Springwell Solar Farm

Preliminary Environmental Information Report

Volume 1
Chapter 7: Climate

Phase 2 consultation
Springwell Energyfarm Ltd

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7. Climate

7.1. Introduction

7.1.1. This chapter presents the preliminary environmental information and a preliminary assessment of the likely significant environmental effects arising from the construction, operation (including maintenance) and decommissioning of the Proposed Development upon climate.

7.1.2. The very nature of the Proposed Development 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 (amended 2019) which is aligned with the goals of the Paris Agreement.

7.1.3. This chapter is intended to be read as part of the wider Preliminary Environmental Information Report (PEIR), with particular reference to **Appendix 4.1 - 4.3 and Appendix 7.1** presented in **Volume 3**.

7.2. Consultation, scope and study area

Consultation undertaken to date

7.2.1. An Environmental Impact Assessment (EIA) Scoping Report, presented in **Appendix 4.1**, setting out the proposed climate assessment scope and methodology for the Proposed Development, was submitted to the Planning Inspectorate in March 2023. A Scoping Opinion, presented in **Appendix 4.2**, was issued by the Planning Inspectorate on behalf of the Secretary of State in May 2023. **Appendix 4.3** provides responses to comments relating to climate in the Scoping Opinion and details how these have been addressed in this preliminary assessment.

7.2.2. Aside from the EIA Scoping process, no specific consultation has been undertaken to inform this preliminary assessment. Engagement with Lincolnshire County Council and North Kesteven District Council will be undertaken to inform the ES.

Scope of the assessment

7.2.3. This section updates the scope of assessment and confirms, and where necessary updates, the evidence base for scoping out receptors/matters following further iterative assessment and consideration of the Scoping Opinion.

7.2.4. As documented in **Appendix 4.2** and **Appendix 4.3**, in relation to climate no major alterations have been made to the proposed scope as set out in the EIA Scoping Report, with climate resilience remaining scoped out for all phases of the Proposed Development,

and greenhouse gas (GHG) emissions remaining scoped in for all phases of the Proposed Development. The Scoping Opinion agreed that an assessment of the resilience to flooding could be scoped out of the climate assessment, and **Chapter 2: Description of the Proposed Development** explains how the Proposed Development has been designed to be resilient to high heat and increased wind speeds. **Table 7.1** and **Table 7.2** below set out the receptors and matters that have been scoped out of, or into, further assessment.

Receptors/matters scoped out of further assessment

7.2.5. **Table 7.1** presents the receptors/matters that are scoped out of further assessment, with appropriate justification. Where a change has occurred to the approach proposed within the EIA Scoping Report, this is clearly stated and justified

Table 7.1 Receptor/matters scoped out of further assessment

Receptor/ matter	Phase	Justification	Change to the approach proposed in the EIA Scoping Report
Climate resilience	Construction, operation and decommissioning	The UK Climate Projections published in 2018 (UKCP18)[1] projections suggest that climate change will lead to hotter drier summers, warmer wetter winters, increased likelihood of extreme weather events (e.g., heat waves, high rainfall events) and sea level rise of up to 1.15 m (by 2070 in London, assuming a high-emissions scenario). Due to the embedded resilience of solar panels to high heat and wind speeds, low risk of Site flooding and the Site's distance from the coast, these factors are not expected to significantly impact the construction, operation or	No change – this matter was proposed to be scoped out of further assessment within the EIA Scoping Report and the Scoping Opinion has agreed with this approach.

[1] The UK Climate Projections (UKCP) (2018). Met Office. Available online: UK Climate Projections (UKCP) - Met Office

Receptor/ matter	Phase	Justification	Change to the approach proposed in the EIA Scoping Report
		decommissioning of the Proposed Development.	

Receptors/matters scoped into further assessment

7.2.6. **Table 7.2** presents the receptors/matters that are scoped into further assessment, together with appropriate justification. Where a change has occurred to the approach proposed within the EIA Scoping Report, this is clearly stated and justified.

Table 7.2 Receptor/matters scoped into further assessment

Receptor/ matter	Phase	Justification	Change to the approach proposed in the EIA Scoping Report
GHG emissions	Construction	Embodied carbon of solar PV modules (e.g., the emissions from manufacture, processing and transport of materials) can be relatively high and construction-related emissions should be considered in relation to overall lifecycle emissions of the Proposed Development, to determine an accurate 'carbon-payback' time of the Proposed Development.	No change – this matter was proposed to be scoped into further assessment within the EIA Scoping Report and the Scoping Opinion has agreed with this approach.
	Operation	Given the proposed operational life of around 40 years, the cumulative effect of GHG reductions associated with the operation of the Proposed Development will likely provide significantly beneficial effects.	No change – this matter was proposed to be scoped into further assessment within the EIA Scoping Report and the Scoping Opinion

Receptor/ matter	Phase	Justification	Change to the approach proposed in the EIA Scoping Report
			has agreed with this approach.
	Decommissioning	The decommissioning process is likely to result in GHG emissions, particularly from disposal of solar PV modules and any ESS. It is important to include all emissions when considering the overall lifecycle emissions of the Proposed Development, to determine an accurate 'carbon payback' time for the Proposed Development.	Change - this matter was proposed to be scoped out of further assessment within the EIA Scoping Report but the Scoping Opinion has requested it be scoped in. Following further consideration, the Applicant agrees with this opinion.
In-combination climate change impacts	Operation	Requested to be included by the Scoping Opinion in consideration of solar panels "potential to alter precipitation runoff rates and patterns".	Change - this matter was not considered within the EIA Scoping Report, but the Scoping Opinion has requested it to be considered. Following further consideration, the Applicant agrees with this opinion.

Extent of the study area

7.2.7. 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 (amended 2019), which aligns with the goals of the Paris Agreement to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C.

7.2.8. The Proposed Development has the potential to affect the climate by the addition and avoidance of GHG emissions in comparison to the baseline and future baseline scenario.

7.2.9. The scope of the GHG assessment includes the addition of GHG emissions directly from construction, operational, and decommissioning activities undertaken within the footprint of the Proposed Development, including site fuel consumption (construction and decommissioning).

7.2.10. It will also extend to include emissions which will occur outside the proposed Site boundary, but related to the activities of the Proposed Development, including those from:

- the extraction, manufacture, and transportation of materials to the construction site (construction); and
- the transportation of workers to Site (construction).

7.2.11. This preliminary assessment will also consider the GHG savings from the Proposed Development as a result of displacing fossil-fuel based energy in the National Grid.

7.3. Legislative framework, planning policy and guidance

Relevant legislation and planning policy

7.3.1. The legislative and planning policy relevant to the assessment of climate change is summarised in **Table 7.3**.

Table 7.3 Legislative and planning policy relevant to climate change

Relevant legislation/planning policy	Summary
The 2015 Paris Agreement	The Paris Agreement is a legally binding international treaty which commits Parties to the United Nations Framework Convention on Climate Change to objectives to reduce GHG emissions, with the view to 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”. The Agreement is revisited five-yearly to allow Parties to the Convention to evaluate and enhance the level of ambition of their climate action plans, known as nationally determined contributions (NDCs).

Relevant legislation/planning policy	Summary
United Nations Framework Convention on Climate Change	The United Nations Framework Convention on Climate Change came into force on 21 March 1994 and sought to stabilise the atmospheric 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. Currently there are 197 parties signed up to the Convention. The Convention embodies a series of review mechanisms. The 21st session of the Conference of the Parties (COP21) which was held in Paris in December 2015 resulting in a legally binding global climate change target agreed by all 197 member parties with the aim of capping climate change well below 2°C of warming. The outcome of the 26th session in Glasgow in November 2021 (COP26) was a package of decisions, resolutions and statements that formalised how the commitments made at COP21 would be enacted. COP26 covered three key themes around climate change: adaptation; finance (including increasing support to developing companies) and mitigation, with the aim to limit the rise in global average temperature to 1.5°C above pre-industrial levels.
Kyoto Protocol	The Kyoto Protocol 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.
EU Renewable Energy Directives	The Renewable Energy Directive 2018/2001/EI came into force in December 2018. It created a new binding target for member states to achieve a renewable energy target of 32% by 2030. There is the potential for this to be revised upwards in 2023. The UK notified the EU of its intention to leave the union in March 2017. The European (Withdrawal) Act 2018 (as amended by the European (Withdrawal

<table>
<tr><th>Relevant legislation/planning policy</th><th>Summary</th></tr>
<tr><td></td><td>Agreement) Act 2020) requires that the EU laws, rules and greenhouse gas emissions targets which have been set in respect of climate change through European law, are transferred into UK domestic governance.</td></tr>
<tr><td>The UK Climate Change Act 2008 (amended 2019)</td><td>The Climate Change Act 2008 set a target of reducing GHG emissions by at least 80% by 2050, relative to the baseline year of 1990. The Act further established the Climate Change Committee (CCC) as an independent, statutory body to advise the UK and devolved governments on emission reduction targets and report to Parliament on progress. The CCC 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.

In 2019, the emission targets set out in the Climate Change Act 2008 were made more ambitious by the Climate Change Act 2008 (2050 Target Amendment) Order 2019, thereby making the UK the first major global economy to commit to a net zero target requiring a net reduction of emissions by 100% relative to 1990 levels by 2050. It therefore constitutes a legally binding commitment to end the UK’s contribution to climate change by 2050.</td></tr>
<tr><td>The Climate Change Committee (carbon budgets)</td><td>The CCC is an independent statutory body established under the Climate Change Act 2008 to advise the UK government and Devolved Administrations on reducing GHG emissions and preparing for climate change. The CCC undertakes an annual assessment of GHG emissions to determine whether the UK is on course to meet its target carbon budget. These budgets are presently set as follows:

<table><tr><th>Carbon budget</th><th>Carbon budget level ($MMtCO_2e$)</th><th>% reduction below base year</th></tr><tr><td>1st (2008 – 12)</td><td>3,018</td><td>23</td></tr></table></td></tr>
</table>

Relevant legislation/planning policy	Summary

2nd (2013 – 17)	2,782	29
3rd (2018 – 22)	2,544	35
4th (2023 – 27)	1,950	50
5th (2028 – 32)	1,725 (1,765 incl. international shipping)	57
6th (2033 – 37)	965 (incl. international aviation and shipping)	78

In its most recent budget report (released in December 2020), the CCC recommended that the UK set a Sixth Carbon Budget which requires a reduction of emissions of 78% by 2035, relative to 1990 levels (63% reduction from 2019). This represents a world-leading commitment which is consistent with the over-arching objectives of the Paris Agreement. In addition to this, the CCC further recommended that the UK set a similarly ambitious pledge to reduce GHG emissions by at least 68% by 2030, relative to 1990 levels, noting that this should form part of the UK's NDC ahead of COP26 (November 2021).

The CCC's 2023 Report to Parliament identifies that "the deployment of solar capacity is significantly off track to meet the Government's target of 70GW by 2035".

The Overarching National Policy Statement for Energy (NPS EN-1) (2011)	Details the planning policy for the energy sector. It states that *"…moving to a secure, low carbon energy system is challenging, but achievable*." It sets out the need and urgency for new energy infrastructure to be

Relevant legislation/planning policy	Summary
	consented and built as soon as possible. It stipulates the UK Climate Projection and emissions scenario requirements for a climate change risk assessment, should this be undertaken.
Draft Overarching National Policy Statement for Energy (NPS EN-1) (2023)	Section 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 in order to achieve Net Zero and ensure affordable energy security. It further recognises the importance of electricity storage to mitigate against the intermittency of renewable electricity generation. Section 5 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.
National Policy Statement for Renewable Energy Infrastructure (NPS EN-3) (2011)	Builds upon the National Policy Statement for Energy (EN-1). It does not include specific reference to solar energy.
Draft National Policy Statement for Renewable Energy Infrastructure (NPS EN-3) (2023)	Introduces a new section (Section 2.10) on solar photovoltaic generation, recognising that solar farms are one of the most established renewable electricity technologies in the UK and the cheapest form of electricity generation worldwide. It 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 70GW.
National Policy Statement for Electricity Networks Infrastructure (NPS EN-5) (2011)	References the consideration of whether a project makes a considerable contribution to the promotion renewable energy, the achievement of climate change objectives and the maintenance of energy security. It

Relevant legislation/planning policy	Summary
	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.
Draft National Policy Statement for Electricity Networks Infrastructure (NPS EN-5) (2023)	Does not introduce any new content with regards to climate or solar energy developments.
National Planning Policy Framework (NPPF) (September 2023)	The NPPF presents several requirements and considerations related to climate change. These provisions aim to guide local authorities and developers in addressing climate change issues within the planning process. The framework specific to climate change is broken down into three sections: • Planning for climate change; • Planning and flood risk, and; • Coastal change. The framework recognises the dual approach of mitigation (reducing greenhouse gas emissions) and adaptation (preparing for the impacts of climate change) as essential components of climate action. Local planning authorities are encouraged to develop local plans and policies that integrate climate change considerations. This includes setting out policies to reduce carbon emissions and adapt to future climate risks. In line with this, local authorities are expected to prioritise low-carbon developments and the development of renewable energy sources, such as wind, solar, and biomass; with the framework indicating that planning authorities should support their development, provided they are environmentally and socially sustainable.

Relevant legislation/planning policy	Summary
North Kesteven Climate Emergency Action Plan (2023)	North Kesteven's Climate Emergency Action Plan establishes the specific actions to be undertaken without the council and district towards reaching net zero and addressing the climate emergency. The plan identifies nine key areas in which action will be focussed: decision-making, communication and engagement, adaptation, buildings, transport, natural environment, energy, industry, and waste and water. The energy theme focuses on "reducing fossil fuel dependence and associated emissions by promoting renewable energy generation opportunities for both North Kesteven District Council and the District."

Applicable guidance

7.3.2. The following guidance documents have been used during the preparation of this preliminary assessment:

- Institute of Environmental Management and Assessment (IEMA) *Assessing Greenhouse Gas Emissions and Evaluating their Significance* (2022);
- British Standards Institution *PAS 2080 – Carbon management in Infrastructure* (2023)*;*
- The Greenhouse Gas Protocol *Corporate Accounting and Reporting Standard* (2004) ("GHG Protocol");
- Royal Institution of Chartered Surveyors (RICS) *Whole Life Carbon Assessment for the Built Environment* (2017); and
- Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government *Planning Practice Guidance on Climate Change* (2019).

7.4. Methodology

Data sources to inform baseline characterisation

7.4.1. Data required to undertake the lifecycle GHG assessment has been provided by the Applicant and processed using the methodology below. The data that has informed this preliminary assessment is provided in **Appendix 7.1**.

Surveys to inform baseline characterisation

7.4.2. No surveys or site visits have been undertaken to inform this preliminary assessment.

Design Assumptions

7.4.3. **Chapter 2: Description of the Proposed Development** details the preliminary design principles of the Proposed Development components as they are currently known. Preliminary parameter plans, which define the broad extents within which development can take place, are presented in the following figures within **Volume 2**:

- **Figure 2.3** – Zonal Masterplan;
- **Figure 2.4** – Indicative Height Parameters Plan;
- **Figure 2.5** – Indicative Green Infrastructure Parameters Plan; and
- **Figure 2.6** – Indicative Operational Access & Movement Parameters Plan.

7.4.4. **Chapter 4: Approach to EIA** sets out those elements of the Proposed Development for which optionality is present within the current design and sets out the scenario assessed for the purpose of this PEIR.

7.4.5. The design principles and parameters that have been applied in relation to climate are detailed below.

Construction

7.4.6. To estimate emissions from construction a 48-month construction period has been assumed.

7.4.7. The quantity of materials for the Proposed Development is based upon the information in **Chapter 2: Description of the Proposed Development**, alongside more specific product information provided by the Applicant 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.

7.4.8. 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), Environmental Product Declarations, Inventory of Carbon and Energy (ICE) (University of Bath, 2019) and Department for Energy Security and Net Zero's conversion factors (UK Government, 2023) to use the most accurate densities and emission factors as possible. An emission factor is a generic value indicative of emissions associated with a certain activity or product. Product-specific emissions factors have

not been applied at this stage due to the preliminary design stage of the Proposed Development.

7.4.9. Conversions between mass, volume and area have been calculated where appropriate to allow the application of specific emissions factors. In addition, some material types, build ups, weights and dimensions were based on publicly available information, where required.

7.4.10. To estimate construction fuel use, details of the anticipated construction plant has been provided by the project team. Average fuel efficiency data (litres per hour) was gathered using publicly available information for each piece of construction plant. It was estimated for the purposes of the PEIR that plant would be in operation 12 hours a day, 5 days a week, at 50% capacity. This would be for a duration of 48 months.

7.4.11. To calculate emissions from the transportation of materials associated with the various elements of the Proposed Development, the project team provided the expected country or continent of manufacture, which has been used to estimate delivery distances. It should be noted, however, that the infrastructure manufacturers utilised for the Proposed Development may be subject to change and the source assumptions used are conservative to represent a reasonable worst-case scenario. The Applicant is actively strengthening their existing procurement process to make every effort to prevent any negative impact on people and the environment. The assessed components and source location are outlined below:

- Solar panels would be sourced from China;
- Solar panel frames and foundations would be sourced from Europe – based on publicly available data it was assumed they would be manufactured in Italy;
- Inverter transformer stations and inverters would be sourced from Asia and Europe – based on publicly available data it was assumed 50% would be sourced from China, and 50% from Italy;
- Battery Energy Storage System (BESS) would be sourced from China;
- BESS containers and control containers would be sourced from the UK (100km delivery distance);
- Transformers would be sourced from Europe – based on publicly available data it was assumed they would be sourced from Portugal; and
- Construction plant would be sourced from UK (100km delivery distance).The quantification of transport emissions

uses the tonne kilometre unit, equivalent to the transport of one tonne over one kilometre.

7.4.12. Construction workers would be UK based and assumed to have an each-way commuting distance of 25km over 48 months. This distance is a conservative assumption based upon distance to major nearby towns (e.g., Lincoln). It has been assumed that all commuting would be undertaken in cars, comprising 60% petrol- and 40% diesel-fuelled based upon UK government vehicle licensing statistics.

Operation

7.4.13. It has been assumed that the Proposed Development will be in operation from 2030 and will have an installed capacity of 800MW, and generation of 952,320MWh in the first year. A degradation factor of 0.4% has been applied each year to account for year-on-year reduction in yield.

7.4.14. To estimate emissions associated with the maintenance and replacement of the various assets during the operational phase, the following assumptions have been applied:

- 175% of the inverters would be replaced over the operational lifetime of the Proposed Development; this is equivalent to all the inverters being replaced 1.75 times on average.
- Approximately 48% of the total emissions associated with the construction and operation of the Springwell substation would be allocated to maintenance and replacement. This is based on the LETI Climate Emergency Design Guide proportions for commercial buildings.
- 150% of the BESS would be replaced over the lifetime of the Proposed Development; this is equivalent to all the BESS being replaced 1.5 times on average.
- 5% of the transformers would be replaced over the lifetime of the Proposed Development.

7.4.15. The above proportions take into account product, transport and decommissioning emissions associated with the replacement and maintenance of the relevant assets as these are the key associated emission sources. No replacement has been assumed for the solar panels given that there will be 0.7% module spares delivered with the initial construction materials to cover the operational life of the solar farm. It has been assumed that no replacement would be required for the inverter transformer stations, BESS containers and solar PV frames. This assumption is based on data from similar solar farm projects.

7.4.16. In addition to the emissions associated with asset replacement and maintenance, the following assumptions have also been applied to estimate emissions from operational worker transport:

- Two technician visits per year, with a one-way commuting distance of 100km, all travelling via petrol cars.
- 8 regular on-site workers every day, with a one-way commuting distance of 25km, all travelling via battery electric vehicles.
- 5 additional visits for washing and grass cutting, 3 times a year, with a one-way commuting distance of 25km, all travelling via petrol cars.

Decommissioning

7.4.17. It has been assumed that all materials would be either re-used or recycled at the end of their operational life, with the exception of approximately 1% of transformer materials assumed to go to landfill at end of life. This has largely been based on publicly available data.

7.4.18. For decommissioning fuel use, it has been estimated that the fuel required would be 50% of the fuel used during the construction stage, as per *Whole Life Carbon Assessment for the Built Environment*, Royal Institution of Chartered Surveyors Professional Standard, 2nd edition, best practice guidance.

Embedded mitigation measures

7.4.19. This preliminary assessment has been based on the principle that measures have been 'embedded' into the design of the Proposed Development to remove potential 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 the Proposed Development are detailed within **Table 4.4** of **Chapter 4: EIA Methodology**. Those embedded mitigation measures relevant to this preliminary climate assessment comprise the following:

- The use of concrete will be minimised.
- All members of the supply chain will provide a carbon reduction plan.

7.4.20. Vegetation may need to be cleared to facilitate access and cable routes that form part of the Proposed Development. However, the carbon sequestration potential of the land is likely to increase based on the proposed planting of new hedgerows and trees.

Assessment methodology

7.4.21. This preliminary assessment establishes present and future baseline GHG emissions. Aligned with the GHG Protocol, it quantifies applicable Kyoto Protocol GHGs as measured in tonnes of carbon dioxide equivalence (tCO2e), 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 (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF6) and perfluorocarbons (PFCs). Nitrogen trifluoride (NF3), a chemical released in certain high-tech industries, was added in 2013. The global warming potential (GWP) of each is presented in **Table 7.4**.

Table 7.4 Kyoto Protocol GHGs and their global warming potential (GWP) based upon Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report (AR5)

Greenhouse gas/group	Chemical formula	GWP (CO_2e)
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265
Hydrofluorocarbons	HFCs	Depends on specific gas (~4 – 12,400)
Sulphur hexafluoride	SF_6	23,900
Perfluorocarbons	PFCs	Depends on specific gas (~6,630 – 11,100)
Nitrogen Trifluoride	NF_3	16,100

7.4.22. Data associated with the activities contributing to the construction of the Proposed Development have been provided by the project team. Where it has not been possible to obtain this data, 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. Emissions have then been quantified by applying the most relevant and up-to-date emission factors.

7.4.23. 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.

7.4.24. The approach to this preliminary GHG assessment follows the GHG Protocol's core principles:

- **Relevance**: selecting an appropriate inventory boundary that reflects the GHG activities of the Proposed Development 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.
- **Accuracy**: minimising uncertainty and avoiding systematic over- or under-quantification of emissions, and ensuring any necessary estimates or assumptions required are conservative and guided by industry standards.

7.4.25. In line with the GHG Protocol and the Institute of Environmental Management and Assessment's *Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance* (2022), a materiality threshold of 1% may be set whereby emissions that are expected to contribute to less than 1% of the overall emissions inventory may be excluded from the assessment.

Assessment criteria and assessment of significance

7.4.26. Impact assessments normally assess to what degree the Proposed Development will affect the baseline environment of the study area. In the case of GHG emissions, any emissions will 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 will have impacts globally.

7.4.27. This preliminary GHG assessment therefore evaluates the significance of emissions based upon guidance from Institute of Environmental Management and Assessment's *Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance* (2022), which provides a framework of determining significance

against the goals of the Paris Agreement (i.e., against a science-based 1.5°C trajectory) (see **Table 7.5**).

7.4.28. The Institute of Environmental Management and Assessment's 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.

7.4.29. If GHG emissions cannot be avoided, a goal of the EIA process should be to identify mitigation options to reduce the project's residual emissions at all stages. If GHG emissions remain significant but cannot be further reduced, approaches to compensate the project's remaining emissions should be considered.

Table 7.5: IEMA's Guidance to assessing GHG significance (2022) Framework for assessment of significant 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 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 Paris Agreement.
Not significant	Minor adverse	Project may have residual emissions, but the project is compatible with the goals of the 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 Paris Agreement, complying with up-to-date policy and best practice.

Significance	Level	Criteria
Significant	Beneficial	Project causes GHG emissions to be avoided or removed from the atmosphere, substantially exceeding the goals of the Paris Agreement with a positive climate impact.

7.4.30. The UK's GHG inventory and corresponding five-year carbon budgets provide a framework to measure the amount of GHG emissions the UK is legally permitted to emit per five-year period to stay aligned with the goals of the Paris Agreement (see **Table 7.6**). The determination of significance will therefore reference the appropriate budget period in which the emissions arise.

7.4.31. The UK is currently in the 4th carbon budget period, which runs from 2023-27. The construction program for the Proposed Development falls within this 4th carbon budget. The operational phase emissions have been compared to the appropriate and available carbon budgets within the design life of the Proposed Development. These comprise the 5th and 6th carbon budgets, which span 2028-2032 and 2033-2037 respectively. Beyond this date, no carbon budgets have been published.

7.4.32. The UK carbon budgets are useful for context. However, rather than comparing the Proposed Development's emissions to national carbon budgets, a more appropriate proxy would be a comparison against those of the local authority area.

7.4.33. Based on 2021 data published by the UK Government (the latest available data at the time of writing), the North Kesteven local authority area emits 0.24% of the total UK emissions (based upon North Kesteven local authority area emissions of 974.4 ktCO2e and national emissions of 399,046.1 ktCO2e). The North Kesteven local authority area carbon budget has therefore been based upon 0.24% of the national Carbon Budget and is displayed in **Table 7.6**.

Table 7.6 UK and North Kesteven local authority area carbon budgets

Carbon budget	Carbon budget level (MMtCO2e)	North Kesteven local authority area proportional emissions budget (ktCO2e)
1st (2008 – 12)	3,018	737
2nd (2013 – 17)	2,782	679

Carbon budget	Carbon budget level (MMtCO2e)	North Kesteven local authority area proportional emissions budget (ktCO2e)
3rd (2018 – 22)	2,544	621
4th (2023 – 27)	1,950	476
5th (2028 – 32)	1,725	421
6th (2033 – 37)	965	236

7.5. Summary of baseline conditions

7.5.1. There is currently no existing infrastructure within the Site boundary. The Site mainly consists of agricultural land, predominantly fields interspersed with hedgerows, small woodland blocks and farm access tracks. It is used for arable production but with limited livestock use e.g., sheep rearing. It is assumed that no ruminant livestock utilise the Site.

7.5.2. The GHG baseline comprises the existing carbon stock and possible minor emissions sources. These minor emissions sources may comprise vehicle fuel and fertiliser use, with possible contributions from the land depending on soil and vegetation types. In line with the Institute of Environmental Management and Assessment's *Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance* (2022), 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.

Sensitive receptors

7.5.3. The sensitive receptor for GHG emissions is the global climate, which is considered highly sensitive to GHG fluctuations.

Future baseline

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

7.6. Emissions sources

7.6.1. This section sets out the key anticipated emissions sources associated with the Proposed Development. For this preliminary assessment, some emissions sources have not been quantified due to their assumed small magnitude and/or lack of specific information. These emissions sources have been identified in the tables below; the ES will include an assessment of these sources.

7.6.2. Results within the tables of this report are accurate to the number of significant figures presented. Any inconsistencies in totals versus individual values are due to rounding and should not be viewed as erroneous.

Construction phase emissions sources

7.6.3. 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.

7.6.4. **Table 7.7** provides an indication of the key emissions sources which are anticipated during the construction phase of the Proposed Development. The total construction GHG emissions have been estimated to be 522,606 tCO_2e, with 90% comprising those from the product stage (also known as embodied carbon).

Table 7.7 Anticipated key emissions sources during the before-use stage.

Life cycle boundary	Emissions source	Description	Total emissions (tCO_2e)	Proportion of total construction emissions
Product stage (A1 – A3)	Raw material extraction	Embodied emissions associated with the production of material used for the construction of the Proposed Development.	470,562	90%
	Precursor product processing			
	Product manufacture			
	Packaging			
	Transport to factory gate			

Life cycle boundary	Emissions source	Description	Total emissions (tCO_2e)	Proportion of total construction emissions
Construction process stage (A4 – A5)	Transport to site	Emissions associated with the transport of equipment, materials and members of staff to the site of the Proposed Development.	20,657	4%
	Construction activities	Emissions associated with the consumption of fuels onsite for the purposes of construction of the Proposed Development.	31,387	6%
	Waste	Emissions associated with the disposal of waste generated onsite.	Unable to calculate at this stage	N/A
	Land use change	Emissions due to the loss of carbon from vegetation and soil carbon.	Unable to calculate at this stage	N/A
Total			**522,606**	**100%**

7.6.5. The largest emission source from the overall construction phase is embodied emissions from the BESS (61%), followed by the Solar PV modules (25%). A breakdown of the embodied emissions sources for the different components is provided below in **Table 7.8**.

Table 7.8 Embodied emissions from the manufacture of materials and components

Component	Embodied emissions	Proportion of total emissions
Battery storage (BESS)	284,800	61%
BESS containers and control containers	251	0.1%
Solar PV Modules	117,878	25%
Inverters	176	0.04%
PV framework	63,336	13%
Springwell Substation	230	0.05%
Transformers	3,291	1%
Inverter Transformer Stations	600	0.1%
Cables	No data provided	N/A
Concrete	No data provided	N/A
Aggregate	No data provided	N/A
Total	**470,562**	**100%**

Operational phase emissions sources and savings

GHG emissions

7.6.6. Total operational emissions have been estimated to be 445,815 tCO_2e, the majority of which (98%) come from the replacement of the BESS over the lifetime of the Proposed Development (see **Table 7.9**).

Table 7.9 Use stage emissions from maintenance and replacement of the components and worker transportation

Component	Use stage emissions	Proportion of total emissions
BESS	436,615	98%
Inverters	960	0.2%
Springwell Substation	216	0.05%
Transformers	166	0.04%
Worker Transportation	7,860	2%
Total	**445,815**	**100%**

7.6.7. The carbon sequestration potential of the land is likely to increase based on the proposed planting of new hedgerows and trees. In the absence of detailed landscaping plans, the carbon sequestration potential has not been quantified for the purposes of this preliminary assessment. This will be considered in the ES.

GHG savings

7.6.8. GHG savings as part of the operation of the Proposed Development and the displacement of fossil-fuel derived electricity within the National Grid are expected to be significant and have been quantified below.

7.6.9. The Proposed Development is anticipated to have an installed capacity of 800MW, and generation of 952,320MWh in the first year. Taking into account an annual degradation factor of 0.4%, the total energy generation from the proposed 40-year operational life is approximately 35,266,691 MWh.

7.6.10. To determine the GHG savings of the Proposed Development, the emissions intensity of electricity generation has been calculated. Only operational emissions are included to ensure consistency with the methodology of the UK government electricity emissions factors, which only take into account operational emissions per kWh

generated, and not the emissions associated with the construction or decommissioning of any associated energy infrastructure.

7.6.11. Dividing the operational emissions of the Proposed Development (445,817 tCO_2e) by the lifetime energy generation (35,266,691 MWh) gives a total carbon intensity value of 12.64 gCO_2e/kWh. This value is likely to change and become more refined as more information about the Proposed Development becomes available.

7.6.12. Based on the most recently published data (Department for Energy Security and Net Zero and Department for Business, Energy and Industrial Strategy (BEIS), 2023), the UK National Grid generates GHG emissions of 225 gCO2e/kWh at point of generation. These emissions are mainly from the fossil-fuel component of the energy mix (for 2022 this predominantly comprised natural gas at 38.5%, imported mixed energy sources at 5.5% and coal at 1.5%). The operational emissions of the Proposed Development therefore represent a 94% reduction in emissions per kWh compared to the current UK electricity fuel mix.

7.6.13. Due to the increase in renewable energy inputs, the UK National Grid is projected to decarbonise to an expected carbon intensity of 2.28g by 2050[2]. The Proposed Development therefore may have a higher carbon intensity than the National Grid during the latter part of its lifetime (specifically from 2043 based upon current projections).

7.6.14. This does not mean that the Proposed Development does not have an overall positive impact on the UK's ability to meet its climate targets. The renewable electricity from the Proposed Development is directly replacing that generated by fossil-fuel energy, and so to allow for a more meaningful comparison, the emissions per kWh can be compared against that directly from fossil-fuel generated electricity. 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 the Proposed Development will emit 341 g fewer CO_2e per kWh than if the same electricity were generated by a gas fired CCGT, representing savings of 96%.

7.6.15. Over the proposed 40-year lifetime of the Proposed Development, this equates to GHG savings of over 12 million tonnes CO_2e.

Decommissioning phase emissions sources

7.6.16. GHG emissions from decommissioning of the Proposed Development have been identified, aligned with standard practice

[2] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

for Life Cycle Assessments (**Table 7.10**). These emissions are subject to a high level of uncertainty, as the decommissioning conditions cannot be predicted approximately 40 years into the future.

Table 7.10 Anticipated key emissions sources during the end of life stage

Description	Total emissions (tCO_2e)	Proportion of total decommissioning emissions
End of life (C1-4)	62,474	100.0%

Summary lifecycle emissions

7.6.17. The predicted GHG emissions of the Proposed Development are displayed in **Table 7.11**. Product stage construction emissions are the largest emissions source (46%), followed by those product stage emissions from the replacement of materials over the 40-year lifetime.

Table 7.11 Lifecycle emissions from the Proposed Development during construction, operation and end-of-life

Description	Total emissions (tCO_2e)	Proportion of total emissions
Product stage (A1 – A3)	470,562	46%
Construction process stage (A4 – A5)	52,044	5%
Operation (B1 – B9)	445,815	43%
End of life (C1 – C4)	62,792	6%
Total GHG emissions (not including any GHG savings from operation)	**1,031,214**	

7.7. Likely effects, additional mitigation and residual effects

7.7.1. Preliminary GHG impacts have been assessed for each phase of the Proposed Development (construction, operation and decommissioning). It is important to understand the impacts at each phase, particularly with regards to identifying hotspots to facilitate mitigation efforts. However, the net impact of the Proposed Development must be considered across the entire lifecycle due to the long-term and cumulative nature of GHG emissions across the lifetime of the Proposed Development.

Construction phase

Table 7.12 Assessment of likely effects, additional mitigation and residual effects during construction

Receptor/matter	Likely effects/additional (secondary and tertiary) mitigation/residual effects	
GHG emissions	Likely effects	The GHG impact of construction is anticipated to result emissions of 522,606 tCO2e. Whilst this is large in comparison to North Kesteven local authority area carbon budget for 2023-27, it represents 0.027% of the national carbon budget for this period. As this renewable energy will be going into the National Grid, it is appropriate to compare these emissions against the national carbon budget.
	Additional (secondary and tertiary) mitigation	A large majority of GHG emissions associated with the Proposed Development comprise those embodied emissions from infrastructure, primarily the BESS and Solar PV modules. The most effective mitigation will therefore be in the responsible sourcing of materials and infrastructure. Environmental Product Declarations should be required and scrutinised for materials and equipment wherever possible, most particularly for the BESS and Solar PV modules. Use of products with lower embodied/pre-use phase emissions will significantly improve the carbon balance of the Proposed Development.

Receptor/matter	Likely effects/additional (secondary and tertiary) mitigation/residual effects
	In addition to procurement, measures to decrease GHG emissions from the construction process phase will be documented within and secured by the Outline Construction Environmental Management Plan and the Outline Construction Traffic Management Plan. These are anticipated to include: • Implementing 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. • Using locally sourced and/or produced materials. The use of recycled aggregates, where appropriate, for foundations, subbases, hard-standings and pavement materials. • Carrying out actions to meet the waste hierarchy in accordance with the principles of the Government's Resources and Waste Strategy 2018. Promoting the recycling of materials by segregating construction waste

Receptor/matter	Likely effects/additional (secondary and tertiary) mitigation/residual effects	
		to be re-used and recycled where practical.
	Likely residual effects	Even if all the proposed additional mitigation measures were applied to maximum effect, there would still be a certain unavoidable amount of GHG emissions during the construction phase. The construction emissions are therefore anticipated to have a **minor adverse** (**not significant**) effect on the climate.

Operational phase

Table 7.13 Assessment of likely effects, additional mitigation and residual effects during operation

Receptor/Matter	Likely effects/additional (secondary and tertiary) mitigation/residual effects	
GHG emissions	Likely effects	The operation of the Proposed Development will result in GHG emissions savings as a result of the displacement of fossil-fuel derived electricity within the National Grid. These equate to savings of over 12 million tCO_2e compared to gas-generated electricity.
	Additional (secondary and tertiary) mitigation	As the overall impact on the receptor during this phase is positive, no additional mitigation measures are required.
	Likely residual effects	The operation emissions savings are anticipated to have a **beneficial** (**significant**) effect on the climate.

Decommissioning phase

Table 7.14 Assessment of likely effects, additional mitigation and residual effects during decommissioning

Receptor/matter	Likely effects/additional (secondary and tertiary) mitigation/residual effects	
GHG emissions	Likely effects	The GHG impact of decommissioning is anticipated to result in emissions of 62,792 tCO_2e. This is a conservative figure based upon worst-case assumptions, and the actual emissions from decommissioning cannot be accurately predicted 40 years into the future. The UK Government has not released carbon budgets for the year of decommissioning, but it is likely that emissions from the Proposed Development will be low in magnitude in comparison to carbon budgets.

Receptor/matter	Likely effects/additional (secondary and tertiary) mitigation/residual effects	
	Additional (secondary and tertiary) mitigation	Due to the potential advancements in technology and best practice between the present and the time in which decommissioning will take place, it is difficult to accurately propose additional mitigation at this time. However, mitigation as part of the decommissioning phase will be documented within and secured by the Outline Decommissioning Environmental Management Plan.
	Likely residual effects	Even if all additional mitigation measures were applied to maximum effect, there would still be a certain unavoidable amount of GHG emissions during the decommissioning phase. The decommissioning emissions savings are therefore anticipated to have a **minor adverse** (**not significant**) effect on the climate.

Net significance

7.7.2. Renewable energy developments such as the Proposed Development have a major role to play in the transition to a low carbon economy, and the decarbonisation of the UK National Grid. Without projects like the Proposed Development, 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.

7.7.3. Emissions from the construction, operation and decommissioning of the Proposed Development total 1,031,214 tCO2e (**Table 7.11**), whilst operational savings are over 12 million tCO2e. The net GHG savings, compared against equivalent gas-fired electricity generation, are therefore over 11 million tonnes of CO2e.

7.7.4. Therefore, the Proposed Development overall is considered likely to have a **beneficial** (**significant**) effect on the climate.

7.8. Climate in-combination assessment

7.8.1. The Scoping Opinion requested that the "potential to alter precipitation runoff rates and patterns" be scoped into the assessment.

7.8.2. The climate projections displayed in **Table 7.15** have been extracted from the UKCP18 data developed by the UK Climate Impacts Programme. The projections displayed cover the indicative lifetime of the Proposed Development at the 10th, 50th and 90th probability level for the RCP 4.5 (intermediate emissions) and RCP 8.5 (high emissions) scenario.

Table 7.15 Projected change in precipitation rate in the East Midlands area, showing 50th,10th and 90th percentile

Climate variable	RCP 4.5		RCP 8.5	
	2020 – 2039	**2040 – 2059**	**2020 – 2039**	**2040 – 2059**
Annual precipitation rate anomaly (%)	+1.5 (-5.1 to + 8.8)	-2.1 (-10.1 to + 6.5)	+1.6 (-5.7 to + 9.0)	-2.1 (-11.1 to + 6.9)

7.8.3. Precipitation in the East Midlands area is expected to increase in the short term (2020 – 2039) and decrease in the longer term (2040 – 2059) under both climate scenarios. The range of probabilities is highly variable.

7.8.4. The Solar PV modules used as part of the Proposed Development will measure up to approximately 2.4m in length, 1.3m in width with a depth of up to 30mm and consist of a series of photovoltaic cells beneath a layer of toughened glass. The spacing between the rows of PV modules will vary across the Site, with a minimum separation space of 3m.

7.8.5. It is not anticipated that the installation of the Solar PV modules will involve the introduction of significant hardstanding at ground level, ensuring minimal superficial cover compared to baseline. In addition, the Solar PV modules will have regular rainwater gaps to prevent concentration of water along a single drip line.

7.8.6. Surface water run-off will be controlled using water management techniques informed by Sustainable Drainage Systems (SuDS). The Site will be planted with native species including grassland and wildflower mixes. This planting will ensure that water that falls from the drip line will be intercepted by vegetation, promoting water interception and infiltration potential, and limiting channelisation from surface water run-off from Solar PV modules.

7.8.7. Given the embedded mitigation proposed, it is deemed that there is no significant risk of detrimental effects on the environment arising

as a result of the increased precipitation rates predicted during 2020 – 2039 and the Solar PV modules altering precipitation runoff rates and patterns.

7.9. Opportunities for environmental enhancement

7.9.1. The nature of the Proposed Development offers an enhancement to the original environment in terms of GHG emissions. It is expected that its operation will reduce emission by 96% compared against a gas-fired energy source, equating to GHG savings of over 12 million tonnes CO_2e over 40 years.

7.10. Difficulties and uncertainties

7.10.1. The information provided in this PEIR is preliminary and is based on the information available at the time of writing. A number of smaller emissions sources have been omitted due to a lack of data available at this time. This includes the cables, concrete and aggregate used during construction. The final assessment of likely significant effects will be reported in the ES.

7.10.2. The accuracy of a GHG assessment depends on the quality of the data provided. Primary data should be used where available; however, 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.

7.10.3. To mitigate against this, a conservative approach has been adopted, whereby a reasonable worst-case scenario has been assumed. For example, the infrastructure manufacturer for the Proposed Development has not yet been selected, and it has been assumed that Solar PV modules and BESS will be sourced from China.

7.11. Further work to inform the ES

7.11.1. This preliminary assessment has considered the main expected material sources of GHG emissions for the Proposed Development. However, there are specific emissions sources that have not yet been quantified. These include:

- Waste and land-use change as part of the construction phase;
- The embodied emissions of specific materials and infrastructure; and
- Operational emissions, including auxiliary power, repair and maintenance of the Site.

7.11.2. The climate assessment presented within the ES will include an assessment of these sources, informed by the final project design and in conjunction with input from the project design team.

7.11.3. Engagement with Lincolnshire County Council and North Kesteven District Council will be undertaken to inform the ES.

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