Rosefield Solar Farm

Preliminary Environmental Information Report

Volume 1
Chapter 8: Climate

September 2024

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8. Climate

8.1. Introduction

8.1.1. This chapter presents a preliminary assessment of the likely significant effects arising from the construction, operation (including maintenance) and decommissioning of Rosefield Solar Farm upon climate and should be read in conjunction with the following appendix in **Volume 3**:

- **Appendix 8.1 – Climate Data Sources and Assumptions.**

8.2. Stakeholder engagement

8.2.1. Engagement with Buckinghamshire Council has been initiated to inform the ES; however, no specific consultation with regards to climate has been undertaken to inform this preliminary assessment.

8.3. Legislative framework, planning policy and guidance

8.3.1. One of the objectives of Rosefield Solar Farm is to mitigate against climate change, in order to align with relevant climate change legislation and planning policies, particularly with regards to the UK Climate Change Act 2008 (2050 Target Amendment) Order 2019[1], which is aligned with the goals of the 2015 Paris Agreement[2].

8.3.2. The preliminary assessment has been undertaken with regard to the following legislation, planning policy and guidance.

Legislation

- The 2015 Paris Agreement - this is a legally binding international treaty which commits Parties to the United Nations Framework Convention on Climate Change to objectives to reduce greenhouse gases (GHG) emissions, which include limiting the global average temperature rise to well below 2˚C above pre-industrial levels, whilst “pursuing efforts to limit the temperature increase to 1.5˚C”. It was adopted in December 2015, coming into effect November 2016;
- United Nations Framework Convention on Climate Change[3] - this came into force on 21 March 1994 and sought to stabilise the atmospheric

[1] Climate Change Act 2008. (2050 Target Amendment) Order 2019. Available online: https://www.legislation.gov.uk/ukdsi/2019/9780111187654
[2] The Paris Agreement 2015. Available online: https://unfccc.int/process-and-meetings/the-paris-agreement
[3] United Nations Framework Convention on Climate Change 1994. Available online: conveng.pdf (unfccc.int)

concentrations of greenhouse gases at safe levels. The Convention provides an overall framework for international government efforts to address the challenge posed by climate change;

- Kyoto Protocol[4] - this was an international treaty with the aim to reduce global GHG emissions. It was adopted in 1997 and came into force in 2005. It outlined six categories of GHG emissions weighted by their global warming potential and aggregated to give total greenhouse gas emissions in CO_2 equivalents. The Kyoto Protocol was effectively replaced by the Paris Agreement, which came into effect in 2016; and
- Climate Change Act 2008 (2050 Target Amendment) Order 2019[5] – sets a target of reducing GHG emissions by 100% by 2050 within the UK, relative to the baseline year of 1990. The Climate Change Act further established the Climate Change Committee as an independent, statutory body to advise the UK and devolved Governments on emission reduction targets and report to Parliament on progress. The Climate Change Committee is further tasked with the production of the UK Climate Change Risk Assessment, followed by a National Adaptation Programme to address those risks every five years, as well as undertaking an annual assessment of GHG emissions to determine whether the UK is on course to meet its target carbon budget.

National planning policy

- Overarching National Policy Statement for Energy (NPS EN-1) (2023)[6] - Section 3.3, sets out the importance of nationally significant energy infrastructure projects and explicitly includes solar generation within its scope. It recognises the urgent need for renewable technologies, such as Solar PV, in order to achieve net zero and ensure affordable energy security. Section 5.3 details the requirement for a GHG assessment as part of the Environmental Statement, to include construction, operation and decommissioning impacts. This must be used *"to drive down GHG emissions at every stage of the proposed development and ensure that emissions are minimised as far as possible for the type of technology"*. The impact of any residual GHG emissions and their impacts on national and international efforts to limit climate change must be detailed;

[4] Kyoto Protocol 1997. Available online: https://unfccc.int/resource/docs/convkp/kpeng.pdf
[5] Climate Change Act 2008 (2050 Target Amendment) Order 2019. Available online: https://www.legislation.gov.uk/ukdsi/2019/9780111187654
[6] Department for Energy Security and Net Zero. (2023). Overarching National Policy Statement for Energy (EN-1). Available online: https://www.gov.uk/government/publications/overarching-national-policy-statement-for-energy-en-1

- National Policy Statement for Renewable Energy Infrastructure (NPS EN-3) (2023)[7] - Section 2.10 states that solar is important to deliver national energy security, and references the British Energy Security Strategy, whereby a five-fold increase in solar deployment is expected by 2035, up to 70 GW;
- National Policy Statement for Electricity Networks Infrastructure (EN-5) (2023)[8] references the consideration of whether a project makes a considerable contribution to the promotion of renewable energy, the achievement of climate change objectives and the maintenance of energy security. It references the requirements of NPS EN-1 to ensure the resilience to climate change is considered if applicable, with regards to flooding, wind, storms, increased heat and earth movement caused by flooding or drought;
- National Planning Policy Framework (NPPF) (2023)[9] presents several requirements and considerations related to climate change. Reducing GHG emissions, adapting to and avoiding areas subject to high climate risks (flooding, coastal risk, overheating) and enhancing resilience are implemented in planning systems. Examples include, reusing resources, using renewable energy, enhancing sustainable design, and incorporating green infrastructure. These provisions aim to guide local authorities and developers in addressing climate change issues within the planning process;
- British Energy Security Strategy (2022)[10] states that 95% of British electricity could be from low carbon sources by 2030, and by 2035, the electricity system will have been decarbonised. At the time of publication of this strategy, there was 14 GW of solar capacity within the UK, and it is anticipated that this figure could increase by up to five-fold by 2035, equating to 70 GW of solar capacity. Of this five-fold increase,

[7] Department for Energy Security and Net Zero (2023). National Policy Statement for Renewable Energy Infrastructure (EN-3). Available online: https://www.gov.uk/government/publications/national-policy-statement-for-renewable-energy-infrastructure-en-3
[8] Department for Energy Security and Net Zero (2023). National Policy Statement for Electricity Networks Infrastructure (EN-5). Available online: https://www.gov.uk/government/publications/national-policy-statement-for-electricity-networks-infrastructure-en-5
[9] Ministry of Housing, Communities and Local Government and Department for Levelling Up, Housing and Communities (2023). National Planning Policy Framework. Available online: https://www.gov.uk/government/publications/national-planning-policy-framework--2
[10] HM Government (2022). British Energy Security Strategy. Available online: https://assets.publishing.service.gov.uk/media/626112c0e90e07168e3fdba3/british-energy-security-strategy-web-accessible.pdf

Rosefield Solar Farm would contribute to approximately 1% of the UK's proposed solar capacity;

- Energy White Paper: Powering our Net Zero Future (2020)[11] outlines the UK's commitment to achieving net zero GHG emissions by 2050. It prioritises reducing carbon emissions through enhanced energy efficiency, technological innovation, and infrastructure investments. Examples include the introduction of smart tariffs to ensure affordable solar energy, which the net zero system will primarily be composed of. The policy also includes measures to support economic growth and job creation in the green sector while aligning with international climate agreements; and
- Powering Up Britain (2023)[12] highlights the expansion of renewable energy infrastructure and the modernisation of the energy grid to support increased renewable capacity in addition to improving energy efficiency improvements across buildings and transportation, and emphasising the role of technological advancements, such as hydrogen and carbon capture, in reducing emissions. This policy is designed to translate the broad goals of the Energy White Paper into actionable initiatives, ensuring that the UK meets its climate targets while fostering economic resilience and energy security.

Local planning policy

- Buckinghamshire Council Climate Change and Air Quality Strategy (2021)[13] – following up on Buckinghamshire's 2020 commitment to achieve carbon zero by 2050, this policy integrates air quality into the emissions reduction strategy. This document sets out the strategy for climate change mitigation/adaption and reducing air quality pollutants, which are also main sources of GHGs. The strategy details 60 actions involving Council operations, partner and supplier relations, and county activity influence. Emission reductions will be focused on the following sources: building and waste, air pollutant sequestration, absorption/screening, and flood risk management; and

[11] HM Government (2020). Energy White Paper: Powering our Net Zero Future. Available online: https://assets.publishing.service.gov.uk/media/5fdc61e2d3bf7f3a3bdc8cbf/201216_BEIS_EWP_Command_Paper_Accessible.pdf
[12] HM Government (2023). Powering Up Britain. Available online: https://assets.publishing.service.gov.uk/media/642468ff2fa8480013ec0f39/powering-up-britain-joint-overview.pdf
[13] Buckinghamshire Council Climate Change and Air Quality Strategy (2021). Available online: Climate Change and Air Quality Strategy | Buckinghamshire Council

- Vale of Aylesbury Local Plan (VALP) 2013 – 2033 Adopted Plan (2021)[14] – a 20-year sustainable development plan to be carried out between 2013-2033. There are eight objectives set out in Section 2.6, one of which is climate change adaptation and mitigation, largely focused on flood management. This objective also outlines sustainable and climate-adapted infrastructure, land use management, waste management and circular economy implementation, renewable energy, and wildlife corridors. Section 3.4 S1 states the requirement of developments to comply with the principles of sustainable development set out in the NPPF, and specifies considerations including S1(j)- meeting the effects of climate change and flooding. The relevance of renewable energy is detailed in Sections 10.51-10.60 and encouraging relevant developments in Section C3.

Guidance

- Assessing Greenhouse Gas Emissions and Evaluating their Significance (IEMA, 2022)[15];
- Climate Change Resilience and Adaptation (IEMA, 2020)[16];
- PAS 2080 - Carbon management in Infrastructure (British Standards Institute (BSI), 2023)[17];
- Planning Practice Guidance on Climate Change (Ministry of Housing, Communities and Local Government and Department for Levelling Up, Housing and Communities, 2019)[18];

14 Vale of Aylesbury Local Plan (VALP) 2013 – 2033 Adopted Plan (2021). Available online: https://buckinghamshire-gov-uk.s3.amazonaws.com/documents/Aylesbury_local_plan_L46JWaT.pdf
15 Institute of Environmental Management and Assessment (2022). Assessing Greenhouse Gas Emissions and Evaluating their Significance. Available online: https://www.iema.net/preview-document/assessing-greenhouse-gas-emissions-and-evaluating-their-significance
16 Institute of Environmental Management and Assessment (2020). Climate Change Resilience and Adaptation. Available online: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020
17 British Standards Institute (2023). PAS 2080 - Carbon management in Infrastructure. Available online: https://www.bsigroup.com/en-GB/insights-and-media/insights/brochures/pas-2080-carbon-management-in-infrastructure-and-built-environment/
18 Ministry of Housing, Communities and Local Government and Department for Levelling Up, Housing and Communities (2019). Planning Practice Guidance on Climate Change. available online: https://www.gov.uk/guidance/climate-change

- A Corporate Accounting and Reporting Standard (The Greenhouse Gas Protocol, 2004)[19]; and
- Whole Life Carbon Assessment for the Built Environment (Royal Institution of Chartered Surveyors (RICS), 2023)[20].

8.4. Study area

8.4.1. The sensitive receptor for GHG emissions is the global climate, which is considered highly sensitive to GHG fluctuations. By proxy, the sensitive receptor can also be extended to the UK's commitments under the UK Climate Change Act 2008 (2050 Target Amendment) Order 2019[21], which aligned with the goals of the 2015 Paris Agreement[22], to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C.

8.4.2. Rosefield Solar Farm has the potential to affect the climate by the addition and avoidance of GHG emissions in comparison to the baseline and future baseline scenario.

8.4.3. The scope of the GHG assessment includes the addition of GHG emissions directly from construction, operational (including maintenance) and decommissioning activities undertaken within the Site boundary of Rosefield Solar Farm, including project fuel consumption (construction and decommissioning).

8.4.4. It also extends to include emissions that would occur outside the Site boundary, but related to the activities of Rosefield Solar Farm, including those from:

- The extraction, manufacture, and transportation of materials to the construction site (construction and operation (including maintenance));
- The transportation of workers to Site (construction and operation (including maintenance)); and

[19] The Greenhouse Gas Protocol (2004). A Corporate Accounting and Reporting Standard. Available online: https://ghgprotocol.org/corporate-standard
[20] Royal Institution of Chartered Surveyors (2023). Whole Life Carbon Assessment for the Built Environment. Available online: https://www.rics.org/content/dam/ricsglobal/documents/standards/whole_life_carbon_assessment_for_the_built_environment_1st_edition_rics.pdf
[21] Climate Change Act 2008 (2050 Target Amendment) Order 2019. Available online: https://www.legislation.gov.uk/ukdsi/2019/9780111187654
[22] Paris Agreement 2015. Available online: https://unfccc.int/process-and-meetings/the-paris-agreement

- Off-site transport and disposal of waste materials (construction, operation (including maintenance) and decommissioning).

8.4.5. This preliminary assessment also considers the GHG savings from Rosefield Solar Farm as a result of displacing fossil-fuel based energy in the national electricity network.

8.5. Establishing baseline conditions

8.5.1. No surveys or site visits have been undertaken to inform the baseline conditions for climate.

8.5.2. Information concerning the baseline climactic conditions has been sourced from the Met Office (2024)[23], as well as UK Climate Projections 2018 (UKCP18) [24]. This information has been used to build a profile of climatic conditions in the project region.

8.6. Environmental baseline

GHG emissions

8.6.1. The land within the Site predominantly consists of agricultural fields, hedgerows and mature trees. In line with IEMA's (2022) 'Assessing Greenhouse Gas Emissions and Evaluating their Significance'[25], if a site currently has no development or significant activity, the baseline can be considered to have zero GHG emissions, to ensure a reasonable worst-case approach to establishing the net GHG effect.

8.6.2. While the Site is currently in agricultural use (associated emissions with vehicles and livestock), the emissions likely to be associated with these activities have not been considered to constitute significant activity.

Future baseline

8.6.3. No change is expected for the future baseline when compared to the current baseline. It is unlikely that under a future 'business-as-usual' scenario (wherein the land would remain used for its current purposes),

[23] Met Office (2024). UK Climate Averages. Available online: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/
[24] UK Climate Projections (2018). Available online: https://ukclimateprojections-ui.metoffice.gov.uk/ui/home
[25] Institute of Environmental Management and Assessment (2022). Assessing Greenhouse Gas Emissions and Evaluating their Significance. Available online: https://www.iema.net/preview-document/assessing-greenhouse-gas-emissions-and-evaluating-their-significance

there would be any significant changes to the amount of GHG emissions from the Site, either positive or negative.

8.6.4. It is important to note that the UK's national grid is expected to decarbonise as a result of projected renewable energy developments, such as Rosefield Solar Farm. Therefore, Rosefield Solar Farm already forms part of the baseline assumption for future grid decarbonisation.

Climate change

8.6.5. The Met Office (2024)[26] climate profiles considered the region as *"essentially transitional between northern and southern England in terms of temperature and between Wales and eastern England as regards rainfall."*

8.6.6. The climate in the South East has been changing over the most recent decades, as shown in **Table 8.1** (which displays climate averages recorded from the nearest climate station to the Site, in this case Oxford). Temperature has increased across the decades studied, with an increase of 1.24˚C from the average annual maximum temperatures of 1961 – 1990 to those in 1991 – 2020 (standard industry practice is to define a regions' climate over a period of 30 years, which is also the method adopted by the Met Office). Rainfall has fluctuated across the decades studied, with the driest month experiencing an overall increase in rainfall of 3.21 mm and wettest month experiencing an overall increase in rainfall of 10.38 mm from 1961 – 1990 to 1991 – 2020.

Table 8.1 – Climate change in South East England since 1961

Climate variable	1961 – 1990	1971 – 2000	1981 – 2010	1991 – 2020
Average Annual Maximum Temperature (˚C)	13.78	14.13	14.57	15.02
Warmest Month Max Temperature (˚C)	21.73 (July)	22.33 (July)	22.72 (July)	23.06 (July)
Coldest Month Min Temperature (˚C)	1.39 (February)	1.73 (February)	1.83 (February)	2.32 (February)

[26] Met Office (2024) Climate Profiles. Available online: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/weather/regional-climates/midlands_-climate-met-office.pdf

Climate variable	1961 – 1990	1971 – 2000	1981 – 2010	1991 – 2020
Total Annual Rainfall (mm)	632.12	641.97	659.70	681.55
Rainfall in Driest Month (mm)	39.95 (February)	42.55 (February)	42.50 (February)	43.16 (March)
Rainfall in Wettest Month (mm)	62.80 (December)	64.67 (December)	69.64 (October)	73.18 (October)

Future baseline

8.6.7. Future climatic conditions are projected to change in comparison to the present baseline conditions. In particular, winters are projected to become increasingly warmer and wetter whilst summers are projected to become increasingly hotter and drier, as shown in **Table 8.2**, **Table 8.3** and **Table 8.4**.

8.6.8. Annually, atmospheric pressure at sea level is predicted to increase across the short to long-term time horizons, although there is much variation in terms of model outputs. High-pressure systems usually lead to fair, calm weather, and it may be expected that these conditions become more prevalent in the future. Though, as identified in **paragraph 8.6.10**, the frequency of winter storms may increase in line with projected windspeed changes.

8.6.9. The climate projections displayed in the following tables have been extracted from the UK Climate Projections 2018 (UKCP18)[27] data developed by the UK Climate Impacts Programme. The projections displayed in the tables below cover the indicative lifetime of Rosefield Solar Farm at the 50th percentile, with ranges shown for the 10th and 90th percentiles, for the Representative Concentration Pathway (RCP) 8.5 (high emissions) scenario. The figures are expressed as temperature/precipitation anomalies in relation to a 1981 – 2000 baseline.

8.6.10. UKCP18 projections do not contain specific outputs for windspeed changes for the UK. However, global projections of wind speed over the UK at 10 m height show no significant changes in the first part of the 21st century but predict increases in wind speed for the winter season from 2050 onwards. This would be associated with an increase in frequency of winter storms.

[27] UK Climate Projections (2018). Available online: https://ukclimateprojections-ui.metoffice.gov.uk/ui/home

Table 8.2 – Projected change in temperature in the South East England region (50th percentile with ranges for the 10th and 90th percentiles)

Climate variable	Time horizon relative to 1981 – 2000		
	2020 – 2039	2040 – 2059	2080 – 2099
Mean annual air temperature anomaly at 1.5 m (˚C)	+1.06 (+0.45 to +1.7)	+1.88 (+0.96 to +2.85)	+4.34 (+2.58 to +6.2)
Mean summer air temperature anomaly at 1.5 m (˚C)	+1.37 (+0.40 to +2.34)	+2.53 (+1.13 to +3.96)	+5.83 (+3.02 to +8.75)
Mean winter air temperature anomaly at 1.5 m (˚C)	+0.88 (+0.09 to +1.73)	+1.60 (+0.48 to +2.8)	+3.47 (+1.42 to +5.67)
Maximum summer air temperature anomaly at 1.5 m (˚C)	+1.51 (+0.2 to +2.8)	+2.79 (+0.95 to +4.71)	+6.46 (+2.87 to +10.21)
Minimum winter air temperature anomaly at 1.5 m (˚C)	+0.91 (+0.04 to +1.89)	+1.70 (+0.4 to +3.14)	+3.71 (+1.27 to +6.48)

Table 8.3 – Projected change in precipitation rate in the South East England region (50th percentile with ranges for the 10th and 90th percentiles)

Climate variable	Time horizon relative to 1981 – 2000		
	2020 – 2039	2040 – 2059	2080 – 2099
Annual precipitation rate anomaly (%)	+1.27 (-5.42 to +8.12)	-0.48 (-8.39 to +7.72)	-1.13 (-12.65 to +11.09)

Climate variable	Time horizon relative to 1981 – 2000		
	2020 – 2039	2040 – 2059	2080 – 2099
Summer precipitation rate anomaly (%)	-5.93 (-29.34 to +17.37)	-16.79 (-44.81 to +12.03)	-41.4 (-71.21 to +0.58)
Winter precipitation rate anomaly (%)	+8.06 (-4.59 to +21.95)	+12.56 (-3.86 to +31.56)	+26.01 (-1.69 to +59.79)

Table 8.4 – Projected change in sea level pressure in the South East England region (50th percentile with ranges for the 10th and 90th percentiles)

Climate variable	Time horizon relative to 1981 – 2000		
	2020 – 2039	2040 – 2059	2080 – 2099
Annual sea level pressure (hPa)	+0.28 (-0.65 to +1.25)	+0.63 (-0.57 to +1.8)	+0.83 (-1.21 to +2.84)
Summer sea level pressure (hPa)	+0.50 (-0.46 to +1.53)	+0.90 (-0.66 to +2.53)	+1.26 (-1.46 to +4.25)
Winter sea level pressure (hPa)	+0.01 (-2.01 to +2.06)	+0.09 (-2.43 to +2.71)	-0.45 (-4.87 to +3.84)

8.7. Mitigation embedded into the design

8.7.1. This preliminary assessment has been based on the principle that measures have been 'embedded' into the design of Rosefield Solar Farm to remove potential likely significant effects as far as practicable, for example by the considered placement of infrastructure. Embedded (primary) environmental mitigation measures that are considered to be an inherent part of Rosefield Solar Farm are detailed within **Chapter 5: Approach to the EIA**.

8.7.2. The embedded mitigation measures relevant to climate and the benefits these provide are outlined in **Table 8.5** below.

Table 8.5 – Embedded mitigation measures relevant to climate

Embedded mitigation measures relevant to Climate	Benefit
GHG emissions	
The use of concrete would be minimised where reasonably practicable.	Reduced embodied GHG emissions from concrete.
Any vegetation cleared to facilitate the construction of Rosefield Solar Farm will be compensated during operation by a planting scheme that equals or exceeds the current levels of vegetation.	The carbon sequestration potential of the Site will remain the same, or be enhanced, by Rosefield Solar Farm.
Climate risk	
Electrical infrastructure would be sited in locations at low risk of flooding and/or set at the necessary minimum ground levels.	Electrical infrastructure will be less likely to flood.
The condition and integrity of assets would be regularly assessed, and maintenance undertaken as early as required, giving consideration to materials with enhanced tolerance to fluctuating temperatures and exposure to rainfall.	Assets would be less likely to fail due to changes in climate.

8.8. Optionality

8.8.1. **Chapter 5: Approach to the EIA** sets out those elements of Rosefield Solar Farm for which optionality is present within the current design and sets out the scenarios assessed for the purpose of this PEIR.

8.8.2. The preliminary design principles as outlined in **Chapter 5: Approach to the EIA** and preliminary parameter plans (**Figures 3.1** to **3.5** in **Volume 2**) set out the reasonable 'worst case scenario' that has been assessed within this chapter.

8.8.3. Between the optionalities presented, there is no difference with regards to the Flood Zone any infrastructure is located in, nor is there any change in the number or capacity of the Solar PV modules.

8.8.4. For construction emissions assessed within this preliminary assessment, a worst case assumption of 30 months of peak construction has been assessed.

8.9. Approach to the preliminary assessment

GHG emissions

8.9.1. Data that has informed this preliminary assessment is provided in **Appendix 8.1** in **Volume 3**.

8.9.2. This preliminary assessment establishes present and future baseline GHG emissions. Aligned with The Greenhouse Gas Protocol[28], it quantifies applicable Kyoto Protocol[29] GHGs as measured in tonnes of carbon dioxide equivalence (tCO_2e), where equivalence means having the same warming effect as CO_2 over 100 years. The six original Kyoto Protocol gas groups are CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and perfluorocarbons (PFCs). Nitrogen trifluoride (NF_3), a chemical released in certain high-tech industries, was added in 2013. The global warming potential (GWP) of each is presented in **Table 8.6**.

Table 8.6 – Kyoto Protocol GHGs and their global warming potential (GWP) based upon Intergovernmental Panel on Climate Change's Fifth Assessment Report

Greenhouse gas/group	Chemical formula	GWP (CO_2e)
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	$N2_O$	265
Hydrofluorocarbons	HFCs	Depends on specific gas
Sulphur hexafluoride	SF_6	23,900

[28] The Greenhouse Gas Protocol (2004). A Corporate Accounting and Reporting Standard. Available online: https://ghgprotocol.org/corporate-standard
[29] Kyoto Protocol 1997. Available online: https://unfccc.int/resource/docs/convkp/kpeng.pdf

Greenhouse gas/group	Chemical formula	GWP (CO_2e)
Perfluorocarbons	PFCs	Depends on specific gas
Nitrogen Trifluoride	NF_3	16,100

8.9.3. As this preliminary assessment represents a forecast of emissions and some information may not yet be known, secondary data (such as estimates, extrapolations, benchmarks, and proxy data such as distance travelled) have been used where applicable. Emissions have then been quantified by applying the most relevant and up-to-date emission factors. All supporting data used is available in **Appendix 8.1** in **Volume 3**.

8.9.4. An emission factor is a representative value that relates the quantity of a pollutant released into the atmosphere with an activity associated with the release of that pollutant. Emission factors are typically available from Government publications, independent agencies, and scientific research journals. However, the quality and accuracy of such factors can vary significantly. Factors can differ depending on the research body and/or underlying methodologies applied. It is, therefore, good practice to apply emission factors only from reputable sources, which is the methodology applied for this preliminary assessment.

8.9.5. The approach to this preliminary GHG assessment follows The Greenhouse Gas Protocol's[30] core principles:

- **Relevance**: selecting an appropriate inventory boundary that reflects the GHG activities of Rosefield Solar Farm and serves the decision-making needs of users;
- **Completeness**: accounting for all emission sources within the chosen inventory boundary, with any specific exclusions disclosed and justified;
- **Consistency**: aiming to collect meaningful and consistent data over time whilst transparently documenting any significant changes to data quality and/or format;
- **Transparency**: addressing all relevant issues in a coherent and clear manner; and
- **Accuracy**: minimising uncertainty and avoiding systematic over- or under-quantification of emissions, and ensuring any necessary

[30] The Greenhouse Gas Protocol (2004). A Corporate Accounting and Reporting Standard. Available online: https://ghgprotocol.org/corporate-standard

estimates or assumptions required are conservative and guided by industry standards.

8.9.6. In line with The Greenhouse Gas Protocol[31] and IEMA's (2022) 'Assessing Greenhouse Gas Emissions and Evaluating their Significance'[32], a materiality threshold of 1% may be set whereby emissions that are expected to contribute to less than 1% of the overall project emissions total may be excluded from the assessment.

Construction phase

8.9.7. The quantity of materials for Rosefield Solar Farm is based upon the information in **Chapter 3: Description of Rosefield Solar Farm**, alongside more specific product information (based on the design specification) and publicly available data (e.g., typical material composition of products), where required. This information has been used to estimate embodied emissions associated with material use.

8.9.8. Emissions from materials have been quantified by utilising One Click LCA (a life cycle assessment tool for calculating building and infrastructure whole life carbon emissions), scientific research papers, Environmental Product Declarations, Inventory of Carbon and Energy (University of Bath, 2019)[33] and Department for Energy Security and Net Zero's (2023)[34] conversion factors to use the most accurate densities and emission factors as possible.

8.9.9. Conversions between mass, volume and area have been calculated where appropriate to allow the application of specific emissions factors. Details of emission factors used have been included in **Appendix 8.1** in **Volume 3**. In addition, some material types, build ups, weights and dimensions have been based on publicly available information, where required (see **Appendix 8.1** in **Volume 3**).

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[31] The Greenhouse Gas Protocol (2004). A Corporate Accounting and Reporting Standard. Available online: https://ghgprotocol.org/corporate-standard
[32] Institute of Environmental Management and Assessment (2022) Assessing Greenhouse Gas Emissions and Evaluating their Significance. Available online: https://www.iema.net/preview-document/assessing-greenhouse-gas-emissions-and-evaluating-their-significance
[33] University of Bath (2019). Inventory of Carbon and Energy. Available online: https://greenbuildingencyclopaedia.uk/wp-content/uploads/2014/07/Full-BSRIA-ICE-guide.pdf
[34] Department for Energy Security and Net Zero (2023). Conversion factors. Available online: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023

8.9.10. To estimate construction fuel use, the following assumptions have been used, which are based upon previous project experience and data from similar developments:

- Plant and machinery would use 5,000 litres per week; and
- Generators would use 500 litres per week.

8.9.11. It should be noted that the above (**paragraph 8.9.10**) is based on the assumption that generators would run for six hours a day, 26 days a month over the 30-month construction period. This assumes peak construction over the 30-month construction period and is therefore considered to be a worst case for the purposes of this assessment

8.9.12. To calculate emissions from the transportation of materials associated with the various elements of Rosefield Solar Farm, the expected continent of manufacture has been used to estimate delivery distances using guidelines published by RICS (2023)[35]. Where the source location was unknown, the location of manufacture has been estimated based on information provided by the Applicant and publicly available information. The quantification of transport emissions uses the tonne kilometre unit, equivalent to the transport of one tonne over one kilometre. The assessed components and source location are outlined below:

- Solar PV modules, frames, BESS, switchgear, transformers and inverters would be sourced from East Asia; and
- Foundations would be sourced from Europe.

8.9.13. Material wastage rates have been assumed based on RICS (2023), publicly available research[36] and previously consented projects.

8.9.14. Construction workers would be UK-based and assumed to have a one-way commuting distance of 50 km (100 km round trip) over the 30-month construction programme. This is based on experience of previously consented projects. The following assumptions have been applied (in line with the assumption outlined in the Transport Assessment **Appendix 14.1** in **Volume 3**):

- 70% of staff will arrive by minibus;
- 20% will arrive by van (car sharing for up to three staff); and

[35] Royal Institution of Chartered Surveyors (2023). Whole Life Carbon Assessment for the Built Environment. Available online: https://www.rics.org/content/dam/ricsglobal/documents/standards/whole_life_carbon_assessment_for_the_built_environment_1st_edition_rics.pdf
[36] Solar Builder 2022. Available online: https://solarbuildermag.com/featured/how-to-solve-the-challenge-of-utility-solar-construction-waste-right-now/

- 10% will arrive by car.

8.9.15. It is understood that during the peak construction phase, there would be 600 workers on-site per day.

8.9.16. It has also been assumed that construction workers would consume 45 litres of water per day, per person, during construction[37].

Operational (including maintenance) phase

8.9.17. Based on the grid connection offer for Rosefield Solar Farm, it is assumed for this preliminary assessment (and may be subject to change for the ES) that Rosefield Solar Farm will have an installed capacity of 340 MW, and generation of 335,000 MW per hour (MWh) in the first year. A degradation factor of 0.4% has been applied each year to account for year-on-year reduction in yield.

8.9.18. To estimate emissions associated with the maintenance and replacement of Rosefield Solar Farm, the service life of the various assets has been tabulated below in **Table 8.7**. It should be noted that the service life of Rosefield Solar Farm is expected to be 40 years, at which point Rosefield Solar Farm would be decommissioned. Therefore, assets with a service life of 40 years or more would not require any replacement.

Table 8.7 – Service life of Rosefield Solar Farm components

Item	Service life (years)
Solar PV modules	40
Solar PV modules frames and foundations	40
BESS	20
BESS containers and Inverter containers	40
Inverters	10
Transformers	30
Switchgear	30
Rosefield Substation and security cabin	40

8.9.19. The emissions associated with the construction of Rosefield Substation has been modelled using One Click LCA software, and a 40-year service

[37] Building Services and Information Association, 2011

life has been applied. However, replacement and maintenance of individual parts/elements of Rosefield Substation would likely be required and is accounted for within the model. Therefore, there are some replacement emissions associated with these assets despite a 40-year service life being applied.

8.9.20. The above service lives take into account product, transport and decommissioning emissions associated with the replacement and maintenance of the assets.

8.9.21. The following assumptions have also been applied to estimate emissions from operational worker transport (distances based on experience of previously consented projects):

- 24 daily on-site workers, with a one-way commuting distance of 25 km, travelling via petrol ca34r; and
- One annual visit for general maintenance requirements, with a one-way commuting distance of 25 km, travelling via diesel van.

8.9.22. Emissions associated with water consumption and treatment for Solar PV module cleaning have also been estimated. Based on publicly available information[38], it has been assumed that 76 litres of water would be required per MWh of anticipated annual generation. The initial year's expected generation (assumed to be 335,000 MWh and may be subject to change for the ES) has been applied and the water use projected onto subsequent years.

8.9.23. Finally, emissions associated with repair are assumed to equal 25% of emissions associated with maintenance, as per RICS (2023)[39] guidance.

Decommissioning phase

8.9.24. It has been assumed that the majority of all materials would be recycled at end of life, with a very small proportion sent to landfill. This has largely been based on publicly available data, namely from disposal scenarios available in Environmental Product Declarations used. All emission factors and Environmental Product Declarations used can be found in **Appendix 8.1** in **Volume 3**.

8.9.25. For decommissioning fuel use (fuel required by plant to deconstruct Rosefield Solar Farm), it has been estimated that the fuel required would

[38] SEIA. Available online: https://www.seia.org/initiatives/water-use-management
[39] Royal Institution of Chartered Surveyors (2023). Whole Life Carbon Assessment for the Built Environment. Available online: https://www.rics.org/content/dam/ricsglobal/documents/standards/whole_life_carbon_assessment_for_the_built_environment_1st_edition_rics.pdf

be 50% of the fuel used during the construction stage, as per RICS (2023)[40] guidance.

8.9.26. An off-site disposal distance of 100 km has been applied to estimate emissions from transportation of waste materials from the Site to waste processing facilities at end of life. This is a conservative distance based on access to specialist construction recycling facilities.

Assessment criteria and assessment of significance

8.9.27. Impact assessments normally assess to what degree a development would affect the baseline environment of the Study area. In the case of GHG emissions, any emissions would have a long-term, irreversible negative effect on the global climate, which is considered to be highly receptive to any emissions of GHGs. A specific source of GHG emissions cannot be linked to impacts at a specific location, but would have impacts globally.

8.9.28. This preliminary GHG assessment therefore evaluates the significance of emissions based upon guidance from IEMA's (2022) 'Assessing Greenhouse Gas Emissions and Evaluating their Significance'[41], which provides a framework of determining significance against the goals of the 2015 Paris Agreement[42] (i.e., against a science-based 1.5°C trajectory) (see **Table 8.8**).

8.9.29. The IEMA guidance acknowledges that some projects may replace existing development or baseline activity with a higher GHG profile and thus the significance of a project's emissions should be based on its net impact over its lifetime, which may be positive, negative or negligible. It states that significance should not be determined purely on the magnitude of GHG emissions, but whether a project contributes to reducing GHG emissions consistent with a trajectory towards net zero by 2050.

8.9.30. If GHG emissions cannot be avoided, a goal of the IEMA (2022) process is to identify mitigation options to reduce the project's residual emissions at all stages. If GHG emissions remain significant but cannot be further

[40] Royal Institution of Chartered Surveyors (2023). Whole Life Carbon Assessment for the Built Environment. Available online: https://www.rics.org/content/dam/ricsglobal/documents/standards/whole_life_carbon_assessment_for_the_built_environment_1st_edition_rics.pdf
[41] Institute of Environmental Management and Assessment (2022). Assessing Greenhouse Gas Emissions and Evaluating their Significance. Available online: https://www.iema.net/preview-document/assessing-greenhouse-gas-emissions-and-evaluating-their-significance
[42] Paris Agreement 2015. Available online: https://unfccc.int/process-and-meetings/the-paris-agreement

reduced, approaches to compensate the project's remaining emissions should be considered.

Table 8.8 – Framework for assessment of significant GHG effects

Significance	Level	Criteria
Significant	Major adverse	Project adopts a business-as-usual approach, not compatible with the national net zero trajectory, or aligned with the goals of the 2015 Paris Agreement (i.e., a science-based 1.5°C trajectory). GHG impacts are not mitigated or reduced in line with local or national policy for projects of this type.
	Moderate adverse	Project's GHG impacts are partially mitigated, and may partially meet up-to-date policy; however, emissions are still not compatible with the national net zero trajectory, or aligned with the goals of the 2015 Paris Agreement.
Not significant	Minor adverse	Project may have residual emissions, but the project is compatible with the goals of the 2015 Paris Agreement, complying with up-to-date policy and good practice.
	Negligible	Project has minimal residual emissions and goes substantially beyond the goals of the 2015 Paris Agreement, complying with up-to-date policy and best practice.
Significant	Beneficial	Project causes GHG emissions to be avoided or removed from the atmosphere, substantially exceeding the goals of the 2015 Paris Agreement with a positive climate impact.

Climate resilience

8.9.31. This preliminary assessment adopts a standard risk assessment-based methodology to identify potentially significant climate change impacts to Rosefield Solar Farm. Significance has been determined based upon the guidance set out in IEMA's (2020) 'Guide to Climate Change Resilience and Adaptation'[43].

[43] Institute of Environmental Management and Assessment (2020). Climate Change Resilience and Adaptation. Available online: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020

8.9.32. Based on feedback from the Planning Inspectorate received in the Rosefield Solar Farm Scoping Opinion (December 2023), the receptors that are assessed in this preliminary assessment are:

- BESS;
- Inverters;
- Transformers; and
- Rosefield Substation.

8.9.33. The climate change risk assessment considers the likelihood of the climate hazard occurring and the magnitude of the effect.

8.9.34. The likelihood of the hazard is premised upon both the probability and frequency of the projected occurrence. The criteria for likelihood are set out in **Table 8.9**.

Table 8.9 – Definition of likelihood

Likelihood	Description
Very likely	The event occurs multiple times during the lifetime of the Rosefield Solar Farm (40 years) e.g., approximately annually.
Likely	The event occurs several times during the lifetime of the Rosefield Solar Farm (40 years), e.g., approximately once every five years.
Possible	The event occurs limited times during the lifetime of the Rosefield Solar Farm (40 years), e.g., approximately once every 15 years.
Unlikely	The event occurs infrequently during the lifetime of the Rosefield Solar Farm (40 years), e.g., once every 30 years.
Very unlikely	The event may occur once during the lifetime of the Rosefield Solar Farm (40 years).

8.9.35. Magnitude is the degree of change from the relevant baseline conditions caused by climate change. The magnitude of impact takes account of the timing, scale, size, and duration of the potential impact. The criteria for impact magnitude are set out in **Table 8.10**.

Table 8.10 – Definition of impact magnitude

Impact magnitude	Summary
Very large	Substantial change, affecting the majority of the Site and for a prolonged period of time (more than one month) including irreversible changes.
Large	Noticeable change, affecting much of the Site and for a relatively long period of time (more than one week but less than one month).
Moderate	Noticeable change, affecting a few areas of the Site and for a moderate amount of time (more than three days but less than one week).
Minor	Noticeable change, affecting very few of the areas of the Site and for a small amount of time (no more than three days).
Negligible	Negligible and/or unnoticeable change or no change lasting one day or less.

8.9.36. The assessment of likely significant effects employs professional judgement to cross-examine the impact magnitude and likelihood scores using the criteria for significance of effects, as shown in **Table 8.11**. These effects can be either beneficial or adverse.

Table 8.11 – Significance assessment matrix for climate

Likelihood	Impact magnitude				
	Negligible	Minor	Moderate	Large	Very Large
Very unlikely	Negligible	Negligible or minor	Negligible or minor	Minor	Minor or moderate
Unlikely	Negligible or minor	Negligible or minor	Minor	Minor or moderate	Moderate or major
Possible	Negligible or minor	Minor	Moderate	Moderate or major	Major
Likely	Minor	Minor or moderate	Moderate or major	Major	Major
Very likely	Minor or moderate	Moderate or major	Major	Major	Major

8.9.37. Only 'major' effects are deemed 'significant' and would require additional mitigation to be applied. Where the significance matrix indicates a range for the effect significance (e.g. 'moderate or major'), professional judgement can be applied to select one option (which would be justified by evidence, as appropriate) or an effect significance range can be applied. If a significance of effect is assigned as 'moderate or major', this would be considered significant unless further information could be provided to downgrade the significance effect to 'moderate'.

8.10. Assessment of likely effects (without additional mitigation)

GHG emissions

8.10.1. GHG emissions associated with Rosefield Solar Farm have been reported using the modular structure as outlined in RICS's (2023) guidance[44]. For the purposes of clarity when interpreting results, the reporting modules are defined as follows:

- A1-3 Product Stage – this category includes the embodied emissions of materials used to construct Rosefield Solar Farm. It includes the emissions associated with raw material extraction, transport to the manufacturing site and manufacturing emissions;
- A4 Transport – this comprises the emissions associated with the transport of materials from the manufacturing site to the construction site;
- A5 Construction and Installation – this source includes 4 sub-categories which include emissions from pre-construction demolition (if applicable), construction activities (such as equipment fuel use), material wastage and construction worker transport;
- B1 In-use emissions – emissions associated with refrigerant gas leaks (if applicable) and emission release from products or reabsorption into products (such as sequestration from timber);
- B2-5 Maintenance, Repair, Replacement and Refurbishment – this includes emissions associated with routine maintenance (B2), repair (B3), replacement of materials (B4) and any planned refurbishment (B5);
- B6 Operational Energy – energy used during the operation of the asset;
- B7 Operational Water – water used during the operation of the asset;

[44] Royal Institution of Chartered Surveyors (2023). Whole Life Carbon Assessment for the Built Environment. Available online: https://www.rics.org/content/dam/ricsglobal/documents/standards/whole_life_carbon_assessment_for_the_built_environment_1st_edition_rics.pdf

- B8 User activities not covered in B1-7 – emissions may include transport of persons to and from the asset during operation, for example; and
- C1-4 End of Life – this category includes deconstruction and demolition emissions (C1), transport of waste materials from the Site to disposal sites (C2), waste processing for recycling (C3) and disposal emissions from landfill (C4).

Construction phase GHG emissions sources

8.10.2. The preliminary GHG assessment of construction emissions has calculated the life cycle emissions for the building materials and systems, accounting for their embodied emissions, construction, maintenance, repair and replacement emissions.

8.10.3. **Table 8.12** provides an indication of the key emissions sources that are anticipated during the construction phase of Rosefield Solar Farm. The construction GHG emissions are 816,763 tCO_2e, with 92% comprising those from the product stages (modules A1 –A3) and 8% from construction processes (modules A4 – A5).

Table 8.12 – Anticipated key emissions sources during the before-use stage

Description	Emissions (tCO_2e)	Proportion of total emissions
Product Stage (A1 – A3)	748,626	92%
Transport (A4)	17,375	2%
Construction and Installation (A5)	50,762	6%
Total	816,763	100%

8.10.4. The largest emission sources from the A1 – A3 product stage is from the BESS (47%) and the Solar PV modules (43%). A breakdown of the embodied emissions sources for the different components is provided below in **Table 8.13**.

Table 8.13 – Embodied emissions from the manufacture of materials and components

Component	A1-3 embodied emissions (tCO_2e)	Proportion of total A1-3 embodied emissions
BESS	350,000	47%
BESS containers	10,946	1%
Solar PV modules	323,115	43%
Inverters	2,965	<1%
PV framework	10,512	1%

Component	A1-3 embodied emissions (tCO_2e)	Proportion of total A1-3 embodied emissions
PV foundations	34,575	5%
Rosefield Substation	324	<1%
Transformers	15,268	2%
Inverter Transformer Stations	845	<1%
Switchgear	77	1%
Total	748,626	100%

Operational (including maintenance) phase GHG emissions sources

8.10.5. Total operational (including maintenance) GHG emissions equal 562,197 tCO_2e, the majority of which (62%) come from the replacement of the BESS over the lifetime of Rosefield Solar Farm (see **Table 8.14**).

8.10.6. It should be noted that B1 (in use emissions), B5 (planned refurbishment) and B6 (operational energy) emissions are not included in the assessment given that these sources are deemed immaterial or not relevant to the assessment.

Table 8.14 – Use stage emissions from maintenance, repair and replacement of the components and worker transportation

Component	B2-4 maintenance, repair and replacement and B7-8 water and user activities emissions (tCO_2e)	Proportion of total B2-4 maintenance, repair and replacement and B7-8 water and user activities emissions
Battery storage (BESS)	520,191	93%
BESS containers	12,869	2%
Solar PV modules	0	0%
Inverters	9,496	2%
PV framework	0	0%
PV foundations	0	0%
Rosefield Substation and security cabins	3	<1%
Transformers	16,302	3%
Inverter	0	0%

Component	B2-4 maintenance, repair and replacement and B7-8 water and user activities emissions (tCO_2e)	Proportion of total B2-4 maintenance, repair and replacement and B7-8 water and user activities emissions
Transformer Stations		
Switchgear	88	<1%
PV cleaning	383	<1%
Worker transport	2,864	1%
Total	562,197	100%

8.10.7. The carbon sequestration potential of the land is likely to increase based on the proposed planting as part of Rosefield Solar Farm. In the absence of detailed landscaping plans, the carbon sequestration potential has not been quantified for this preliminary assessment. However, it is anticipated that the carbon sequestration potential will increase given that 20% of the Site is set aside for new planting. Further detail on the preliminary landscape and ecological enhancements are detailed in **Volume 2, Figure 3.4.** It is anticipated that this emission source will be included in the climate assessment presented in the ES.

Decommissioning phase GHG emissions sources

8.10.8. GHG emissions from the decommissioning phase of Rosefield Solar Farm have been identified, aligned with standard practice for Life Cycle Assessments (**Table 8.15**). This phase includes emissions from decommissioning fuel use, transport of materials to disposal sites and emissions associated with recycling and landfill. These emissions are subject to a high level of uncertainty, as the decommissioning conditions cannot be predicted with any confidence 40 years into the future.

Table 8.15 – Anticipated key emissions sources during the end of life stage

Description	Total emissions (tCO_2e)	Proportion of total emissions
End of Life (C1 – C4)	171,718	100%

Summary lifecycle GHG emissions

8.10.9. The predicted lifecycle GHG emissions of Rosefield Solar Farm are displayed in **Table 8.16**. Product emissions are the largest emissions source (48%), followed by operational emissions (36%).

Table 8.16 – Lifecycle emissions from Rosefield Solar Farm during construction, operation (including maintenance) and end of life

Description	Total emissions (tCO_2e)	Proportion of total emissions
Product Stage (A1 – A3)	748,626	48%
Construction Progress Stage (A4 – A5)	68,137	4%
Operation (including maintenance) (B2-4 and B7-8)	562,197	36%
End of Life (C1 – C4)	171,718	11%
Total GHG emissions (not including any GHG savings from operation)	1,550,678	100%

GHG savings

8.10.10. GHG savings as part of the operation (including maintenance) of Rosefield Solar Farm and the displacement of fossil-fuel derived electricity within the national electricity network are expected to be considerable and have been quantified below.

8.10.11. Rosefield Solar Farm is assumed to have an installed capacity of 340 MW, and generation of 335,000 MWh in the first year of operation, however, noting that this figure may be subject to change for the ES. Taking into account an annual degradation factor of 0.4%, the total energy generation from the proposed 40-year operational life is approximately 12,405,853 MWh.

8.10.12. Dividing the lifetime emissions of Rosefield Solar Farm (1,550,678tCO_2e) by the lifetime energy generation (12,405,853 MWh) gives a total lifecycle carbon intensity value of 125.0 gCO_2e/kWh.

8.10.13. This cannot be directly compared with the UK grid carbon intensity, or projected future intensities, as published by the Department for Energy Security and Net Zero and the Department for Business, Energy and Industrial Strategy (2024)[45], as those intensities comprise operational emissions only and predominantly come from the combustion of fossil fuels used in the generation of that electricity.

8.10.14. Rosefield Solar Farm will provide electricity to the National Grid that would otherwise be generated by processes with higher carbon intensities, and

[45] Department for Energy Security and Net Zero (2024) Conversion factors. Available online: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024

the benefit of Rosefield Solar Farm, with regards to climate, is to replace the electricity generation from fossil fuels. To assess the GHG savings of Rosefield Solar Farm, operational emissions from a Combined Cycle Gas Turbine (CCGT) have been used as a comparison, as it is currently the most carbon-efficient fossil-fuelled technology available. The carbon intensity of a CCGT is 354 gCO_2e/kWh, and so Rosefield Solar Farm would emit 229 g fewer CO_2e per kWh than if the same electricity were generated by a gas fired CCGT, representing a reduction of 65%.

8.10.15. Over the proposed 40-year lifetime of Rosefield Solar Farm, this equates to GHG savings of over 2.8 million tonnes CO_2e, when compared to CCGT-generated electricity. It should be noted that, like the UK grid carbon intensities published by the UK Government, this comparison does not account for the embodied carbon in the CCGT and is therefore a conservative estimate.

Climate change resilience

8.10.16. Based on feedback from the Planning Inspectorate received in the Rosefield Solar Farm Scoping Opinion (December 2023), the receptors considered in this preliminary assessment are:

- Battery Energy Storage System (BESS);
- Inverters;
- Transformers; and
- Rosefield Substation.

Construction phase

8.10.17. Based upon the historic data and future projections presented by the UK Met Office (**Section 8.6**), the following climate hazards have been identified as requiring further assessment for the construction phase (2028 – 2031):

- Increased temperatures (acute);
- River flooding (acute); and
- Wildfire (acute).

Temperature

8.10.18. The performance of a battery system significantly depends on the operating temperature and the performance of the battery management system. The optimum operating temperatures of a BESS are between

20°C and 35°C; however, this can fluctuate depending on the specific type of battery used (Sarjiya *et al.*, 2022)[46].

8.10.19. Temperatures greater than 35°C have been shown to reduce capacity during the first 50 cycles, and temperatures over 55°C impact the maximum capacity of the BESS (Sarjiya *et al.*, 2022).

8.10.20. The performance of inverters and substations are impacted by environmental factors such as solar irradiance and ambient temperature. However, the degree of impact is hugely dependent on the temperature extremes.

8.10.21. Given the current climatic conditions (described in **Section 8.6**), the likelihood of temperatures above 35 °C in the short-term (2028 – 2031) is deemed 'Unlikely'.

Flood

8.10.22. Based upon the UK Government's tool for long-term flood risk, the Site is predominately located within Flood Zone 1, with a small section on the eastern boundary of fields within Parcel 3, adjacent to the Claydon Brook, that form part of Flood Zones 2 and 3.

8.10.23. The likelihood of river flood has therefore been assessed as 'Unlikely', following the definitions listed in **Table 8.9**. The UK Government tool does not highlight any likelihood of coastal flood, which has been deemed here as 'Very Unlikely'.

Wildfire

8.10.24. In the UK, wildfires are typically limited by fuel moisture and availability, i.e., the amount of dry vegetation or soil (peat) susceptible to burn, and therefore driven by droughts and lack of rainfall rather than temperature. Given the current climatic conditions (described in **Section 8.6**), the likelihood of wildfire in the short-term (2028 – 2031) is deemed 'Unlikely'.

Operational (including maintenance) phase

8.10.25. Based upon the historic data and future projections presented by the UK Met Office in **Section 8.6**, the following climate hazards have been identified as requiring further assessment for the operational (including maintenance) phase (2031 – 2071) of Rosefield Solar Farm:

[46] Apribowo, C.H.B., Sarjiya, S., Hadi, S.P. and Wijaya, F.D. (2022). Optimal planning of battery energy storage systems by considering battery degradation due to ambient temperature: a review, challenges, and new perspective. *Batteries*, *8*(12), p.290.

- Increased temperatures (acute);
- River flooding (acute); and
- Wildfire (acute).

Temperature

8.10.26. The impacts of increased temperatures on the sensitive receptors are listed in **paragraphs 8.10.17** to **8.10.20** Due to the impacts of climate change, (described in **Section 8.6**) the likelihood of temperatures above 35°C in the medium to long-term (2031 – 2071) is deemed 'Possible'.

Flooding

8.10.27. Due to increased likelihood of extreme precipitation events as a result of climate change, river floods are likely to affect the Site on a more regular basis during the operational (including maintenance) phase (2031 – 2071). Therefore, the likelihood has been deemed as 'Possible'. Coastal floods are still deemed to be 'Very Unlikely' during the operational (including maintenance) phase.

Wildfire

8.10.28. Due to the increased likelihood of drought, decreased summer precipitation and increased temperatures as a result of climate change, wildfires are likely to become more possible on the Site. As such, the likelihood of wildfire has been deemed as 'Possible' for the operational (including maintenance) phase, however these wildfires are likely to be small and localised in nature.

Decommissioning phase

8.10.29. Due to the inherent uncertainty surrounding climate conditions in the far future (40 years), it is impractical to accurately attempt to assess the climate hazards and their impacts during the decommissioning process.

8.11. Additional mitigation

GHG emissions

Construction phase

8.11.1. A large majority of GHG emissions associated with Rosefield Solar Farm would comprise embodied emissions from infrastructure, primarily the BESS and Solar PV modules. The most effective mitigation would therefore be in the responsible sourcing of materials and infrastructure.

8.11.2. An Outline Construction Environmental Management Plan will be submitted in support of the DCO application. This, and the Outline

Construction Traffic Management Plan (also to be submitted in support of the DCO application, a 'draft' of which is presented in **Appendix 14.1** in **Volume 3**), will include measures to decrease GHG emissions from the construction process phase. These will include:

- Implement measures to decrease fuel use by maximising energy efficiencies, for example to ensure all vehicles switch off engines when stationary and ensure construction vehicles are well maintained and conform to current emissions standards;
- Promoting the use of sustainable fuels in construction vehicles, and where possible making use of electric vehicles to reduce fuel consumption;
- Liaising with construction staff to minimise GHG emissions associated with commute to Site, including provision of staff minibuses, and promoting of lower carbon modes of travel such as car sharing options and use of public transport;
- Use of locally sourced and/or produced materials. The use of recycled aggregates, where appropriate, for foundations, subbases, hard-standings and pavement materials; and
- Actions to meet the waste hierarchy in accordance with the principles of the Government's Resources and Waste Strategy 2018[47], promoting the recycling of materials by segregating construction waste to be re-used and recycled where practical.

Operational (including maintenance) phase

8.11.3. As the likely effects for climate during the operational (including maintenance) phase are expected to be beneficial, there are limited mitigation measures proposed. However, it is anticipated that use of electric vehicles for operational worker and maintenance visits will be encouraged.

Decommissioning phase

8.11.4. An Outline Decommissioning Environmental Management Plan will be submitted in support of the DCO application. Due to the potential advancements in technology and best practice between the present and the time in which decommissioning of Rosefield Solar Farm would take place, agreement would be sought with the relevant planning authority at the time of decommissioning.

[47] Department for Environment, Food and Rural Affairs 2018. Resources and waste strategy for England. Available from: Resources and waste strategy for England - GOV.UK (www.gov.uk)

Climate change resilience

Construction phase

8.11.5. Supply chain risks should be considered to determine resilience to climate-related events that may disrupt the procurement of time-sensitive materials.

Operational (including maintenance) phase

8.11.6. Climate hazards and measures to mitigate and adapt to these during the operational (including maintenance) phase of Rosefield Solar Farm have been identified below:

- The condition and integrity of assets would be regularly assessed, and maintenance undertaken as early as required, giving consideration to materials with enhanced tolerance to fluctuating temperatures and exposure to rainfall; and
- An Outline Operational Environmental Management Plan will be submitted in support of the DCO application. This will include measures to decrease GHG emissions from the operational (including maintenance) phase.

Decommissioning phase

8.11.7. The decommissioning phase of Rosefield Solar Farm is expected to take place after 40 years of operation. Therefore, consideration must be given to advancements that may be made in this time, which could supersede any measures recommended here.

8.11.8. An Outline Decommissioning Environmental Management Plan will be submitted in support of the DCO application. The Outline Decommissioning Environmental Management Plan will include measures to mitigate and adapt to climate change risks during the decommissioning phase of Rosefield Solar Farm, such as:

- Weather forecasts would be monitored on a daily basis. Forecasts should be used to inform the sequencing of activities and the use of appropriate PPE;
- Welfare facilities including breaks, shade, and hydration facilities, as well as first aid amenities would be provided; and
- Provision of an Incident Response Plan, which identifies flooding as a key site risk and identifies the correct policies and procedures to follow.

8.11.9. The decommissioning phase of Rosefield Solar Farm would present similar risks to those experienced during the construction phase, and any measures recommended would be assessed for their applicability in this phase.

8.12. Assessment of residual effects (with additional mitigation)

GHG emissions

8.12.1. Renewable energy developments such as Rosefield Solar Farm have a major role to play in the transition to a low carbon economy, and the decarbonisation of the UK national electricity network. Without projects such as Rosefield Solar Farm, the GHG intensity of the UK's electricity generation would not decrease as projected and would severely compromise the UK's ability to meet its carbon reduction targets.

8.12.2. Emissions from the construction, operation (including maintenance) and decommissioning of Rosefield Solar Farm total 1.6 million tCO_2e (**Table 8.16**), whilst operational savings are over 3.8 million tCO_2e. The net GHG savings, compared against equivalent gas-fired electricity generation, are therefore 2.2 million tonnes of CO_2e.

8.12.3. Rosefield Solar Farm is therefore considered likely to have a **positive significant** effect on the climate over its life-cycle.

Climate resilience

8.12.4. The vast majority of climate hazards were found to pose a **negligible or minor adverse** significance of effect to the receptors identified, prior to any additional mitigation, during the construction and operational (including maintenance) phases. The only climate hazard that poses a **moderate adverse** significance of effect occurs during the operational (including maintenance) phase, and relates to river flooding (due to the small area of the Site which falls into Flood Zone 3).

Construction phase

8.12.5. **Table 8.17** presents the likely significance of the identified climate hazards on the four highlighted receptors for the construction phase of Rosefield Solar Farm.

8.12.6. No hazards were identified as likely to have a significant effect on Rosefield Solar Farm during the construction phase.

Table 8.17 – Summary of likely climate change effects on the construction of Rosefield Solar Farm

Receptor	Hazard	Likelihood	Impact Magnitude	Significance of effect
BESS	Increased temperatures (>35°C)	Unlikely	Minor	Negligible adverse
	River Flooding	Unlikely	Moderate	Minor adverse

Receptor	Hazard	Likelihood	Impact Magnitude	Significance of effect
	Coastal Flooding	Very Unlikely	Moderate	Negligible adverse
	Wildfire	Unlikely	Moderate	Minor adverse
Inverters	Increased temperatures (>35°C)	Unlikely	Minor	Negligible adverse
	River Flooding	Unlikely	Moderate	Minor adverse
	Coastal Flooding	Very Unlikely	Moderate	Negligible adverse
	Wildfire	Unlikely	Moderate	Minor adverse
Transformers	Increased temperatures (>35°C)	Unlikely	Minor	Negligible adverse
	River Flooding	Unlikely	Moderate	Minor adverse
	Coastal Flooding	Very Unlikely	Moderate	Negligible adverse
	Wildfire	Unlikely	Moderate	Minor adverse
Substations	Increased temperatures (>35°C)	Unlikely	Minor	Negligible adverse
	River Flooding	Unlikely	Moderate	Minor adverse
	Coastal Flooding	Very Unlikely	Moderate	Negligible adverse
	Wildfire	Unlikely	Moderate	Minor adverse

Operational (including maintenance) phase

8.12.7. **Table 8.18** displays the likely significance of the identified climate hazards on the four highlighted receptors for the operational (including maintenance) phase of Rosefield Solar Farm.

8.12.8. No hazards were identified as likely to have a significant effect on Rosefield Solar Farm during the operational (including maintenance) phase.

8.12.9. River flooding, while classed as having an effect of **moderate** significance, only relates to a small area of the Site which falls within Flood Zone 3. None of the receptors assessed are also located within this area, and therefore the effect is deemed **not significant**.

Table 8.18 – Summary of likely climate change effects on the operation (including maintenance) of Rosefield Solar Farm

Receptor	Hazard	Likelihood	Impact Magnitude	Significance of effect
BESS	Increased temperatures (>35°C)	Possible	Minor	Minor adverse
	River Flooding	Possible	Moderate	Moderate adverse
	Coastal Flooding	Very Unlikely	Moderate	Minor adverse
	Wildfire	Possible	Minor	Minor adverse
Inverters	Increased temperatures (>35°C)	Possible	Minor	Minor adverse
	River Flooding	Possible	Moderate	Moderate adverse
	Coastal Flooding	Very Unlikely	Moderate	Minor adverse
	Wildfire	Possible	Minor	Minor adverse
Transformers	Increased temperatures (>35°C)	Possible	Minor	Minor adverse
	River Flooding	Possible	Moderate	Moderate adverse
	Coastal Flooding	Very Unlikely	Moderate	Minor averse
	Wildfire	Possible	Minor	Minor adverse
Substations	Increased temperatures (>35°C)	Possible	Minor	Minor adverse
	River Flooding	Possible	Moderate	Moderate adverse
	Coastal Flooding	Very Unlikely	Moderate	Minor adverse
	Wildfire	Possible	Minor	Minor adverse

Decommissioning phase

8.12.10. Due to the inherent uncertainty surrounding climate conditions in the far future (40 years), it is impractical to accurately attempt to assess the

climate hazards and their impacts during the decommissioning process, though they are anticipated to be equivalent to those identified during the operational (including maintenance) phase.

8.13. Opportunities for enhancement

8.13.1. The nature of Rosefield Solar Farm offers an enhancement to the baseline environment in terms of GHG emissions.

8.14. Difficulties and uncertainties

8.14.1. The information provided in this PEIR is preliminary and is based on the information available at the time of writing. A full assessment of likely significant effects will be reported in the ES.

8.14.2. The accuracy of a GHG assessment depends on the quality of the data provided. The fact that this preliminary assessment represents a forecast from a future scenario means that all data is 'secondary' (extrapolated, estimated or benchmarked). Assessments such as this, based largely on secondary data, should be viewed as an estimate of GHG emissions impact, and actual emissions may vary.

8.14.3. To mitigate against this, a conservative approach has been adopted, whereby the most reasonable worst-case scenario has been assumed. For example, the infrastructure manufacturer for Rosefield Solar Farm has not yet been selected, and it has been assumed that the majority of the products will be sourced from East Asia, as this is a conservative estimation of both the embodied and transport emissions compared to modules being sourced from Europe.

8.14.4. As with all climate models, there are inherent limitations to the models used. In particular, the estimated ranges for future climate variability are conditional on a number of assumptions with expert judgement playing a role in the various methodological and data choices. The UKCP18 projections used here are considered the optimal projection models to use within the UK.

8.15. Further work required to inform the ES

8.15.1. This preliminary assessment has considered the main expected material sources of GHG emissions for Rosefield Solar Farm and likely effects associated with climate resilience. The full ES will be based upon more detailed project data once the design has been finalised.

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