uses of the Proposed Development Site, the Applicant does not consider it to contain contaminated land. The Inspectorate therefore considers that 'ground conditions – airborne particulates from soil increasing through changes in climate factors' can be scoped out of the assessment, provided that information demonstrating that the Proposed Development Site is not	No action necessary. **Chapter 2: EIA Methodology [EN010163/APP/6.2.2]** of the ES provides information on the **Appendix 2.2 - Phase 1 Geoenvironmental Desk Study Report [EN010163/APP/6.3.2])**, which indicates that no significant sources	N/A

Consultee	Summary of Consultation Response	How is matter addressed in the ES	Location of response
	contaminated land is included with the ES.	of contamination are anticipated at this stage such that these effects have been scoped out of the ES.	
PINS EIA Scoping Opinion [EN010163/APP/6.3.1]	The Inspectorate agrees that 'socio-economics and human health – flood events' can be scoped out of the assessment. Flood risk will be covered in the Hydrology, Hydrogeology, Flood Risk and Drainage section of the ES.	No action necessary	N/A
PINS EIA Scoping Opinion [EN010163/APP/6.3.1]	The Inspectorate agrees that 'Effects of higher temperatures in summer months on construction teams and the need for climate change adaptation' can be scoped out.	No action necessary, although this is discussed further under 'Project Resilience'.	N/A
PINS EIA Scoping Opinion [EN010163/APP/6.3.1]	The ES should ensure that where guidance is used to inform the assessment methodology that it is clear how it has been applied and where differences occur in the	Details of the guidance used to inform the methodology for the climate change	Section 12.12 of **Chapter 12: Climate Change [EN010163/APP/6.2.12]**

Consultee	Summary of Consultation Response	How is matter addressed in the ES	Location of response
	approach, that reasons are given for any changes. The ES should seek to agree the approach to the climate change assessment with the relevant consultation bodies with evidence of any agreement provided in the ES.	adaptation are provided in this ES.	
PINS EIA Scoping Opinion [EN010163/APP/6.3.1]	Where relevant the Climate Change chapter of the ES should describe and assess the adaptive capacity that has been incorporated into the design of the Proposed Development. This may include, for example alternative measures, such as changes in the use of materials or construction and design techniques that will be more resilient to risks from climate. This should include a description of any measures embedded into the design to enable climate resilience during construction, operation and decommissioning.	Details of mitigation and enhancement measures have been outlined in this ES.	Sections 12.17 and 12.18 of **Chapter 12: Climate Change [EN010163/APP/6.2.12]**

12.14.3 No comments on the climate change chapter (Part B: Climate Change Adaptation) of the Preliminary Environmental Information Report (PEIR) have been received as part of the Statutory Consultation process.

12.15 Baseline Conditions

Current Climate

12.15.1 The current baseline is that of the current climate between the years of 1991 and 2020 at Scampton Climate Station; the nearest climate station, 16.7km (10.4 miles) to the Proposed Development. The average maximum summer temperature was 20.7°C and the average minimum summer temperature was 11.3°C. The average maximum winter temperature was 7.2°C and the average minimum winter temperature was 1.1°C.

12.15.2 The average rainfall during the same period and the same location noted above was 60.4mm and 47.0mm for summer and winter, respectively.

12.15.3 The average winter sunshine was 63.1 hours whilst the average summer sunshine was 177.9 hours, at the same location between 1991 and 2020.

12.15.4 The average summer wind speed at 10m was 8.7 knots, whilst the average winter wind speed at 10 m was 10.7 knots.

Extreme Weather Events

12.15.5 Storms, heavy rain, heatwaves, and drought conditions have affected most of the UK between 1990 and 2023. A summary of extreme weather events reported by the Met Office includes:

- The 2022 summer heatwave, which saw record-breaking temperatures across the UK, including the East Midlands. Temperatures were above 40°C for the first time in the UK;
- The official drought event, declared in August 2022 due to prolonged dry weather, which affected water levels in rivers, reservoirs, and aquifers across the East Midlands;
- The unprecedented extreme heatwave over most of the UK in July 2022 which resulted in disruptions to rail services due to tracks buckling and sagging overhead cables, flight cancellations, and increased stress to NHS services; and

- Major storm events bringing heavy rain, strong winds, travel disruptions, and damage to properties, to areas of the UK, including the East Midlands, such as Storm Ciara in 2020, Storm Dennis in 2020, and Storm Evert in 2021.

Future Baseline

12.15.6 The UKCP projections show a general trend towards warmer, wetter winters and drier, hotter summers. However, it should be noted that both temperature and rainfall patterns across the UK are not consistent and will vary depending on seasonal and regional scales and will continue to vary in the future[55].

Temperature

12.15.7 Temperatures in the East Midlands are projected to increase, with projected increases in summer temperatures the greatest. The central estimate of the increase in winter mean temperature is 2.4°C; there is a 90% probability of temperature change exceeding 0.8°C and a 10% probability of temperature change exceeding 4.2°C[56]. The central estimate of the increase in summer mean temperature is 3.4°C; there is a 90% probability of temperature change exceeding 1.5°C and a 10% probability of temperature change exceeding 5.4°C.

Precipitation

12.15.8 Winter rainfall is projected to increase, and summer rainfall is most likely to decrease. The central estimate of change in winter mean precipitation is an increase of 15%; there is a 90% probability of precipitation decreasing by up to 3% with a 10% probability of precipitation increasing by 35%[57]. The central estimate of change in summer mean precipitation is a decrease of 26%; there is a 90% probability of summer precipitation decreasing by 54% and a 10% probability of summer precipitation decreasing by 2%.

Wind speed and storms

12.15.9 Changes in wind speeds are not currently available at the regional level and there remains considerable uncertainty in the projections, with respect to wind speed. However, the global projections over the UK show a modest increase in near-surface wind speeds over the UK for the second half of the 21st century for the winter

[55] Met Office, (2018). UKCP18 Derived Projections of Future Climate over the UK. Met Office.
[56] Met Office, (2018). UK Climate Projections (UKCP) Data. Met Office.
[57] Met Office, (2018). UK Climate Projections (UKCP) Data. Met Office.

season[58]. This is accompanied by an increase in the frequency of winter storms over the UK.

Sunshine Hours and Cloud Cover

12.15.10 Climate change is expected to alter the number of sunshine hours, and the amount of cloud cover that different regions of the UK receive. In comparing two 30-year periods (1961-1990 and 1991-2020), the Met Office has found that sunshine has increased by 5.6% across the UK[59]. North-eastern and eastern England have seen increases of more than 13%. A recent study from Imperial College London suggested that low clouds have a cooling effect whereas high clouds have a warming effect[60]. There are no robust predictions on how this will affect the UK, however, clouds are likely to play a significant role in the UK's future climatic conditions.

12.16 Assessment of Likely Significant Effects

12.16.1 This section gives consideration as to whether or not the projected climate change will materially affect any impact judgements, which may lead to additional potentially significant effects, taking into account relevant mitigation measures. The Proposed Development's resilience to climate change is also considered, particularly whether the Proposed Development could be affected by climate change to such an extent that the construction and/or operation of the Proposed Development was potentially no longer viable.

In-combination Climate Change Effects

12.16.2 The assessment of in-combination climate effects identifies how the resilience of various receptors in the surrounding environment is affected by a combination of future climate conditions and impacts from the Proposed Development. For in-combination effects, each environmental topic chapter's respective effects and corresponding mitigation measures are considered as part of the assessment. The relevant receptors for each identified environmental topic chapter are considered against the future climate conditions; with a proportionate discussion on the potential for additional significant effects on identified receptors.

[58] Met Office, et al, 2019. UKCP18 Factsheet: Wind. Met Office.
[59] Grahame Madge, 2021. Charting the UK's changing climate. Met Office.
[60] Hayley Dunning, 2021. Global satellite data shows clouds will amplify global heating. Imperial College London.

Topics Scoped Into the Assessment of In-Combination Effects

12.16.3 For each topic within the ES, consideration has been given as to the relevance of the climate change projections for receptor baseline conditions. Those with a higher sensitivity to climate change have been scoped into the climate change adaptation assessment, as follows:

- Landscape and Visual Impact and Residential Amenity;
- Ecology & Biodiversity;
- Cultural Heritage;
- Land Use and Agriculture; and,
- Glint & Glare (operation only).

Topics Scoped Out of the Assessment of In-Combination Effects

12.16.4 The topics scoped out of the assessment of in-combination effects as they are judged to have a lower sensitivity to climate change were presented in Chapter 13: Climate Change of the EIA Scoping Report (**Appendix 1.1 - Steeple Renewables Project EIA Scoping Report [EN010163/APP/6.3.1]**) and are discussed further below.

Air Quality

12.16.5 An increase in winter rainfall and/or in heavy rain days could lead to a possible decrease in relevant pollutant concentrations, with a decrease in summer rainfall leading to a possible increase in concentrations. Changes in atmospheric composition and their impact on climate change are uncertain, and it is not possible to quantify them at the local level. Overall, however, it is not anticipated that air quality conditions at the Site will fail to meet relevant air quality objectives as a consequence of projected climate change.

Noise and Vibration

12.16.6 As a result of higher temperatures, any building services equipment that provides cooling for components of the Proposed Development will be required to operate at a higher intensity and for longer periods in the future, resulting in increased noise emissions. However, this is not considered likely to increase the significance of overall noise emissions associated with the Proposed Development. Furthermore, the potential for increased noise emissions has been considered as part of the noise

assessment in **Chapter 11: Noise and Vibration [EN010163/APP/6.2.11]** and has informed appropriate mitigation measures.

Transport & Access

12.16.7 Whilst increased rainfall and storms have the potential to lead to traffic disruption during flooding episodes, this is not considered to require further assessment. Increased summer temperatures may cause some disruption and discomfort to those travelling, although this is unlikely to be a significant concern, particularly for the operational phase of the Proposed Development.

Socio-Economics

12.16.8 Recent storm and flooding events in the UK have highlighted the extent to which economic activity and human welfare can be affected by storms and flooding from increased rainfall. Temperatures are also likely to increase, which may lead to overheating concerns for workers, particularly during construction, and the few permanent employees during operation. However, it is considered that this topic can be scoped out of the in-combination assessment as significant effects are not considered likely (noting that impacts from flooding are scoped in as a separate topic in the ES under **Chapter 8 - Hydrology, Hydrogeology, Flood Risk and Drainage [EN010163/APP/6.2.8]**).

Hydrology, Hydrogeology, Flood Risk and Drainage

12.16.9 The potential impact of climate change on the Proposed Development in relation to flooding is considered as part of **Chapter 8 - Hydrology, Hydrogeology, Flood Risk and Drainage [EN010163/APP/6.2.8]** of the ES. The assessment has been informed by **Appendix 8.1 - Flood Risk Assessment** (FRA) **[EN010163/APP/6.3.8]** which incorporates appropriate allowances for climate change, as advised by the Environment Agency. As such, further consideration of in-combination effects is not necessary.

Miscellaneous Issues

12.16.10 Topics included in **Chapter 17 – Miscellaneous Issues [EN010163/APP/6.2.17]** of the ES, namely Major Accidents and Disasters, Electric, Magnetic and Electromagnetic Fields, Telecoms & Utilities and Waste are also scoped out from further assessment.

Project Resilience

12.16.11 Based on future climate projections, the following potential climate change hazards which may affect the resilience of the Proposed Development, have been identified:

- The impact of strong winds and extreme weather events on structures and equipment, as well as on construction workers during the construction phase;
- The impact of strong winds and extreme weather events on structures and equipment, as well as the limited number of permanent employees during the operational phase;
- The impact of overheating and high temperatures on employees during the construction phase of the Proposed Development;
- The impact of overheating and high temperatures on structures and equipment, as well as on the limited number of employees associated with the operational phase of the Proposed Development;
- The impact of wildfires on structures and equipment, on the limited number of employees, habitats and plant and animal species, during the operational phase;
- The impact of flooding on structures and equipment and employees during the construction phase; and
- The impact of flooding on structures and equipment and the limited number of employees, habitats and plant and animal species, during the operational phase.

12.17 Assessment of Potential Effects

In-combination Climate Change Effects

Landscape and Visual Impact and Residential Amenity

12.17.1 The Landscape Institute's Position Statement on climate change[61] acknowledges that changes in average temperatures, precipitation and extreme weather events will have an effect on the landscape. Therefore, landscape and visual effects have been taken forward for further assessment.

[61] Landscape Institute, 2021. Landscape for 2030: How landscape practice can respond to the climate crisis.

Construction and decommissioning

12.17.2 The existing ground cover is mostly arable farmland or pasture. It is anticipated that there may be minor loss to vegetation and carbon stores during construction, involving some minor new hedgerow breaks for the internal access tracks. As the existing ground cover is mostly arable land, any loss of habitat due to the construction compounds or new tracks, where they do not follow existing farm tracks, would be of that farmland habitat only. Any hedgerow loss will be compensated for with the new planting that forms part of the Proposed Development, which will as a minimum, mean no-net loss of hedgerow, and more likely an uplift, as the Proposed Development will secure at least 10% Biodiversity Net Gain. Additionally, all trees and the small areas of existing woodland within the Site are to be retained as part of the Proposed Development, with an appropriate standoff also applied during the construction period to ensure no potential for any effects to these high sensitivity landscape features. Standoffs have also been built into the Proposed Development for the drainage and water features at the Site, ensuring no substantive impacts to these as elements of the landscape.

12.17.3 Therefore, whilst it is considered possible that an in-combination climate change effect could occur, the consequence of a climate effect is considered to be low, and a **minor** and **not significant** in-combination climate change effect is anticipated for Landscape and Visual Impact and Residential Amenity during the construction and decommissioning phases.

Operation

12.17.4 There is likely to be a net change in vegetation cover on the Site once operational, due to an increase in vegetation, in particular hedgerows and individual hedgerow and trees. The Proposed Development would, therefore, bring about a net gain in the hedgerow resource within the Site, recognising that habitat connectivity is one way of creating an environment resilient to climate change. In addition, the proposed hedgerow planting would act as a carbon sink, assisting in sequestering more carbon than the structural vegetation currently present within the Site.

12.17.5 A rise in temperatures may influence the growth rates of vegetation. Slight increases in temperature would typically stimulate growth, but prolonged periods of drought are likely to stunt the vegetation. Whilst there are many variables that may affect the future growth of the existing and proposed vegetation, it is envisaged that it will continue to provide screening.

12.17.6 Whilst the proposed planting may be sensitive to the increased frequency of extreme weather events, the selected species would be native and of local provenance/or a suitable substitution. These are considered to be better suited to the local soil and climate and are likely to adapt and be more resilient to climate change. Any non-native species may be regarded as incongruous with the local landscape character, with the risk of becoming invasive due to the unknown aspects and effects of climate change.

12.17.7 As such, whilst it is considered possible that an in-combination climate change effect could occur during the operational phase of the Proposed Development, the consequence of a climate effect is considered to be low. Therefore, a **minor** and **not significant** in-combination climate change effect is anticipated for Landscape and Visual Impact and Residential Amenity during the operational phase.

Ecology & Biodiversity

12.17.8 Increased rainfall and flooding events, coupled with rising temperatures, may modify UK flora and fauna over time, with shifts in species' ranges. 'Natural England's Climate Change Risk Assessment and Adaptation Plan' sets out the risks and threats posed by current climate change projections[62]. In association with the RSPB, Natural England has also published a Climate Change Adaptation Manual which details the potential effects of climate change on different habitat types.

Construction and decommissioning

12.17.9 The construction phase of the Proposed Development will impact local habitats and species. Permanent clearing of some agricultural land, including arable fields and pasture, will result in minor losses of hedgerows and grassland field margins. Additionally, temporary habitat disruptions will occur where underground cables are installed, particularly affecting arable land and adjacent field margins. During decommissioning, the removal of solar panels and associated infrastructure will likely cause temporary disturbances, particularly to permanent grassland and species that have adapted to these habitats. Impacts are expected on local fauna due to noise, human presence, and the movement of vehicles and machinery.

12.17.10 Projected increases in summer temperatures and drier summer conditions may lead to prolonged dry periods that stress local plant and animal species. Warmer,

[62] Natural England, (2021). Natural England's climate change risk assessment and adaptation plan (2021) (NE761). Natural England.

drier summers may reduce water availability in field margins and ditches, which would negatively impact plant life and species that rely on these water sources for foraging or breeding. Nearby retained features, such as trees and hedgerows, may also suffer degradation from localised soil compaction and the movement of construction vehicles.

12.17.11 Projected increases in winter rainfall could lead to temporary waterlogging and flooding in low-lying habitats. Whilst increased soil moisture may benefit some plant communities, it also poses a risk of inundating sensitive areas and degrading habitats for species adapted to drier conditions. Prolonged wet conditions may further harm foraging grounds for certain species, particularly where construction activities have already altered soil structure and vegetation cover, which could slow recovery of these habitats.

12.17.12 Some insects are already struggling to keep up with the plants they rely on because climate change is advancing key seasonal timings, such as plant blooming or insect emergence, earlier in the year, at different rates[63]. Drier summers and intense heat can reduce insect populations and dry out soil, making it challenging for birds to find food and for animals like badgers, which rely on softer soil to dig for beetles and worms and need access to water sources that may become limited[64]. Species may be further disturbed by noise, light, and human presence during the construction period, with potential risks of pollution from dust and spills that could further harm soil and water quality in the area (pre-mitigation).

12.17.13 As climate change drives shifts in temperature and rainfall, many plant species may need to adjust their ranges to survive. Maintaining intact habitats and wildlife corridors, such as hedgerows and roadside verges, is crucial, as these features provide pathways for climate-adapted species to migrate[65].

12.17.14 The Proposed Development includes a number of measures which will enhance the Site's resilience to climate change from an ecological perspective. These measures involve converting portions of arable land beneath the solar arrays to grassland, creating permanent grassland and woodland areas, and improving hedgerows to

[63] British Ecological Society, (2023). Climate change causing 60% of plants and insects to fall out of synch. British Ecological Society.
[64] Fritha West, (2022). How do heatwaves affect wildlife? Woodland Trust.
[65] University of York, (2023). UK habitats to be impacted by exposure to climate change - but some more than others.

enhance habitat quality and connectivity. A summary of the designed-in measures is presented in **Chapter 7 - Ecology & Biodiversity [EN010163/APP/6.2.7]**.

12.17.15 Given the relatively short duration of the construction period, it is unlikely that a significant shift in species ranges or major climate-driven ecological changes will occur within this timeframe. Although some temporary habitat disturbances and minor habitat losses are expected, these are not likely to combine meaningfully with climate change effects to cause a significant impact on local ecology.

12.17.16 Therefore, whilst it is considered possible that an in-combination climate change effect could occur, the consequence of a climate effect is considered to be low, and a **minor**, and **not significant** in-combination climate change effect is anticipated for Ecology and Biodiversity, during the construction and decommissioning phases.

Operation

12.17.17 During the operational phase, some ongoing impacts on habitats and species are anticipated. The introduction of infrastructure may fragment local habitats, creating barriers that restrict movement and isolate certain populations. Species within and around the Site are also likely to experience some degree of disturbance from human activities, vehicle movement, and light exposure. Additionally, the installation of solar arrays may influence foraging and movement patterns, either attracting or deterring species like bats, birds, and invertebrates, which could lead to shifts in local biodiversity. As climate change continues to alter local conditions, these impacts may be further intensified. Rising temperatures and shifts in precipitation patterns could change the distribution and behaviour of species within the Site.

12.17.18 The shift away from agriculture to grasslands underneath the solar arrays will likely benefit the biodiversity of the area by reducing pesticide use, promoting diversity, and supporting a range of species that feed on these insects. Additionally, the shift to grassland will also have a positive benefit for soil health and quality during the operational phase. Without heavy machinery traffic, the compacting of soils will be limited, leading to the natural enhancement of the soil in combination with increasing organic matter levels. Warmer conditions may attract more species populations, potentially benefiting insectivorous species such as birds and bats. However, more frequent droughts, driven by hotter, drier summers, could strain soil moisture levels and reduce the availability of food for animals reliant on soil-

dwelling invertebrates, such as earthworms, impacting foraging quality for species like badgers and hedgehogs.

12.17.19 During the operational phase, the long-term presence of solar arrays, fencing, and reduced human intervention (from transitioning to grassland) may influence local species behaviours and habitat connectivity. However, these impacts are expected to be mostly beneficial or neutral in nature, with increased habitat diversity and reduced pesticide application providing improved ecological conditions.

12.17.20 Therefore, whilst it is considered possible that an in-combination climate change effect could occur, the consequence of a climate effect is considered to be low and a **minor**, and **not significant** in-combination climate change effect is anticipated for Ecology and Biodiversity, during the operational phase.

Cultural Heritage

12.17.21 Changes in temperature and rainfall patterns can affect above and below-ground heritage assets. For example, waterlogged archaeological sites are susceptible to changes and fluctuations within the water table and so the remains of known and unknown archaeological remains have the potential to be affected by climate change.

Construction and decommissioning

12.17.22 In terms of archaeology, there are areas of archaeological potential within the Site, however, the archaeological potential is contained within discrete areas and is not widespread across the entire Site (see **Chapter 9 - Cultural Heritage [EN010163/APP/6.2.9]**).

12.17.23 The Proposed Development has been offset from what are considered to be the most significant areas of archaeological potential, including the archaeological remains in the east, so these will not be directly impacted. This also offsets development from the floodplain adjacent to the River Trent, which is likely to be the most susceptible area to impacts associated with climate change. Elsewhere, the potential for archaeological remains is located within arable fields with extensive drainage systems (as indicated by the geophysical survey), and there are not anticipated to be any waterlogged deposits which would be impacted by the Proposed Development. Additionally, the proposed cable areas do not coincide with key archaeological areas and impacts on the potential for below-ground

deposits are expected to be low due to narrow trenches (see **Chapter 9 - Cultural Heritage [EN010163/APP/6.2.9]**).

12.17.24 The Proposed Development has also been offset from above ground assets including the Scheduled Monument Segelocum (NHLE ref. 1003669), and the Grade II Listed Littleborough Cottage (NHLE ref. 1275674), ensuring that impacts to the heritage significance or value of any of these or any other heritage assets are minimised as much as possible

12.17.25 Whilst it is considered possible that an in-combination climate change effect could occur, the consequence of a climate effect is considered to be low and a **minor**, and **not significant** in-combination climate change effect is anticipated for Cultural Heritage during the construction and decommissioning phases.

Operation

12.17.26 Regarding built heritage and potential operational effects on setting, physical components of the Proposed Development will be offset from cultural heritage assets, whilst boundary vegetation which provides screening will be retained or enhanced. Therefore, whilst it is considered possible that an in-combination climate change effect could occur, the consequence of a climate effect is considered to be low and a **minor**, and **not significant** in-combination climate change effect is anticipated for Cultural Heritage during the operational phase.

Land Use and Agriculture

12.17.27 Climate change is expected to affect agricultural practices and enterprises, due to changes in rainfall patterns and quantities, and due to increasing temperatures, which may alter cropping and stocking patterns and choices in the future. The ability of these soils to grow crops depends upon the availability of water, especially in the spring and early summer peak growing season. Climate change may necessitate different cropping in the future. It is also anticipated that climate change could affect soil properties including drainage, soil moisture content, nutrient recycling rates, carbon sequestration, changes in leaching and run-off, and soil biodiversity and stability through clay shrinkage. It is, however, noted that the land is being converted from its current arable use into primarily a renewable energy generating site, with grazing, for the duration of the consent.

Construction and decommissioning

12.17.28 It is not anticipated that climate change will impact agricultural activities during the construction period. Therefore, it is considered unlikely that an in-combination climate change effect could occur, the consequence of a climate effect is considered to be **negligible**, and a **not significant** in-combination climate change effect is anticipated for Land Use and Agriculture during the construction phase.

12.17.29 It is not anticipated that the effects reported for Land Use and Agriculture during the decommissioning phase will be further influenced by climate change. Therefore, it is considered unlikely that an in-combination climate change effect could occur, the consequence of a climate effect is considered to be **negligible**, and a **not significant** in-combination climate change effect is anticipated Land Use and Agriculture during the decommissioning phase.

Operation

12.17.30 It is not anticipated that climate change will alter the effects reported for Land Use and Agriculture. Therefore, it is considered unlikely that an in-combination climate change effect could occur, the consequence of a climate effect is considered to be **negligible**, and a **not significant** in-combination climate change effect is anticipated Land Use and Agriculture during the operational phase.

Glint & Glare

12.17.31 An increase in solar intensity, sun hours, and changes in weather patterns resulting in clearer skies, can result in changes in the intensity of glint and glare from solar panels during operation (only).

Operation

12.17.32 Once operational, it is not anticipated that any potential impacts on road safety, residential amenity, railway operations, and aviation activity associated with glint and glare will significantly be significantly altered by an increase in sun hours and solar intensity. Whilst it is considered possible that an in-combination climate change effect could occur, the consequence of a climate effect is considered to be low and a **minor,** and **not significant** in-combination climate change effect is anticipated for Glint & Glare during the operational phase.

Project Resilience

12.17.33 In general and taking account of design and additional mitigation measures proposed, it is not considered that the Proposed Development could be affected by

climate change to such an extent that the construction and/or operation of the Proposed Development could potentially become unviable. Further details are provided below.

Overheating and extreme temperatures

12.17.34 The UKCP18 projections show a general trend towards drier summers and wetter winters, with more extreme weather events.

12.17.35 Solar modules and inverters are designed to be used globally, including places with much higher ambient temperatures. The modules will typically operate from -40 to +85 degrees Celsius but derate at higher temperatures. The inverters will operate up to approximately +50 or +60 degrees Celsius and again will derate or shut down under very high temperatures.

12.17.36 Whilst it is possible that there would be slightly lower than expected generation with consistently higher temperatures, it is likely that this would be more than offset by less moisture in the air, and in any case, it would only be a reduction in low single digit percentages so generation would not be materially affected. A study from 2014 also suggested that climate change could lead to a mean increase in the UK's solar resource, although with greater seasonable variability and discrepancy between geographical regions[66]. This could actually increase the energy output of the Proposed Development, accepting that there is a high degree of uncertainty in this projection.

12.17.37 As temperatures are projected to increase, in addition to the frequency and intensity of winter storms, there is an increased risk of discomfort, particularly for construction workers and the limited number of employees working at the Proposed Development during its operational life. The Proposed Development will comply with all relevant UK legislation related to the work environment including The Health and Safety at Work etc. Act 1974 and The Management of Health and Safety at Work Regulations 1999. For example, this may include measures such as ensuring appropriate personal protective equipment (PPE) is worn for the Site conditions and adequate water supplies are available to ensure staff stay hydrated during hotter weather.

[66] Burnett et all, 2014. The UK solar energy resource and the impact of climate change. The University of Edinburgh.

12.17.38 The consequence of the overheating and extreme temperatures effect is considered to be medium, however it is considered unlikely that this effect will occur. Therefore, a **minor** and **not significant** effect is predicted in relation to the Proposed Development's resilience to overheating and extreme temperatures.

Strong winds and extreme weather events

12.17.39 UK near-surface wind speeds are expected to increase in the second half of the 21st century, with winter months, in particular, experiencing more significant impacts of winds, it is anticipated that the Proposed Development will be designed to deal with the maximum wind loading expected (this applies to both fixed and tracking solar PV systems). The provision of new hedgerows and the management of existing hedgerows, where necessary, will help filter and slow wind speeds throughout the Proposed Development. It is also anticipated that the solar PV modules selected for installation will be certified to withstand other severe environmental conditions through their design. This will typically include antireflective and anti-soiling surfaces to minimise power loss from dirt and dust, in addition to resistance mechanisms to offer protection against snow load and ammonia. Ammonia deposits, common in agricultural environments, can cause corrosion and degradation to solar PV modules. The system will also be designed to deal with the maximum wind loading expected. As such, it is not considered likely that the solar PV modules will be affected by extreme weather events.

12.17.40 Whilst the potential consequence of this climate effect occurring is considered to be high in the event of high winds or storms, the probability is considered to be unlikely given the design standards for this equipment. Therefore, **minor** and **not significant** effects are predicted in relation to the Proposed Development's resilience to strong winds and extreme weather events.

Wildfires

12.17.41 The UKCP18 projections show a general trend towards warmer winters and hotter, drier summers. High temperatures and drier summers can increase the risk of wildfires occurring.

12.17.42 It is anticipated that the proposed planting will include native species, which will assist in providing a more climate resilient landscaping strategy, in addition to increasing biodiversity on the Site. However, consideration will also be given to local landscape character, and as such, a balance will be reached.

12.17.43 The consequence of a climate effect occurring would be high in the event of a wildfire. However, the probability is considered unlikely given the intended plant species planned as part of the Proposed Development, there is likely to be a **minor** and **not significant** effect in relation to the Proposed Development's resilience to wildfires.

Flooding and Drainage

12.17.44 Winters in the UK are projected to be wetter with more extreme weather events.

12.17.45 Climate change could exacerbate water quality risks, particularly in terms of increased rainfall and extreme weather events, potentially causing greater runoff and contamination risks.

12.17.46 As water demand remains relatively low, the Proposed Development's contribution to water resource depletion is likely to remain minimal, although there is limited potential for climate change to strain water supplies over time.

12.17.47 Whilst climate change may increase flood risk, the required resilience of the Proposed Development is accounted for in its design, with remote monitoring and the ability to shut down equipment in advance of a flood.

12.17.48 The impacts relating to Flooding and Drainage are considered in **Chapter 8 - Hydrology, Hydrogeology, Flood Risk and Drainage [EN010163/APP/6.2.8]** of the ES. This includes an assessment as part of **Appendix 8.1 – Flood Risk Assessment [EN010163/APP/6.3.8]** to quantify any displacement of floodwater as a result of infrastructure proposals within the 1 in 100 year plus climate change flood extent.

12.17.49 Given that climate allowances are already included in the flood risk modelling, the consequence of a further climate effect occurring would be low and the probability unlikely, leading to a **negligible** and **non-significant** effect for Flooding and Drainage.

12.18 Mitigation and Enhancement

12.18.1 Additional mitigation measures to address negative environmental effects are discussed below.

Project Resilience

Overheating and extreme temperatures

12.18.2 To avoid employee discomfort, for example during periods of extreme temperatures or increased precipitation, construction and operational activities will be managed so that the hottest or wettest/coldest parts of the day are avoided to ensure worker safety, although it is noted that this may not always be possible during the construction phase. The design, orientation and positioning of any welfare facilities for staff will also be carefully considered. Additionally, the risk of overheating/hypothermia will be incorporated into the site risk assessment

Strong winds and extreme weather events

12.18.3 It is anticipated that the risk of strong winds and extreme weather events will be incorporated into the site risk assessment for the Proposed Development.

Flooding and Drainage

12.18.4 Whilst groundwater has been identified at various depths at the Site (see **Chapter 8 - Hydrology, Hydrogeology, Flood Risk and Drainage [EN010163/APP/6.2.8]** of the ES), the **outline Construction Environmental Management Plan (oCEMP)** (see **Appendix 4.1, [EN010163/APP/6.3.1]**) includes measures to prevent contamination, especially given the potential for climate change to influence groundwater recharge rates in the future. The final CEMP will include a drilling fluid breakout plan. Measures such as trenchless Horizontal Directional Drilling (HDD) under watercourses will also be used to minimise the risk of water pollution.

12.18.5 Flood risk mitigation will also be in place, with temporary drainage strategies preventing uncontrolled runoff and using existing watercourse crossings where possible. A Flood Management Plan will guide scheduling to avoid periods of increased flood risk, taking into account climate projections of more intense winter storms and heightened flood risk. The Proposed Development also includes a Surface Water Drainage Strategy, incorporating Sustainable Drainage Systems (SuDS) to manage runoff, and again taking account of climate projections. With the increasing frequency of intense rainfall due to climate change, the effectiveness of these systems will be crucial in preventing additional flood risk from surface water.

12.18.6 An Outline Fire Risk Management Plan is provided as EN010163/APP/6.3.4. This outlines how potentially harmful materials will be controlled and how emergency

releases will be managed, which will help mitigate the incidence and spread of fires. The detail of this Plan will be completed prior to construction.

12.18.7 The high-voltage parts of the Site will also have additional flood protection, as required, through the use of bunding to separate runoff from adjacent areas.

12.19 Residual Effects

12.19.1 There are **no significant** in-combination climate effects and **no significant** effects in relation to project resilience.

In-combination Climate Change Effects

Landscape and Visual Impact and Residential Amenity

12.19.2 The effects remain as reported above during the construction and decommissioning phases and the operational phase and are **not significant**.

Ecology & Biodiversity

12.19.3 The effects remain as reported above during the construction and decommissioning phases and the operational phase and are **not significant**.

Cultural Heritage

12.19.4 The effects remain as reported above during the construction and decommissioning phases and the operational phase and are **not significant**.

Land Use and Agriculture

12.19.5 The effects remain as reported above during the construction and decommissioning phases and the operational phase and are **not significant**.

Glint & Glare

12.19.6 The effects remain as reported above during the operational phase and are **not significant**.

Project Resilience

Overheating and extreme temperatures

12.19.7 The effects are considered to remain as reported above, and **not significant**.

Strong winds and extreme weather events

12.19.8 The effects are considered to remain as reported above, and **not significant**.

Wildfires

12.19.9 The effects are considered to remain as reported above, and **not significant**.

Flooding and Drainage

12.19.10 The effects are considered to remain as reported above, and **not significant**.

12.20 Cumulative Effects

12.20.1 Climate change resilience is largely a project-specific consideration, namely the resilience of the Proposed Development to climate change and the extent to which projected climate change could alter the predicted impact judgements. The Proposed Development's resilience is not likely to be affected by the presence of other developments, assuming required compliance with regulatory standards and accepted good practice mitigation measures.

12.20.2 predicted.

12.21 Summary

Part A: Emissions Reduction

Introduction

12.21.1 This Summary presents a summary of the findings in relation to Emissions Reduction. The assessment considered the potential impact of the Proposed Development on the global climate by considering all major lifecycle sources of GHG emissions, including both direct GHG emissions as well as indirect emissions from activities such as the transportation of materials and embodied carbon within construction materials.

Baseline Conditions

12.21.2 Baseline conditions include existing emissions related to the Site, which comprises primarily agricultural land, with some dividing hedgerows and individual trees and small woodland plantations within some of the fields. Since the land use within the Site is largely agricultural, the baseline is considered to have minor levels of GHG emissions and any development on the Site will result in additional emissions.

Likely Significant Effects

12.21.3 Total GHG emissions from the construction phase are estimated to equate to 273,000 tCO_2e, largely from embodied carbon in construction materials. The magnitude of change is therefore considered to be low. GHG emissions from the construction of the Proposed Development are therefore considered to have a **minor adverse (not significant)** effect on the climate.

12.21.4 Total operational GHG emissions are estimated to equate to 174,000 tCO_2e over the 40-year design life. However, as it is predicted that over the lifecycle of the Proposed Development, there will be a total GHG emissions saving of 1,380,000 tCO_2e, when compared against estimated emissions that would result from sourcing the equivalent energy supply from the grid, the operational phase of the Proposed Development on GHG emissions is considered to have a **beneficial (significant) effect**.

12.21.5 The total GHG emissions from the decommissioning phase are estimated to equate to 14,300 tCO_2e. The magnitude of change is therefore considered to be low. GHG emissions from the construction of the Proposed Development are therefore considered to have a **minor adverse (not significant)** effect on the climate.

Mitigation and Enhancement

12.21.6 While there will be unavoidable GHG emissions from the Proposed Development, measures incorporated within the outline Construction Environmental Management Plan (oCEMP) (see Appendix 4.1, [EN010163/APP/6.3.1]) will help reduce impacts from emissions.

Cumulative and In-Combination Effects

12.21.7 Cumulative effects have also been considered with other planned renewable energy projects from the agreed shortlist, including those within Bassetlaw District Council area. Cumulative operational effects are considered to be **beneficial (significant)**.

12.21.8 In-combination effects are given further consideration below (as a core component of Part B).

Conclusion

12.21.9 In conclusion, the results of this assessment have indicated that the potential environmental effects resulting from GHG emissions to the global atmosphere are concluded to be **minor adverse (not significant)** for both the construction and decommissioning phases, and **beneficial (significant)** for the operational phase, both for the Proposed Development in isolation, and cumulatively.

Part B: Climate Change Adaptation

Introduction

12.21.10 This Summary presents a summary of assessment findings in relation to Climate Change Adaptation. The assessment considered both the vulnerability of the

Proposed Development to climate change and also the implications of climate change for the predicted effects of the Proposed Development, as assessed by the other topic specialists ('in-combination climate effects').

Baseline Conditions

12.21.11 The baseline is the current climate between the years of 1991 and 2020, assessed from Scampton Climate Station, the nearest climate station, 16.7km (10.4 miles) to the Proposed Development.

Likely Significant Effects

12.21.12 With respect to the vulnerability of the Proposed Development, it is not considered that the Proposed Development could be affected by climate change (including strong winds, extreme events, overheating, wildfires and flood risk) to such an extent that the construction and/or operation of the Proposed Development could potentially become unviable. Therefore, **no significant adverse effects** are predicted.

12.21.13 With respect to 'in-combination climate effects', the assessment considered the projected climate change in more detail in relation to landscape and visual impact and residential amenity, ecology & biodiversity, cultural heritage, land use and agriculture and glint & glare. No new significant effects were identified for these topic areas as a consequence of projected climate change.

Mitigation and Enhancement

12.21.14 Several measures are proposed to address negative environmental effects, such as:

- Activity management during periods of extreme temperatures or increased precipitation.
- A site risk assessment to mitigate impacts from strong winds, flooding, and wildfires
- A Flood Management Plan to guide scheduling to avoid periods of increased flood risk
- A Surface Water Drainage Strategy, incorporating Sustainable Drainage Systems (SuDS) to manage runoff

Cumulative and In-Combination Effects

12.21.15 The Proposed Development's resilience is not likely to be affected by the presence of other developments, assuming required compliance with regulatory standards and accepted good practice mitigation measures.

Conclusion

12.21.16 With respect to 'in-combination climate effects', no new significant effects were identified for these topic areas as a consequence of projected climate change.

12.21.17 With respect to project resilience, it is not considered that the project could be affected by climate change to such an extent that the construction and/or operation of the Proposed Development could potentially become unviable.

12.21.18 Table 12.19 provides a summary of effects, mitigation and residual effects.

Table 12.18 Summary of Effects (Emissions Reductions)

Receptor/ Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation/ Enhancement Measures	Residual Effects
Construction								
Global atmosphere	GHG emissions as a consequence of construction activities	Permanent (selected as the IPCC estimates that CO_2 remains in the atmosphere for 50-200 years.)	High	Expressed as the change in mass of GHG emissions, in units of tonnes of carbon dioxide equivalent (tCO2e)	International	Minor adverse (Not Significant)	Carbon reduction measures will be incorporated into the CEMP and CTMP	Minor adverse (Not Significant)
Operation								
Global atmosphere	Net GHG emissions as a consequence of operation of the Proposed Development	Permanent (selected as the IPCC estimates that CO_2 remains in the atmosphere for 50-200 years.)	High	Expressed as the change in mass of GHG emissions, in units of tonnes of carbon dioxide equivalent (tCO2e)	International	Beneficial (Significant)	Not applicable.	Beneficial (Significant)

Receptor/ Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation/ Enhancement Measures	Residual Effects
Cumulative								
Global atmosphere	Net GHG emissions as a consequence of operation of the Proposed Development in addition to other solar schemes considered	Permanent (selected as the IPCC estimates that CO_2 remains in the atmosphere for 50-200 years.)	High	Expressed as the change in mass of GHG emissions, in units of tonnes of carbon dioxide equivalent (tCO2e)	International	Beneficial. (Significant).	Not applicable.	Beneficial (Significant).

Table 12.19 Summary of Effects (Climate Change Adaptation)

Receptor/ Receiving Environment	Description of Effect	Nature of Effect	Probability	Consequence	Geographical Importance	Significance of Effects	Mitigation/ Enhancement Measures	Residual Effects
Construction								
Proposed Development	Impacts on project resilience as a consequence of strong winds, extreme events, overheating, and flood risk.	Temporary	Unlikely	Medium - High	Local	Negligible -Minor adverse	Additional measures to avoid employee discomfort during periods of extreme temperatures or increased precipitation Consideration of risk of strong winds and extreme weather events in site risk assessment Additional measures to minimise flood risk	Negligible -Minor adverse (Not Significant)
Landscape and visual impact	Changes in average Temperatures, precipitation and	Permanent	Possible	Low	Borough/ District to Regional	Minor adverse	No mitigation measures are considered necessary	Minor adverse (Not Significant)

Receptor/ Receiving Environment	Description of Effect	Nature of Effect	Probability	Consequence	Geographical Importance	Significance of Effects	Mitigation/ Enhancement Measures	Residual Effects
and residential amenity	extreme weather events will have an effect on the landscape							
Ecology & biodiversity	Modifications of UK flora and fauna over time, with shifts in species' ranges	Permanent	Possible	Low	Local	Minor adverse	No mitigation measures are considered necessary	Minor adverse (Not Significant)
Cultural heritage	Changes in rainfall patterns can affect below ground heritage assets	Permanent	Possible	Low	Local to Regional	Minor adverse	No mitigation measures are considered necessary	Minor adverse (Not Significant)
Land use and agriculture	Changes in rainfall patterns and quantities, and increasing temperatures, may alter cropping and stocking patterns and choices in the future.	Permanent	Unlikely	Negligible	Local	Negligible	No mitigation measures are considered necessary	Negligible (Not Significant)
Operation								
Proposed Development	Impacts on project resilience	Temporary	Unlikely	Medium - High	Local	Negligible -Minor adverse	Additional measures to	Negligible -Minor adverse

Receptor/ Receiving Environment	Description of Effect	Nature of Effect	Probability	Consequence	Geographical Importance	Significance of Effects	Mitigation/ Enhancement Measures	Residual Effects
	as a consequence of strong winds, extreme events, overheating, wildfires and flood risk.						avoid employee discomfort during periods of extreme temperatures or increased precipitation Additional measures to minimise flood risk	(Not Significant)
Landscape and visual impact and residential amenity	Changes in average Temperatures, precipitation and extreme weather events will have an effect on the landscape	Permanent	Possible	Low	Borough/ District to Regional	Minor adverse	No mitigation measures are considered necessary	Minor adverse (Not Significant)
Ecology & biodiversity	Modifications of UK flora and fauna over time, with shifts in species' ranges	Permanent	Possible	Low	Local	Minor adverse	No mitigation measures are considered necessary	Minor adverse (Not Significant)
Cultural heritage	Changes in	Permanent	Possible	Low	Local to Regional	Minor adverse	No mitigation measures are	Minor adverse (Not Significant)

Receptor/ Receiving Environment	Description of Effect	Nature of Effect	Probability	Consequence	Geographical Importance	Significance of Effects	Mitigation/ Enhancement Measures	Residual Effects
	rainfall patterns and extreme weather events can affect above ground heritage assets						considered necessary	
Land use and agriculture	Changes in rainfall patterns and quantities, and increasing temperatures, may alter cropping and stocking patterns and choices in the future.	Permanent	Unlikely	Negligible	Local	Negligible	No mitigation measures are considered necessary.	Negligible (Not Significant)
Glint and glare	An increase in solar intensity, sun hours, and changes in weather patterns resulting in clearer skies, can result in changes in the intensity of glint and glare from solar panels	Permanent	Possible	Low	Local	Minor adverse	No mitigation measures are considered necessary	Minor adverse (Not Significant)
Cumulative effects not considered further as effects are largely project specific								