SUNNICA ENERGY FARM

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Volume 6

Environmental Statement

6.1 Chapter 6: Climate Change

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Sunnica Energy Farm

Environmental Statement
Chapter 6: Climate Change

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6.1 Introduction

6.1.1 The EIA Regulations (Ref 6-1) require consideration of the likely significant effects from the impact of the Scheme on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the Scheme to climate change. To comply with the EIA Regulations, the following has been undertaken:

a. **Lifecycle greenhouse gas (GHG) impact assessment –** The impact of GHG emissions arising over the lifetime of the Scheme on the climate; and

b. **Climate change resilience (CCR) review –** The resilience of the Scheme to projected future climate change impacts.

6.1.2 An in-combination climate change impact (ICCI) assessment identifies how the resilience of receptors in the surrounding environment are affected by the combined impact of future climate conditions and the Scheme[1]. This has been scoped out of this assessment (see Scoping Report at **Appendix 1A** of this Environmental Statement **[EN010106/APP/6.2]**) as the combined impacts have been assessed through other disciplines. For example, the combined impact of the Scheme on flood risk and drainage together with an increase in heavy precipitation events due to climate change has been covered in the drainage strategy and flood risk assessment.

6.2 Legislation and Planning Policy

6.2.1 **Appendix 6A** of the Environmental Statement **[EN010106/APP/6.2]** identifies the legislation, policy, and guidance of relevance to the assessment of likely significant climate change effects of the Scheme.

6.3 Assessment Assumptions and Limitations

6.3.1 The assessment undertaken has been based on the parameters outlined in Table 3-1 of **Chapter 3: Scheme Description** of this Environmental Statement **[EN010106/APP/6.1]**.

6.3.2 It has been assumed that there will be no material difference between the two options at Burwell in relation to GHG impacts or climate change resilience. Therefore, these options have not been considered separately within the lifecycle GHG impact assessment or climate change resilience review.

6.3.3 Some of the figures reported within this chapter (e.g. emissions figures reported in Section 6.8) have changed since the Preliminary Environmental Information (PEI) Report stage. This is because updated construction and operational data has been provided since the PEI Report stage to reflect design changes following statutory consultation. Also, new emissions factors have been released since the PEI Report stage, such as Defra 2021

[1] Please note, an ICCI assessment is different to a cumulative effects assessment as it looks at the combined impact of future climate conditions and the Scheme on other environmental receptors, whereas a cumulative effects assessment looks at the combined impacts of multiple developments on the environment.

emissions factors (Ref 6-2), which have been incorporated into the calculations.

6.3.4 This section outlines the limitations of the data used, and any key assumptions made within the lifecycle GHG impact assessment and CCR review.

6.3.5 A two-year construction programme has been assumed for the purposes of this assessment (no earlier than Summer 2023 to Summer 2025). However, alternative construction programmes are possible including a phased development (as outlined in **Chapter 5: EIA Methodology** of this Environmental Statement **[EN010106/APP/6.1]**). The Assessment of the construction of 24 months is worst case and any extension or phased construction would be the same or lesser in terms of the effects. The construction programme assumed for the purposes of this assessment is considered to represent a worst-case scenario as the GHG emissions that occur during the construction programme are emitted over a shorter timeframe, therefore increasing the intensity of the impact. It is expected than operation will begin no earlier than Summer 2025.

6.3.6 An assessment of GHG impacts from land use change associated with the conversion of arable land to grassland has been omitted from this chapter. Land use change as a result of the Scheme is anticipated to have a beneficial GHG impact of around 100,000 tonnes carbon dioxide equivalent (tCO_2e), largely due to the conversion of large areas of cropland to grassland, which has a higher carbon sequestration value than cropland[2]. However, it is assumed that the new areas of grassland will be returned to cropland following decommissioning of the Scheme. The beneficial GHG impact from land use change is therefore considered to only be temporary (approximately 40 years) and has therefore been excluded from the lifecycle GHG impact assessment. This is considered to be a robust worst-case approach and likely to underestimate the beneficial effect of the Scheme, as it is expected that tree planting will be retained after decommissioning.

6.3.7 A 1-way distance of 30km per journey has been assumed for the worker transportation calculations, which is a conservative estimate as, where possible, staff will reside much closer to the Order limits, and employees not from the local area would stay in local accommodation. The Defra 2021 emissions factors for ‘Average car’ and ‘Average van’, including well-to-tank (WTT) emissions[3], have been applied to this distance and total worker numbers to calculate GHG emissions associated with worker transport during construction and decommissioning.

6.3.8 HGV and sea freight distances assumed for transportation of materials and waste are outlined below. A likely worst-case country of origin has been provided by the Applicant’s design team for each of the key assets of the

[2] The carbon sequestration calculations were undertaken using carbon sequestration factors published by the European Commission (2010).
[3] Well-to-tank emissions, also known as upstream or indirect emissions, are the GHG emissions released into the atmosphere from the production, processing and delivery of a fuel to the point of use.

Scheme, and assumptions have been made around the specific ports used based on proximity to relevant manufacturing facilities within each country:

a. HGV transport of materials within China prior to sea freight transportation – 150km (based on the average distance of a number of major manufacturing centres in and around Shanghai to the nearest port)[4];
b. HGV transport of materials within South Korea prior to sea freight transportation – 50km (based on the proximity of various battery energy storage system (BESS) manufacturers to the nearest port);
c. HGV transport of materials within Europe, including distance prior to, and following, sea freight transportation – 1,600km (based on half of the reasonable maximum distance equipment might be transported within Europe, plus the distance between Dover and the Scheme);
d. Sea freight distance from China to England – 21,880km (based on the sea freight distance between Shanghai and Dover);
e. Sea freight distance from South Korea to England – 22,920km (based on the sea freight distance between Port of Jinhai and Dover); and
f. Sea freight distance from Europe to England – 50km (based on the sea freight distance between Calais and Dover).
g. HGV transport of materials following sea freight – 200km (based on the road distance between Dover and the Order limits);

6.3.9 For HGV transportation of materials, the Defra 2021 emissions factor for 'Rigid HGV – 7.5-17t' has been applied, including WTT emissions. It has been assumed that HGVs are 100% laden[5].

6.3.10 For sea freight transportation, the Defra 2021 emissions factor for 'Products tanker – Average' has been applied, including WTT emissions.

6.3.11 For HGV transportation during construction and decommissioning, the Defra 2021 emissions factor for 'Rigid HGV – 7.5-17t' has been applied, including WTT emissions. It has been assumed that HGVs are on average 50% laden as they will be empty travelling one way (e.g. to the Scheme for waste collections), and 100% laden for other leg of the journey.

6.3.12 To calculate GHG emissions associated with waste treatment during construction and decommissioning, a conservative assumption that 50% of waste will be recycled, while 50% will be sent to landfill, has been applied, and the Defra 2021 emissions factors for each construction waste stream and disposal method have been used.

[4] Please note, HGV transportation of PV modules within China has been omitted here to avoid double counting as the upstream emissions data used to calculate the embodied carbon of the PV modules already includes transportation from the manufacturing facility to a solar farm in China.
[5] HGVs are assumed to be 100% laden here, but an average of 50% laden for the waste transportation calculations. The apparent difference in assumptions is a result of the units used within the calculations. For example, for waste transportation, the total distance (km) travelled by HGVs for both legs of journey is used to estimate GHG emissions (kgCO_2e/ km). However, for transportation of materials, the 'tonne km' (i.e. total tonnes multiplied by the total km travelled to the Scheme) is used. Therefore, if HGVs were assumed to be 50% laden using the tonne km unit, this would lead to a significant overestimation as double the HGVs would be required for the same quantity of materials.

6.3.13 To calculate the embodied carbon within transformers, the material breakdown of transformers reported in a lifecycle assessment produced by Harrison *et al* (2010) (Ref 6-3) was used as a benchmark to estimate material quantities associated with the transformers required for the Scheme. This breakdown assumes 52.7% of each transformer, by weight, is steel, 13.8% is copper, 21.7% is oil, and 11.9% is 'other'. It has been assumed for the purposes of this assessment that 'other' comprises equal quantities of plastic, aluminium, glass, iron, paint and rubber. Embodied carbon factors for each of these materials from the Inventory of Carbon and Energy version 3 (ICE v3) database (Ref 6-4) have been applied.

6.3.14 While 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. Analysis of an Environmental Product Declaration (EPD) for a broadly comparable module manufactured in China has allowed the embodied carbon of the modules to be installed within the Scheme to be estimated.

6.3.15 The EPD used as a reference for embodied carbon is for the Jolywood JW-D72N-158.75 module rated at 415 Watts (W) (Ref 6-5). The EPD was published in November 2020, prepared in accordance with ISO 14025 and EN 15804, and subject to independent third-party verification. The EPD includes data on embodied carbon in $kgCO_2e$/ kWh of electricity generated over 30 years.

6.3.16 The EPD presents an embodied carbon figure of 0.00814 $kgCO_2e$/ kWh for upstream manufacturing, but the generation data is from an actual site in southern China with 27% higher yield than at the site of the Scheme. When a correction is made for the lower anticipated generation at the Scheme, the embodied carbon figure rises to 0.0103 $kgCO_2e$/ kWh generated during the first 30 years of the development's operational lifetime[6].

6.3.17 For the embodied carbon within the PV inverters and BESS inverters, embodied energy benchmarks reported by Rajput and Singh (2017) (Ref 6-6) have been applied to the indicative Scheme specifications. The embodied energy was then converted from kilowatt hours (kWh) to kilograms of CO_2 equivalent ($kgCO_2e$) using the energy intensity of the countries in which they are produced (Ref 6-7; Ref 6-8), assuming that the energy used in the factories is predominantly electricity. The benchmarks and relevant energy intensities used are outlined in **Table 6-1** below.

6.3.18 The embodied carbon of switchgear was estimated using a benchmark reported by FutureFirma (Ref 6-9), while the embodied carbon of lithium ion batteries (for the BESS) was estimated using a benchmark reported by Philippot et al (2019) (Ref 6-10). These embodied carbon benchmarks are outlined in **Table 6-1** below.

[6] The energy generated over the first 30 years only has been used here to align with the calculation methodology applied within the EPD to allow for a like-for-like comparison.

Table 6-1: Embodied energy benchmarks and emissions intensities assumed[7]

Asset	Embodied energy/ GHG benchmark	Country	Emissions intensity
PV modules	N/a	UK	0.0103 $kgCO_2e$/ kWh generated in the first 30 years
PV inverters	210 kWh/ kW	Europe	0.295 $kgCO_2e$/ kWh rating
BESS inverters	210 kWh/ kW	China	0.57 $kgCO_2e$/ kWh rating
Switchgear	175 $kgCO_2e$/ kV	N/a	N/a
Li-ion batteries	155 $kgCO_2e$/ kWh	N/a	N/a

6.3.19 To estimate the embodied carbon within cabling, it has been assumed that the cables are 50% plastic, 40% copper, and 10% aluminium by weight. Embodied carbon factors for each of these materials from the ICE v3 database (Ref 6-4) have been applied.

6.3.20 The embodied carbon factor for galvanised steel from the ICE v3 database (Ref 6-4) has been applied to the total module structure weight provided by the Applicant's design team to estimate the embodied carbon of module structures.

6.3.21 For GHG emissions associated with replacing components during the operation stage, the following annual part replacement rates were applied to the product and transportation emissions calculated for the construction phase, assuming the same activities would be required for their replacement during operation:

a. Modules – 0.2%
b. PV inverters – 4.4%
c. BESS inverters – 3.1%
d. Transformers – 1.8%
e. Medium voltage (MV) switchgear – 0.8%
f. Module structures – 0.1%

6.3.22 As the emissions associated with maintenance (e.g. plant fuel use, water and energy use, worker transportation and waste management) are not available broken down by asset, it was not possible to apply the part replacement rates to these figures. Instead, the total embodied and transportation emissions estimated for the maintenance phase have been prorated up based on the proportion of embodied and transportation

[7] For modules, PV inverters and BESS inverters, the methodology used provided the embodied energy (kWh required to produce each unit of the asset). The emissions intensity of the country in which they were produced was used to estimate kgCO2e as a result of using this energy. However, for switchgear and li-ion batteries, the methodology used provided a kgCO2e figure, so no conversion using the emissions intensity was necessary.

emissions during construction (94% share). Therefore, the maintenance emissions estimate accounts for emissions from all associated activities.

6.3.23 Operational energy generation data was provided by the Applicant's design team for the first year of operation. Efficiency losses of the PV modules over time has been accounted for based on an initial degradation factor of 2.5% for the first year, and 0.55% degradation for each subsequent year, as per the warranty of the indicative module type (covering the first 30 years). In order to model efficiency losses over the entire assessed lifetime, which is assumed to be 40 years, a 0.55% degradation rate has also been applied to the final 10 years of the operational lifetime.

6.3.24 The accuracy of the CCR review is limited by the accuracy of the UKCP18 climate projections.

6.4 Assessment Methodology

6.4.1 The methodologies described in the following section have been developed in line with the relevant planning policy (see Section 6.2) and appropriate industry guidance for assessing GHGs (Ref 6-11) and considering climate change resilience and adaptation (Ref 6-12) in EIA.

6.4.2 While the lifecycle GHG impact assessment assesses the significance of the GHG impact of the Scheme, the CCR review does not assess the significance as only a review of the impacts is required in line with UK industry (IEMA) guidance (Ref 6-12).

6.4.3 A two-year construction programme has been assumed for the purposes of this assessment (no earlier than Summer-2023 to Summer-2025), followed by a 40-year operational lifetime (Summer-2025 to Summer-2065) and a two-year decommissioning programme (Summer-2065 to Summer-2067).

Study Area

Lifecycle GHG Impact Assessment

6.4.4 The study area for the lifecycle GHG impact assessment considers all GHG emissions arising over the lifecycle of the Scheme. This includes direct GHG emissions arising from activities within the Order limits and indirect emissions from activities outside the Order limits (for example, the transportation of materials to the Order limits, and embodied carbon within construction materials).

Climate Change Resilience Review

6.4.5 The study area for the CCR review is the land within the Order limits and as such it covers all assets and infrastructure which constitute the Scheme, during construction, operation (including maintenance), and decommissioning.

Sources of Information

Lifecycle GHG Impact Assessment

6.4.6 Where available, data required to undertake the lifecycle GHG impact assessment was provided by the project design team and analysed using the methodology outlined below in this section. Where data was unavailable, reasonable assumptions have been made based on professional judgement, details of which are outlined in Section 6.3.

Climate Change Resilience Review

6.4.7 Historic climate data obtained from the Met Office website (Ref 6-13) to determine the historic baseline conditions. In line with National Policy Statement (NPS) EN1 requirements to use the latest credible scientific evidence in relation to climate change (outlined in **Appendix 6A** of this Environmental Statement **[EN010106/APP/6.2]**), UK Climate Projections 2018 (UKCP18) (Ref 6-14) data was obtained to determine the future baseline conditions.

6.4.8 CCR measures that have been built into the Scheme design were determined through liaison with the project design team and relevant environmental discipline leads.

Impact Assessment Methodology

Lifecycle GHG Impact Assessment

6.4.9 The potential effects of the Scheme on the climate during construction are calculated in line with the GHG Protocol (Ref 6-15) and the GHG 'hot spots' (i.e. materials and activities likely to generate the largest amount of GHG emissions) have been identified. This has enabled priority areas for mitigation to be identified. This approach is consistent with the principles set out in IEMA's '*Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance'* (Ref 6-11).

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

6.4.11 Where activity data has allowed, expected GHG emissions arising from the construction, operational, and decommissioning activities, and embodied carbon in materials of the Scheme, have been quantified using a calculation-based methodology as per the following equation as stated in the Defra 2021 emissions factors guidance (Ref 6-2):

Activity data x GHG emissions factor = GHG emissions value

6.4.12 In line with 'The GHG Protocol' (Ref 6-15), when defining potential impacts (or 'hot spots'), the seven Kyoto Protocol GHGs have been considered, specifically:

a. Carbon dioxide (CO_2);

b. Methane (CH_4);
c. Nitrous oxide (N_2O);
d. Sulphur hexafluoride (SF_6);
e. Hydrofluorocarbons (HFCs);
f. Perfluorocarbons (PFCs); and
g. Nitrogen trifluoride (NF_3).

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

6.4.14 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 (Ref 6-11).

6.4.15 **Table 6-2** summarises the key anticipated GHG emissions sources associated with the Scheme.

Table 6-2: Potential sources of GHG emissions

Lifecycle stage	Activity	Primary emission sources
Product stage	Raw material extraction and manufacturing of products required to build the equipment for the Scheme. Due to the complexity of the manufacturing processes and design of the equipment, and the use of materials with high embodied carbon, this stage is expected to make a significant contribution to overall GHG emissions. Transportation of materials for manufacturing.	Embodied GHG emissions from energy use in extraction and production. Emission of potent GHGs during manufacture, such as sulphur hexafluoride (SF6). GHG emissions from vehicle use.
Construction process stage	On-site construction activity including emissions from construction compounds. Transportation of construction materials (where these are not included in embodied GHG emissions). Due to the nature of the equipment required, this could require shipment of certain aspects over significant distances. Transportation of construction workers.	Energy (electricity, fuel, etc.) consumption from plant and vehicles, generators on-site, and construction worker commuting. Fuel consumption from transportation of materials to the Order limits (where these are not included in embodied GHG emissions). GHG emissions from transportation of workers to the Order limits.

Lifecycle stage	Activity	Primary emission sources
Construction process stage (cont.)	Disposal of any waste generated by the construction processes. Land use change. Water use.	GHG emissions from disposal and transportation of waste. GHG emissions from net loss of carbon sink. Provision of potable water, and treatment of wastewater.
Operation stage	Operation of the Scheme. Maintenance of the Scheme.	GHG emissions from energy consumption, provision of potable water, and treatment of wastewater. These operational aspects are expected to be negligible in the context of overall GHG emissions. Leakage of potent GHGs during operation, such as SF6 (derived from certain electric items such as gas-insulated switchgear and gas-insulated transformers during production, operation through leakage, and dismantling). GHG emissions from energy consumption, material use and waste generation as a result of site maintenance. Maintenance is generally expected to be insignificant, however if part replacement is required this has the potential to be significant given the complexity of the equipment required.
Decommissioning stage	On-site decommissioning activity. Transportation and disposal of waste materials. Transportation of workers.	Energy (electricity, fuel, etc.) consumption from plant, vehicles and generators within the Order limits. GHG emissions from disposal and transportation of waste. This has the potential to be significant given the complexity of the design of the equipment, and the use of materials with high associated waste treatment emissions. GHG emissions from transportation of workers to the Order limits.

Climate Change Resilience Review

6.4.16 The EIA Regulations require the inclusion of information on the vulnerability of the Scheme to climate change. Consequently, a review of climate change resilience for the Scheme has been conducted which identifies potential climate change impacts.

6.4.17 The review has included all infrastructure and assets associated with the Scheme. It covers resilience against both gradual climate change, and the risks associated with an increased frequency of extreme weather events as per the UKCP18 projections.

6.4.18 The review of potential impacts and the Scheme's vulnerability considers the in-built mitigation measures that have been designed into the Scheme, discussed in Section 6.7.

Significance Criteria

6.4.19 Due to the absence of any defined industry guidance for assessing the magnitude of GHG impacts for EIA, standard GHG accounting and reporting principles have been followed to assess impact magnitude. According to the IEMA guidance on assessing GHG emissions in EIA (Ref 6-11), "*GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant*".

6.4.20 The IEMA guidance (Ref 6-11) also states it is down to the professional judgment of the practitioner to determine how best to contextualise a project's GHG impact and assign the level of significance. It is suggested that sectoral, local, or national carbon budgets can be used, as available and appropriate, to contextualise a project's GHG impact and determine the level of significance. The approach adopted for the purposes of this assessment is outlined below.

6.4.21 In GHG accounting it is common practice to consider exclusion of emission sources that are <1% of a given emissions inventory on the basis of a *'de minimis'* contribution. Both Department of Energy and Climate Change (DECC) (Ref 6-16) and the PAS 2050 (2011) Specification (Ref 6-17) allow emissions sources of <1% contribution to be excluded from emission inventories, and these inventories to still be considered complete for verification purposes.

6.4.22 Where available, UK national carbon budgets have been used for the purposes of this assessment to represent future emissions inventory scenarios for the UK. These legally binding targets, which outline the total amount of GHGs that the UK can emit over a 5-year period, are currently available to the 6th carbon budget period (2033-2037) which became legislation on 24 June 2021.

6.4.23 As no UK National carbon budgets are available beyond 2037, a qualitative approach has been taken for assessing the significance of GHG emissions arising as a result of the Scheme beyond this point. A quantitative approach is not possible beyond 2037 as although the carbon budgets are set to decrease over time, there will still be permitted GHG emissions beyond 2050, but with offsetting measures in place to ensure net emissions are zero. Therefore, the rate at which they will decrease is not known, so it is not possible to predict the quantity of emissions permitted within the carbon budgets beyond 2037.

6.4.24 For the purposes of this assessment, a development with emissions of <1% of the relevant carbon budget would be considered not material and would therefore be unlikely to impact the UK's ability to meet its net zero carbon emissions target for 2050.

6.4.25 This approach has been used to assess the magnitude of the GHG impact associated with the Scheme and the associated criteria are outlined in **Table 6-3**. This differs from the standard criteria used in the EIA process by omitting the 'Very Low' and 'Medium' categories for magnitude. This is because the magnitude of the impact is determined by a boundary of less than, or equal to or more than, 1% of the carbon budgets.

Table 6-3: Magnitude Criteria for GHG Impact Assessment

Magnitude	Magnitude criteria
High	Annual GHG emissions represent equal to or more than 1% of the relevant annual National Carbon Budget.
Medium	Not applicable
Low	Annual GHG emissions represent less than 1% of the relevant annual National Carbon Budget.
Very low	Not applicable

6.4.26 The UK carbon budgets are in place to restrict the amount of greenhouse emissions the UK can legally emit in a five-year period (Ref 6-18). The UK is currently in the 3rd carbon budget period, which runs from 2018 to 2022.

6.4.27 The appropriate UK national carbon budget that spans the construction programme of the Scheme, taking account of the ongoing construction works (2023 to 2025), is the 4th carbon budget (2023 to 2027). As both construction and operational emissions are emitted during the 4th carbon budget period, the annual average GHG impact of the scheme has been compared against the annualised carbon budget for the period in which the emissions arise to allow separate assessment of each lifecycle stage.

6.4.28 Where possible, operational GHG emissions as a result of the Scheme (fully operational by Summer 2025 at the earliest) have been compared to all the appropriate and available carbon budgets within the design life of the Scheme: the 4th, 5th and 6th carbon budgets (2023 to 2027, 2028 to 2032 and 2033 to 2037, respectively). While the Scheme will be operational beyond this time, the budgets are only available to 2037. Therefore, beyond 2037, a qualitative approach has been adopted, using professional judgement to determine the significance of the impact of GHG emissions arising as a result of the Scheme.

6.4.29 **Table 6-4** shows the current and future UK carbon budgets up to 2037, which highlights a reduction in the amount of greenhouse gas the UK can legally emit in the future. This means that any source of emissions contributing to the UK's carbon inventory will have a greater impact on the UK carbon budgets in the future.

Table 6-4: Relevant Carbon Budgets for this Assessment

Carbon budget	Total budget (MtCO_2e)
4th (2023-2027)	1,950
5th (2028-2032)	1,725
6th (2033-2037)	965

6.4.30 The significance of adverse effects has been determined using the matrix in **Table 6-5**. The sensitivity of the receptor (global climate) to increases in GHG emissions is always considered 'High', and the magnitude of the impact is determined by a boundary of less than, or equal to or more than, 1% of the carbon budgets (i.e. minor or major).

6.4.31 This is in line with the IEMA guidance on assessing GHG emissions in EIA (Ref 6-11) which states that the application of the standard EIA significance criteria is not considered to be appropriate for climate change mitigation assessments. It is therefore considered that any emissions as a result of the Scheme might be considered significant. For the purposes of this assessment, the magnitude of significance will be determined using the criteria outlined in **Table 6-5**.

Table 6-5: Significance of Adverse Effects Matrix for GHG Impact Assessment

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

6.4.32 The significance of beneficial effects has been determined by comparing the operational GHG intensity of the Scheme to the projected grid average GHG intensity, and by comparing the whole lifecycle GHG intensity of the Scheme to that of alternative energy generation types, to demonstrate the impact of the Scheme in helping the UK to meet its carbon reduction targets.

6.4.33 From 2050 onwards, the UK is legally obliged to offset any emissions in line with its net zero target for 2050. Until specific carbon budgets are set out to 2050 and beyond, the permitted quantity of emissions is not known, however it is anticipated to decrease over time. Therefore, over time, the level of impact of any emissions could be considered to become more significant in the context of the UK meeting its carbon reduction target as the quantity of permitted emissions gets smaller.

6.5 Stakeholder Engagement

6.5.1 Consultation undertaken in relation to climate change is outlined in the Consultation Report **[EN010106/APP/5.1]**. **Table 6-6** outlines the matters raised within the Scoping Opinion and how these have been addressed through the ES. **Table 6-7** summarises the main matters raised through the Statutory Consultation and how these have been addressed through the ES.

Table 6-6: Main matters raised within the Scoping Opinion

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
Planning Inspectorate	The ES should include a description and assessment (where relevant) of the likely significant effects the Scheme has on climate and the vulnerability of the project to climate change. Where relevant, the ES should describe and assess the adaptive capacity that has been incorporated into the design of the Scheme.	The likely significant effects the Scheme has on climate, the vulnerability of the project to climate change, and the associated mitigation measures, are outlined in Section 6.8 and Section 6.9 of this Chapter.	See Section 6.1, Section 6.8 and Section 6.9 of this Chapter
Planning Inspectorate	The Scoping Report refers to an 'in-combination' climate change assessment but it does not relate to impacts with other developments and instead refers to the impact the Scheme will have on future climate change predictions. This should be clarified within the ES.	An in-combination climate change impact (ICCI) assessment is separate to a cumulative assessment. An ICCI assessment considers the combined impact of the Scheme and future climate change on receptors, as identified by other environmental assessments in the ES. The purpose of an ICCI is not to assess the cumulative impact of the Scheme with other developments. The ICCI assessment has been scoped out of this assessment. See section 6.1 of this Chapter. A cumulative effects assessment has also been scoped out of this assessment. See section 6.11 of this Chapter.	See Section 6.1 and Section 6.11 of this Chapter

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
Planning Inspectorate	It is unclear how the GHG impact assessment will determine which other forms of electricity production activities "may be avoided or displaced" as a result of the Scheme. The GHG impact assessment within the ES should describe any assumptions made to determine other electricity production activities and explain what is meant by being "avoided or displaced" as result of the Scheme.	The GHG intensity of the Scheme is compared to the GHG intensity of natural gas, nuclear, and onshore and offshore wind energy generation. To put the Scheme into the context of current and future UK grid electricity generation a comparison has also been made between the Scheme and the projected GHG intensity of UK Grid electricity.	See Section 6.8 of this Chapter
Planning Inspectorate	The Scoping Report states the GHG impact assessment will use a "business as usual" approach where the Scheme is not built but also states the baseline will include "emissions that may be avoided as a result of the Scheme". The ES should clarify this matter and explain how these two approaches are used in tandem to inform a "business as usual" baseline.	It is anticipated that baseline GHG emissions will not be material in the context of the overall Scheme. The wording of the description of baseline conditions has been amended within this ES Chapter to provide clarity.	See Section 6.6 of this Chapter
Planning Inspectorate	The Scoping Report states that the Scheme will be 'designed to be as resilient as reasonably practicable to future climate change'. The Scoping Report does not elaborate on this point making it unclear and ambiguous. The ES should clearly describe and assess measures incorporated to adapt to climate change.	Climate change adaptation measures built into the Scheme have been described within this ES Chapter.	See Section 6.7 and Section 6.9 of this Chapter

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
Planning Inspectorate	The Applicant should ensure that assumptions used to assess climate change are based on the worst-case scenario and are clearly stated within the ES.	A conservative, worst-case approach has been followed within the GHG calculations. Assumptions made are described in Section 6.3.	See Section 6.3 of the Chapter
East Cambridge-shire District Council	To gain a true reflective understanding of the benefits/harm to the Environment, the GHG emissions associated with the Scheme should be compared to at least one fossil fuel, nuclear, and at least one alternative renewable energy.	The energy intensity (gCO_2e/kWh) of the Scheme is compared to energy intensity ranges for natural gas, nuclear, and onshore and offshore wind. The Scheme has also been compared with the projected average GHG intensity of the National Grid.	See Section 6.8 of this Chapter
East Cambridge-shire District Council	The location of the upgraded Burwell substation is in area of Flood Defences, it will be important that any climate change resilience considers what would happen if these flood defences were to fail; this might need to reflect on potential sea level changes due to the nature of the fen landscape (much of it below sea level).	Flood risk is assessed in the Flood Risk Assessment (FRA) (**Appendix 9C** of this Environmental Statement **[EN010106/APP/6.2]**). The FRA considers the impacts of sea level rise on the Burwell Substation Extension. Sea level rises are not anticipated to affect the remainder of the Scheme.	N/a
Natural England	The ES should identify how the Scheme's effects on the natural environment will be influenced by climate change, and how ecological networks will be maintained.	This is included within **Chapter 8: Ecology and Nature Conservation** of this Environmental Statement **[EN010106/APP/6.1]**	N/a

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
Cambridge-shire County Council (Mobilising Local Energy Investment)	Within the scoping report, temperature change has been identified as out of scope. This may be the case globally, but it may be worth considering local/microclimate temperature changes associated with significant levels of solar PV panels.	In line with the relevant National Policy Statement (NPS) requirements (outlined in **Appendix 6A** of this Environmental Statement **[EN010106/APP/6.2]**), future climate change impacts are reviewed based on the latest set of UK climate projections (UKCP18). Microclimate temperature changes do not fall under the scope of the UKCP18 data, which has been reviewed at a 25km grid square level. Therefore, it is not possible to comment on microclimate impacts using this data. However, the impact of plant growth under the PV modules has been considered in **Chapter 8: Ecology and Nature Conservation** of this Environmental Statement **[EN010106/APP/6.1]**.	N/a

Table 6-7: Main matters raised through the Statutory Consultation

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
Landowner; West Suffolk Council, East Cambridgeshire District Council, Suffolk County Council and Cambridgeshire County Council; Section 47 response	Comments received in relation to land use change as a result of the Scheme, requesting further consideration of the impacts associated with changes to vegetation and soil carbon sequestration.	The GHG impact of land use change associated with the conversion of arable land to grassland has been considered within this chapter, and a beneficial GHG impact of around 100,000 tCO_2e is anticipated. However, this benefit is considered to only be temporary as it is assumed that new areas of grassland will be returned to cropland following decommissioning, so the impact has been omitted from the lifecycle GHG impact assessment.	See Section 6.3 of this Chapter

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
Landowner; Section 47 response	Comments received in relation to the microclimate impacts of the Scheme on the local environment.	This Chapter assesses the impact of GHG emissions arising as a result of the Scheme on the global climate and provides a review of the resilience of the Scheme to projected future climate change impacts. In line with industry guidance on the scope of Climate Change chapters in EIA, microclimate impacts are not considered within this Chapter.	N/a
West Suffolk Council, East Cambridgeshire District Council, Suffolk County Council and Cambridgeshire County Council.	To better understand comparisons to projects with significant visual impact, the Councils would like to see an appraisal of Onshore Wind as a comparator project or a hybrid Onshore Wind and solar PV project. The reason for this appraisal of the alternative generation technologies is to help us to understand the benefits and challenges of the proposed approach.	The GHG intensity of the Scheme is compared to the GHG intensity of natural gas, nuclear, and onshore and offshore wind energy generation.	See Section 6.8 of this Chapter
West Suffolk Council, East Cambridgeshire District Council, Suffolk County Council and Cambridgeshire County Council.	Comments received in relation to the GHG mitigation measures in place, and minimisation of the GHG impact of the Scheme.	GHG mitigation measures built into the Scheme have been described within this ES Chapter.	See Section 6.7 and Section 6.9 of this Chapter
Section 47 response	Comments received in relation to the scope of the lifecycle GHG impact assessment and assumptions made.	The scope of the lifecycle GHG impact assessment is outlined in Section 6.4 of this chapter, and assumptions and limitations of the assessment are outlined in Section 6.3 of this chapter.	See Section 6.3 and Section 6.4 of this Chapter

Consultee	Main matter raised	How has the concern been addressed	Location of response in chapter
Section 47 response	Comments received in relation to the assessment methodology, requesting the whole lifecycle of the Scheme to be considered.	The methodology for the lifecycle GHG impact assessment has been developed in line with the relevant planning policy and appropriate industry guidance for assessing GHGs (Ref 6-11) in EIA. The assessment methodology adopted is described in Section 6.4 of this chapter.	See Section 6.4 of this Chapter

6.6 Baseline Conditions

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

Lifecycle GHG Impact Assessment

6.6.2 The land within the Order limits consists mainly of arable land, managed hedgerows, and trees. Trees are present individually in some areas as well as rows of trees and small woodland areas. The abundance of vegetation within the Order limits suggests a relatively high carbon sink potential. Also, the current use of the land within the Order limits has minor levels of associated GHG emissions as the land use is largely agricultural. Baseline agricultural GHG emissions are dependent on soil and vegetation types present, and fuel use for the operation of agricultural vehicles and machinery.

6.6.3 The baseline for the lifecycle GHG impact assessment is a ‘do nothing’ scenario whereby the Scheme is not implemented. Lifecycle stages that have been scoped into the assessment are presented in **Table 6-2**. 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 Order limits from the existing activities on-site.

6.6.4 While the current land use within the Order limits will have minor levels of associated GHG emissions[8], it is anticipated that these emissions will not be material in the context of the overall Scheme. Therefore, for the purposes of the lifecycle GHG impact assessment, a conservative GHG emissions baseline of zero is applied, which represents a robust worst-case approach.

[8] While the current land use has some carbon sequestration value, this has not been considered as part of the lifecycle GHG impact assessment. This is because cropland, which makes up the majority of the baseline land use, has a very low carbon sequestration value as the carbon sequestered in the crops is released each year following harvesting and consumption of the crops. This assumption is explained further in Section 6.3.

Climate Change Resilience Review

Current Baseline

6.6.5 The current baseline for the CCR is the current climate in the location of the Order limits. Historic average climate data obtained from the Met Office website (Ref 6-13) recorded by the closest meteorological station to the Order limits (Brooms Barn climate station located near Barrow) for the 30-year climate period of 1981-2010[9] is summarised in **Table 6-8** below.

Table 6-8: Historic climate data

Climatic Factor	Month	Figure
Average annual maximum daily temperature (ºC)	-	14.0
Warmest month on average (ºC)	July	22.2
Coldest month on average (ºC)	February	1.2
Mean annual rainfall levels (mm)	-	631.8
Wettest month on average (mm)	August	62.9
Driest month on average (mm)	February	39.2

6.6.6 The Met Office historic 10-year averages for the East Anglia region identify gradual warming (although not uniformly so) between 1971 and 2020, with increased rainfall. Information on mean maximum annual temperatures (°C) and mean annual rainfall (mm) is summarised in **Table 6-9**.

Table 6-9: Historic 10-year averages for temperature and rainfall for the East Anglia region

Climate Period	Climate Variables	
	Mean maximum annual temperatures (°C)	Mean annual rainfall (mm)
1971-1980	13.5	572.6
1981-1990	13.7	609.4
1991-2000	14.2	621.4
2001-2010	14.6	637.1
2011-2020	15.0	619.0

Future Baseline

6.6.7 The future baseline is expected to differ from the present-day baseline described above. UKCP18 provides probabilistic climate change projections for pre-defined 30-year periods for annual, seasonal, and monthly changes

[9] This baseline period aligns with the baseline period used for the climate projections presented below.

to mean climatic conditions over land areas. For the purpose of the assessment, UKCP18 probabilistic projections for pre-defined 30-year periods for the following average climate variables have been obtained and analysed in this ES:

a. mean annual temperature;
b. mean summer temperature;
c. mean winter temperature;
d. maximum summer temperature;
e. minimum winter temperature;
f. mean annual precipitation;
g. mean summer precipitation;
h. mean winter precipitation;
i. mean annual cloud cover;
j. mean summer cloud cover; and
k. mean winter cloud cover.

6.6.8 Projected temperature, precipitation, and cloud cover variables are presented in **Table 6-10**, **Table 6-11** and **Table 6-12** respectively. UKCP18 probabilistic projections have been analysed for the 25km^2 grid square within which the Order limits is located. These figures are expressed as temperature/ precipitation anomalies in relation to the 1981-2010 baseline.

6.6.9 UKCP18 uses a range of possible scenarios, classified as Representative Concentration Pathways (RCPs), to inform differing future emission trends. These RCPs *"… specify the concentrations of greenhouse gases that will result in total radiative forcing increasing by a target amount by 2100, relative to preindustrial levels."* RCP8.5 has been used for the purposes of this assessment as a worst-case scenario.

6.6.10 As the design life of the Scheme is 40 years, the CCR assessment has considered a scenario that reflects a high level of global GHG emissions at the 10%, 50%, and 90% probability levels up to the 2050-2079 period[10] to assess the impact of climate change over the assessed lifetime of the Scheme. In **Table 6-10**, **Table 6-11** and **Table 6-12**, the 50% probability level is presented initially, with the 10% to 90% probability range presented in brackets underneath.

Table 6-10: Projected changes in baseline temperature variables (°C)

Climate Variable	Time Period	
	2020-2049	2050-2079
Mean annual air temperature anomaly at 1.5 m (°C)	+1.1 (+0.4 to +1.7)	+2.4 (+1.2 to +3.7)

[10] Climate projections are available for various 30-year time periods. The final year of decommissioning (2066) falls roughly in the middle of the 2050-2079 period.

Climate Variable	Time Period	
	2020-2049	2050-2079
Mean summer air temperature anomaly at 1.5 m (°C)	+1.3 (+0.5 to +2.2)	+3.1 (+1.2 to +5.1)
Mean winter air temperature anomaly at 1.5 m (°C)	+0.9 (-0.1 to +2.0)	+2.1 (+0.7 to +3.6)
Maximum summer air temperature anomaly at 1.5 m (°C)	+1.5 (+0.4 to +2.6)	+3.6 (+1.2 to 6.1)
Minimum winter air temperature anomaly at 1.5 m (°C)	+0.9 (-0.1 to +2.0)	+2.1 (+0.6 to +3.8)

Table 6-11: Projected changes in baseline precipitation variables (%)

Climate Variable	Time Period	
	2020-2049	2050-2079
Annual precipitation rate anomaly (%)	-0 (-4 to +4)	-2 (-9 to +4)
Summer precipitation rate anomaly (%)	-10 (-30 to +10)	-25 (-52 to +3)
Winter precipitation rate anomaly (%)	+4 (-4 to +14)	+12 (-2 to +29)

Table 6-12: Projected changes in baseline cloud cover variables (%)

Climate Variable	Time Period	
	2020-2049	2050-2079
Annual total cloud anomaly (%)	-2.5 (-5.7 to +0.6)	-4.9 (-10.4 to +0.6)
Summer total cloud anomaly (%)	-5.4 (-12.4 to +1.1)	-12.0 (-25.5 to +1.4)
Winter total cloud anomaly (%)	+0.0 (-2.2 to +2.2)	+0.9 (-0.9 to +2.6)

Summary of Sensitive Receptors

6.6.11 Based on a review of the baseline conditions, the global climate is the receptor for the lifecycle GHG impact assessment. The sensitivity of this receptor is high, in line with the IEMA guidance on assessing GHG emissions in EIA (Ref 6-11), which highlights the importance of mitigating GHG emissions to reduce the impacts of climate change.

6.6.12 The receptor for the review of climate change resilience is the Scheme itself, including all infrastructure, assets, and workers on-site during construction, operation, and decommissioning. The sensitivity of the receptor has not been defined for the CCR review as only a review of the impacts is required in line with UK industry (IEMA) guidance (Ref 6-12), rather than an assessment of the significance.

6.7 Embedded Design Mitigation

6.7.1 Various GHG mitigation measures are embedded within the Scheme and are included within the Framework Construction Environmental Management Plan (CEMP) (see **Appendix 16C** of this Environmental Statement **[EN010106/APP/6.2]**) and the Construction Traffic Management Plan (CTMP) (see **Appendix 13C** of this Environmental Statement **[EN010106/APP/6.2]**). A Schedule of Environmental Mitigation **[EN010106/APP/6.5]** has been produced, which outlines how this mitigation will be secured..

6.7.2 This embedded mitigation has been implemented to reduce the GHG impact of the Scheme. Specific embedded mitigation measures include:

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

6.7.3 The Framework CEMP (see **Appendix 16C** of this Environmental Statement **[EN010106/APP/6.2]**) also includes various climate change resilience measures embedded within the Scheme. These include:

a. Storing topsoil and other construction materials outside of the 1 in 100-year floodplain extent (Flood Zone 3), as far as reasonably practicable; and

b. Appointing at least one designated Weather Warden who is familiar with the risks and remains vigilant to news reports, Environment Agency flood warnings, relevant weather warnings, and water levels of the local waterways.

6.7.4 A Framework Operational Environmental Management Plan (OEMP) (see **Appendix 16F** of this Environmental Statement **[EN010106/APP/6.2]**) includes a commitment to conduct regular planned maintenance of the Scheme during operation to optimise efficiency.

6.7.5 A Framework Decommissioning Environmental Management Plan (DEMP) (see **Appendix 16E** of this Environmental Statement **[EN010106/APP/6.2]**) has been developed to encourage the use of lower-carbon and more climate change resilient methods. Specific GHG mitigation measures include:

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

b. Disposing of wastes locally where reasonably practicable to reduce emissions associated with transportation;

c. Reusing suitable infrastructure and resources already available in the Order limits where possible to minimise the use of natural resources and unnecessary materials (e.g. reusing excavated soil for fill requirements);

d. Liaising with decommissioning personnel for the potential to implement low carbon transport options;

e. Implementing a Travel Plan to reduce the volume of staff and employee trips to the Scheme;

f. Switching vehicles and plant off when not in use and ensuring vehicles conform to relevant emissions standards; and

g. Conducting regular planned maintenance of the decommissioning plant and machinery to optimise efficiency.

6.7.6 The Framework DEMP (see **Appendix 16E** of this Environmental Statement **[EN010106/APP/6.2]**) also includes the climate change resilience measures mentioned above for the construction phase.

6.7.7 Further climate change resilience measures embedded within the Scheme, particularly in relation to flood risk, are outlined below. These measures have been developed in line with consultation undertaken with relevant consultation bodies, as outlined in **Chapter 9: Flood Risk, Drainage and Water Resources** of this Environmental Statement **[EN010106/APP/6.1]**. A Schedule of Environmental Mitigation **[EN010106/APP/6.5]** has been produced, which outlines how this mitigation will be secured.

6.7.8 The specific flood risk impacts and associated mitigation measures are discussed in more detail in **Chapter 9: Flood Risk, Drainage and Water Resources** of this Environmental Statement **[EN010106/APP/6.1].** These measures include:

a. The drainage systems will be designed so that there will be no significant increases in flood risk downstream during storms up to and including the 1 in 100 (1%) annual probability design flood, with an allowance of 40% for climate change;

b. SuDS features will be utilised to ensure the surface water drainage strategy adequately attenuates and treats runoff from the Sites, whilst minimising flood risk within the Sites and surrounding areas; and

c. No part of the authorised development would be located within fluvial Flood Zone 3b extents, although part of the Order limits includes land in this flood zone. There may be solar PV modules within Flood Zone 3a and 2, however these would be raised on higher struts to mitigate any flood risk to them. The detailed design would determine the various heights required, which are recommended to be at least 850mm.

6.7.9 To embed resilience to projected increases in temperature, inverters will have a cooling system installed to control the temperature and continue to operate efficiently in warmer conditions. As the PV modules and transformers have a wide range of acceptable operational temperatures, it has been determined that increasing temperatures will not adversely affect their operation.

6.7.10 Health and safety plans developed for construction and decommissioning activities will be required to account for potential climate change impacts on workers, such as flooding and heatwaves.

6.7.11 Consideration will also be given to the UKCP18 climate change projections outlined in Section 6.6, and the resilience of the Scheme's infrastructure to these, through the detailed design process.

6.8 Assessment of Likely Impacts and Effects

6.8.1 The impacts and effects (both beneficial and adverse) associated with the construction, operation (including maintenance), and decommissioning of the Scheme are outlined in the sections below. The assessments have been assessed assuming implementation of the embedded mitigation measures as described in Section 6.7.

Lifecycle GHG Impact Assessment

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

6.8.3 The operational phase takes into account both the GHG emissions from the operation and maintenance of the Scheme, and also the GHG benefit from the renewable energy generation in the context of the wider energy generation sector and the projected National Grid average GHG intensity.

6.8.4 The overall energy intensity of the Scheme (accounting for emissions from construction, operation, and decommissioning) has then been compared to other appropriate grid energy generation sources to determine how the Scheme compares to such sources in the context of the UK meeting its 2050 net zero target.

6.8.5 The figures reported in this section have been calculated in line with the assessment methodology outlined in Section 6.4, using assumptions outlined in Section 6.3.

Construction Impact (2023 to 2025)

6.8.6 The greatest GHG impact during the construction phase is as a result of embodied carbon in construction materials which accounts for 93% of total construction emissions.

6.8.7 Other sources of emissions during construction within the scope of the GHG emissions assessment include water, energy, and fuel use for construction activities including fuel consumed by construction plant and machinery, fuel use for the transportation of construction materials to the Order limits, transportation of construction workers to and from the Order limits, and the transportation and disposal of waste.

6.8.8 As discussed in Section 6.3, land use change is anticipated to have a beneficial impact during the lifetime of the Scheme. However, as this beneficial impact is largely reversed during decommissioning, the GHG impact associated with land use change has been excluded from the lifecycle GHG impact assessment. This is assumed to represent a robust worst-case scenario as trees planted during construction will be retained beyond the decommissioning phase.

6.8.9 Total GHG emissions from the construction phase are estimated to equate to around 452,015 tCO_2e. A breakdown of estimated GHG emissions from the construction of the Scheme is presented in **Table 6-13**.

6.8.10 GHG emissions from construction activities will be limited to the duration of the construction programme (2 years). When annualised, the total annual construction emissions equate to around 226,007 tCO_2e.

Table 6-13: Construction GHG emissions

Emissions Source	Emissions (tCO_2e)	% of Construction Emissions[11]
Products	419,336	93%
Water use	<1	<1%
Fuel use	1,187	<1%
Transportation of materials & waste	18,761	4%

[11] Percentages reported may not equate to exactly 100% due to rounding.

Emissions Source	Emissions (tCO_2e)	% of Construction Emissions[11]
Worker transportation	8,099	2%
Waste treatment	4,631	1%
Total	**452,015**	**100%**

Significance of Effect (Construction)

6.8.11 GHG emissions from construction have been assessed to identify the significance of their impact. **Table 6-14** presents the estimated construction emissions against the carbon budget period during which they arise. Construction emissions will fall under the 4th UK carbon budget.

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

Table 6-14: UK carbon budgets relevant to construction period

Relevant UK Carbon Budget	Annualised UK Carbon Budget (tCO_2e)	Annual Construction Emissions During Carbon Budget Period (tCO_2e)	Construction Emissions as a Proportion of Carbon Budget
4th Carbon Budget (2023 to 2027)	390,000,000	226,007	0.0580%

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

Operational Impact (2025 to 2065)

6.8.14 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 Scheme and maintenance activities (including embodied carbon in replacement parts, plant and machinery requirements, fuel and water use during maintenance activities, transportation of materials and waste to and from the Order limits, and waste management activities).

6.8.15 Energy requirements for Scheme operation during the day, i.e. auxiliary services and standby power, will be directly met by energy generated by the Scheme. Therefore, the energy exported to the National Grid (net energy generation) has been calculated by subtracting these energy requirements from the gross energy generation from the Scheme.

6.8.16 Energy requirements for Scheme operation during the night, however, 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 production of grid electricity[12]. These emissions constitute the 'operation' phase emissions reported in **Table 6-15**. This does not take account of the GHG emissions the Scheme avoids by generating renewable energy instead of using fossil fuels.

6.8.17 Total operational GHG emissions equate to approximately 5,733 tCO_2e in the first year of operation, as presented in **Table 6-15**. Annual operational emissions then decrease over time as the grid decarbonises, equating to approximately 208,809 tCO_2e over the 40-year design life.

Table 6-15: Operational GHG emissions (based on the first year of operation)

Emissions Source	Emissions (tCO_2e)	% of Operation Emissions[13]
Worker transportation	199	3%
Maintenance	4,624	81%
Operation	909	16%
Total	**5,733**	**100%**

6.8.18 While sulphur hexafluoride (SF_6) is a potential source of GHG emissions over the lifetime of the Scheme (i.e. derived from certain electric items such as gas-insulated switchgear and gas-insulated transformers during production, operation through leakage, and dismantling), it has not been possible to quantify fugitive emissions from the leakage of SF_6 due to insufficient research data being available on this topic. SF_6 is one of the seven GHGs identified by the Kyoto Protocol (Ref 6-20) due to its high Global Warming Potential (GWP) of 23,900.

6.8.19 It is not anticipated that SF_6 emissions will significantly affect the overall outcome of this assessment, however. For example, total annual SF_6 emissions from the National Grid Transmission Network in 2015-2016 equated to 216,645 tCO_2e (Widger and Haddad, 2018; Ref 6-21), and are assumed to be similar each year. As the Scheme will provide less than 1% of total generation capacity to the National Grid Transmission Network, and as switchgear and transformers are not limited to power generation facilities but can be found all across the network, it is anticipated that the Scheme's contribution to this total will be minimal.

6.8.20 The operational GHG emissions presented in **Table 6-15** are considered to reflect a robust worst-case 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 Scheme. However, carbon and emissions associated with energy and fuel use throughout the supply chain are anticipated to be lower in the future as a result of grid

[12] For the purposes of this assessment, operational GHG emissions have been estimated based on BEIS UK grid GHG intensity projections (Ref 6-23)and actual observed trends.
[13] Percentages reported may not equate to exactly 100% due to rounding.

decarbonisation and machinery and vehicle electrification in line with the UK's net zero carbon emissions target for 2050.

6.8.21 These GHG emissions during operation, however, are far outweighed by the beneficial GHG variation between emissions from projected grid average energy generation and emissions anticipated as a result of the Scheme. Due to the lower operational GHG intensity of the Scheme compared to the national grid GHG intensity projections, a net GHG emissions reduction will be achieved as a result of the Scheme as solar power is a less GHG intensive form of energy generation than the national grid average, which includes generation using fossil fuels.

6.8.22 Energy generation from the Scheme during the first year of operation is estimated to be 643,361 MWh. A 0.55% degradation factor has been applied for each subsequent year, resulting in an estimated energy generation figure of 518,850 MWh in the final year of operation, and a total energy generation figure of around 23,157,296 MWh over the 40-year assessed lifetime.

6.8.23 Future climate change impacts, as identified in Section 6.6, may affect the lifetime energy generation modelled. For example, cloud cover is projected to decrease, which is expected to increase solar resource and have a positive impact on the productivity of the solar PV modules. This benefit, however, is assumed to be counterbalanced by temperature increases projected, which are anticipated to have a negative impact on the efficiency of the solar PV modules and on energy transmission losses (Ref 6-22). Any overall positive or negative effect is not anticipated to have a material impact on the outcome of the assessment.

6.8.24 The average operational GHG intensity of the Scheme has been calculated by dividing the total operational GHG emissions (outlined above) by the total energy generation of the Scheme, giving an average operational GHG intensity of 9 grams of CO_2 equivalent per kWh (gCO_2e/kWh). This operational GHG intensity is well below the 2020 GHG intensity of the grid (231.1 gCO_2e/kWh), as published by Defra (Ref 6-2), and remains below the projected grid GHG intensity (Ref 6-23) over the whole operational lifetime of the Scheme, which is not projected to fall lower than 27 gCO_2e/kWh. Construction and decommissioning emissions have not been included within this calculation to allow a like-for-like comparison with the projected grid intensity, as the grid GHG intensity projections also only account for operational emissions.

6.8.25 Based on the difference between the operational GHG intensity of the Scheme and the projected grid GHG intensity for each year of operation, published by BEIS (Ref 6-23), it is estimated that an additional 957,334 tCO_2e would be emitted to generate the equivalent amount of electricity over the operational lifetime of the Scheme from the projected grid energy mix.

6.8.26 While comparison of the operational GHG intensity of the Scheme against the projected GHG intensity of the UK National Grid enables the calculation of the variation in operational GHG emissions, the impact of the Scheme is further contextualised below in relation to alternative forms of energy generation.

6.8.27 This comparison uses a different GHG intensity to that presented above as this GHG intensity figure also accounts for construction and decommissioning emissions to provide a like-for-like comparison from a lifecycle perspective.

Table 6-16: Lifetime GHG emissions

Lifecycle Stage	Emissions (tCO_2e)
Construction	452,015
Operation	208,809
Decommissioning	15,185
Total	**676,008**

6.8.28 Based on the total energy generation of the Scheme and the lifecycle GHG emissions of 676,008 tCO_2e (see **Table 6-16**), the lifetime GHG intensity of the Scheme is 29.2 gCO_2e/kWh. This compares favourably with fossil fuel electricity generation and is comparable with other low carbon energy generation. **Table 6-17** outlines energy intensity ranges of alternative forms of energy generation (Ref 6-24).

Table 6-17: Comparison of energy intensities of various forms of energy generation

Energy Generation Type	GHG Intensity (gCO2e/kWh)
Combined Cycle Gas Turbine (CCGT)	380 to 500
Nuclear	5 to 55
Offshore Wind	5 to 24
Onshore Wind	7 to 20

Significance of Effect (Operation)

6.8.29 The Scheme is expected to be operational by no earlier than 2025, therefore operational emissions up to 2037 (the end of the 6^{th} carbon budget) will fall under the 4^{th}, 5^{th} and 6^{th} UK carbon budgets, beyond which point no carbon budgets have yet been published. **Table 6-18** presents the estimated operational emissions against the carbon budget periods during which they arise.

Table 6-18: Average annual operational GHG emissions of the Scheme vs the relevant UK carbon budgets relevant to operation phase (up to 2037)

Relevant UK Carbon Budget	Annualised UK Carbon Budget (tCO_2e)	Average Annual Operational Emissions vs the Grid During Carbon Budget Period (tCO_2e)	Operational Emissions as a Proportion of Carbon Budget
4th Carbon Budget (2023 to 2027)	390,000,000	5,695	0.0015%
5th Carbon Budget (2028 to 2032)	353,000,000	5,601	0.0016%
6th Carbon Budget (2033 to 2037)	193,000,000	5,281	0.0027%

6.8.30 Operational emissions to 2037 do not contribute to equal to or more than 1% of the annualised 4th, 5th or 6th carbon budgets. The magnitude of the adverse effect is therefore considered low in the context of the carbon budgets that are currently available (out to 2037).

6.8.31 Regardless, this adverse effect from operational emissions associated with the Scheme is far outweighed by the beneficial impact of the Scheme as a result of renewable energy generation. The GHG variation between the Scheme and projected grid average generation achieved throughout the assessed lifetime of the Scheme demonstrates the role solar energy generation has to play in the transition to, and longer-term maintenance of, a low carbon economy. Without low-carbon energy generation projects such as the Scheme, the average grid GHG intensity will not decrease as is projected, which could adversely affect the UK's ability to meet its carbon reduction targets.

6.8.32 As the operational GHG intensity of the Scheme is considerably lower than the current grid energy mix, and remains well below to projected grid average over the lifetime of the Scheme, the beneficial impact of the Scheme in relation to the UK meeting its carbon reduction targets is considered to be of high magnitude. Therefore, the renewable energy generation of the Scheme overall is considered to have a **major beneficial** effect on the climate.

Decommissioning impact (2065 to 2067)

6.8.33 The greatest GHG impact during the decommissioning phase is due to worker commuting, which accounts for 53% of total decommissioning emissions.

6.8.34 Other sources of emissions during decommissioning within the scope of the GHG emissions assessment include water use for decommissioning activities, fuel use on-site, transportation of materials and waste, and waste disposal.

6.8.35 Total GHG emissions from the decommissioning phase are estimated to equate to 15,185 tCO_2e. A breakdown of estimated GHG emissions from the decommissioning of the Scheme is presented in **Table 6-19**.

6.8.36 GHG emissions from decommissioning activities will be limited to the duration of the decommissioning programme (2 years). When annualised, the total annual decommissioning emissions equate to 7,592 tCO_2e.

Table 6-19: Decommissioning GHG emissions

Emissions Source	Emissions (tCO_2e)	% of Decommissioning Emissions[14]
Water use	<1	<1%
Fuel use	3,041	20%
Transportation of materials & waste	3,368	22%
Worker transportation	8,099	53%
Waste treatment	676	4%
Total	**15,185**	**100%**

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

Significance of Effect (Decommissioning)

6.8.38 While there will be GHG emissions associated with the decommissioning phase of the Scheme, actual emissions are anticipated to be lower as the figures presented in **Table 6-19** represent a robust worst-case scenario, as discussed above. Also, the overall GHG reductions achieved by the Scheme are considered to offset and outweigh any GHG impacts associated with the decommissioning phase of the Scheme. Therefore, the magnitude of impact is considered to be low.

6.8.39 GHG emissions from the decommissioning phase are therefore considered to have a **minor adverse** likely significant effect on climate change. A negligible likely significant effect is not possible where any GHG emissions are released to the atmosphere.

[14] Percentages reported may not equate to exactly 100% due to rounding.

Significance of Effect (Overall)

6.8.40 As the operational GHG intensity of the Scheme is considerably lower than the current grid energy mix, and remains well below to projected grid average over the lifetime of the Scheme, the beneficial impact of the Scheme during operation in relation to the UK meeting its carbon reduction targets is considered to be of high magnitude, and therefore represents a major beneficial effect on the climate.

6.8.41 As mentioned above, based on the difference between the operational GHG intensity of the Scheme and the projected grid GHG intensity during operation, it is estimated that an additional 957,334 tCO_2e would be emitted to generate the equivalent amount of electricity over the operational lifetime of the Scheme from the projected grid energy mix compared to the Scheme.

6.8.42 Also, the lifetime GHG intensity of the Scheme favourably with fossil fuel electricity generation and is comparable with other low carbon energy generation types.

6.8.43 This demonstrates the role solar energy generation has to play in the transition to a low carbon economy in line with the UK's net zero 2050 target.

6.8.44 Therefore, the renewable energy generation of the Scheme overall is considered to have a **major beneficial** effect on the climate.

Combined Effects on Receptors

6.8.45 The impact of GHG emissions has been assessed for the Scheme as a whole and not on individual receptors. Therefore, an assessment of the combined effect on receptors has not been included.

Climate Change Resilience Review

6.8.46 This section describes the potential climate change impacts during construction, operation, and decommissioning, before commenting on the adequacy of the climate change resilience measures built into the Scheme.

Construction (2023 to 2025)

6.8.47 During the construction process, receptors may be vulnerable to a range of climate risks. These could include:

a. Inaccessible construction site due to severe weather event (flooding, snow and ice, storms) restricting working hours and delaying construction;
b. Health and safety risks to the workforce during severe weather events;
c. Unsuitable conditions (due to very hot weather or very wet weather, for example) for certain construction activities; and
d. Damage to construction materials, plant and equipment, including damage to temporary buildings/ facilities within the Order limits such as

offices, compounds, material storage areas and worksites, for example from stormy weather.

Operation (2025 to 2065)

6.8.48 During the operational phase, the Scheme may be vulnerable to a range of climate change risks, which could include:

a. Increased frequency and severity of extreme weather events (such as heavy and/or prolonged precipitation, storm events and heatwaves) leading to damage to infrastructure/ assets;
b. Increased summer temperatures and extreme weather events such as heatwaves leading to an increased risk of fire;
c. Increased winter precipitation leading to surface water flooding and standing water; and
d. Increased summer and winter temperatures leading to an increase in the ambient temperature of BESS units, resulting in higher ventilation and cooling requirements.

Decommissioning (2065 to 2067)

6.8.49 During the decommissioning process, receptors may be vulnerable to the same climate risks as those listed above for the construction process (see paragraph 6.8.47). However, due to the projected increase in severity of climate change over time, the climate change impacts are likely to be more severe during the decommissioning phase.

6.8.50 Section 6.7 outlines a number of adaptation measures that have been built into the Scheme to mitigate these impacts during construction, operation and decommissioning, where necessary and increase the resilience of the Scheme to climate change, particularly in relation to flood risk and health and safety impacts, as determined through consideration of the UKCP18 climate change projections outlined in Section 6.6.

6.8.51 The CCR review has considered the measures which are integrated into the design (see Section 6.7). These are considered an adequate response to the projected climate change impacts to which the Scheme would be exposed.

Combined Effects on Receptors

6.8.52 The resilience of the Scheme to projected future climate change impacts has been considered for the Scheme as a whole and not for individual receptors. Therefore, an assessment of the combined effect on receptors has not been included.

6.9 Additional Monitoring, Mitigation and Enhancement Measures

6.9.1 No additional mitigation or monitoring beyond the measures already described in Section 6.7 are required during construction, operation, or decommissioning of the Scheme.

6.9.2 The GHG emissions from construction, operation and decommissioning of the Scheme are accounted for within the lifetime GHG intensity figure for the Scheme. Therefore, it is considered that the GHG reductions achieved as a result of the Scheme itself adequately outweigh and offset the GHG impacts during the individual lifecycle stages.

6.10 Residual Effects

6.10.1 This section identifies the residual effects, following the implementation of mitigation and monitoring measures, known as 'residual effects' which cannot be eliminated through design changes or the application of standard mitigation measures.

6.10.2 There will be unavoidable GHG emissions resulting from the construction, operation, and decommissioning phases of the Scheme as materials, energy and fuel use, and transport will be required. However, as the overall impact of the Scheme is major beneficial, it is not appropriate to define any mitigation measures further to the ones detailed in Section 6.7.

6.10.3 **Table 6-20** outlines the likely residual construction effects after mitigation.

Table 6-20 Summary of Residual Effects

Receptor	Description of impact	Significance of effect without mitigation	Mitigation/Enhancement measure	Residual effect after mitigation
Climate				
Construction (2023-2025)	GHG emissions as a consequence of construction activities	Minor Adverse	The overall beneficial impact of the Scheme itself is considered to offset any GHG emissions during construction	Minor Adverse
Operation (2025-2065)	Net GHG variation vs the grid average generation as a consequence of operational activities	Major Beneficial	No mitigation required	Major Beneficial
Decommissioning (2065-2067)	GHG emissions as a consequence of decommissioning activities	Minor Adverse	The overall beneficial impact of the Scheme itself is considered to offset any GHG emissions during decommissioning	Minor Adverse
Overall	Overall GHG impact over the lifetime of the Scheme	Major Beneficial	No mitigation required	Major Beneficial

6.11 Cumulative Effects

6.11.1 Most development results in GHG emissions and consequently all development therefore have the potential to result in a cumulative effect on GHG emissions. As such it is not possible to define a study area for the assessment of cumulative effects on GHG emissions nor to undertake a cumulative effects assessment, as the identified receptor is the global climate and effects are therefore not geographically constrained.

6.11.2 Further, as the assessment methodology uses the relevant UK National Carbon Budgets as a proxy for the global climate, in line with IEMA guidance (Ref 6-11), this wider perspective is already covered by default. Undertaking a cumulative effects assessment would therefore result in double counting as the GHG emissions from the cumulative schemes also fall within the UK carbon budgets. Consequently, consideration of the effects of the Scheme together with other developments on GHG emissions has been scoped out of this assessment.

6.11.3 It should also be noted that other schemes falling under the EIA Regulations (Ref 6-1) will also need to consider climate change assessment within their own planning or DCO application.

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

6.12 References

Ref 6-1 Her Majesty's Stationery Office (HMSO) (2017). The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.

Ref 6-2 Department for Environment, Food and Rural Affairs and the Department of Business, Energy and Industrial Strategy (2021). UK Government GHG Conversion Factors for Company Reporting.

Ref 6-3 Harrison, G. P., Maclean, E. N. J., Karamanlis, S. and Ochoa, L. F. (2010). Life cycle assessment of the transmission network in Great Britain.

Ref 6-4 Bath University and Circular Ecology (2019). Inventory of Carbon and Energy (ICE) Database V3.0 – 10 Nov 2019.

Ref 6-5 EPD International AB (2020). Environmental Performance Declaration (EPD) for Jolywood N-type Bifacial Double Glass Photovoltaic Modules.

Ref 6-6 Rajput, S. K. and Singh, O. (2017). Reduction in CO2 Emission through Photovoltaic System: A Case Study.

Ref 6-7 Carbon Transparency Initiative (2016).

Ref 6-8 European Environment Agency (2019). Overview of Electricity Production and Use in Europe.

Ref 6-9 FutureFirma Sustainability Consulting (2018) Life-Cycle Carbon Impact Assessment of the Respond Project

Ref 6-10 Philippot, M., Alvarez, G., Ayerbe, E., Van Mierlo, J. and Messagie, M. (2019). Eco-Efficiency of a Lithium-Ion Battery for Electric Vehicles: Influence of Manufacturing Country and Commodity Prices on GHG Emissions and Costs.

Ref 6-11 Institute of Environmental Management and Assessment (IEMA) (2017). Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance.

Ref 6-12 Institute of Environmental Management and Assessment (IEMA) (2020). Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation.

Ref 6-13 UK Met Office (2019). Historic climate data.

Ref 6-14 UK Met Office (2018). UK Climate Projections 2018 (UKCP18).

Ref 6-15 World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI). The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard.

Ref 6-16 Department of Energy and Climate Change (DECC) (2013). Guidance on Annual Verification for emissions from Stationary Installations.

Ref 6-17 British Standards Institution (2011). PAS 2050:2011 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services.

Ref 6-18 Committee on Climate Change (2017). UK Carbon Budgets.

Ref 6-19 Committee on Climate Change (2019). Net Zero: The UK's contribution to stopping global warming.

Ref 6-20 United Nations Framework Convention on Climate Change (UNFCCC) (2005). Kyoto Protocol.

Ref 6-21 Widger, P. and Haddad, A. (2018). Evaluation of SF6 Leakage from Gas Insulated Equipment on Electricity Networks in Great Britain.

Ref 6-22 Crook, J. A., Jones, L. A., Forster, P. M. and Crook, R. (2011), Climate change impacts on future photovoltaic and concentrated solar power energy output.

Ref 6-23 Department for Business, Energy & Industrial Strategy (BEIS) (2019). Data Tables 1 to 19.

Ref 6-24 Committee on Climate Change (2013). Reducing the UK's carbon footprint.