One Earth Solar Farm

Preliminary Environmental Information Report [EN010159]

Chapter 15: Climate Change

May 2024

One Earth Solar Farm Ltd

Contents

15. Climate Change

Summary of Preliminary Likely Significant Effects

15.1. This Chapter sets out our preliminary assessment of the potential significant effects of our Project on Climate Change during its construction, operation, and decommissioning phases.

15.2. This Chapter concludes that our Project will lead to a likely significant positive effect in terms of reducing Greenhouse Gas (GHG) emissions and supporting the UK's transition to a net zero economy by 2050.

15.3. The impact of future climate change on our Project is identified as being non-significant. This means that Our Project is resilient to a range in potential future climatic changes such as hotter drier summers, warmer wetter winters and increased storminess.

15.4. No in-combination climate change impacts have been identified. This means that future climate change is not expected to significantly alter any of our Project's environmental effects as set out in other PEIR Chapters.

Introduction

15.5. This Chapter of the PEIR has been prepared by Logika and presents the likely significant environmental effects in relation to Climate Change. The experience of the consultants that have prepared this Chapter, who are competent experts for the purpose of the EIA Regulations, is set out in **Appendix 1-1** in **Chapters 1-6**. It is based on the environmental information to date (which is detailed in this Chapter), as well as the current description of our Project as set out in **Chapter 4: Our Project**.

15.6. This Chapter is supported by further detailed information contained in:

- **Appendix 15-1**: Climate Change Legislation, Planning Policy and Guidance;
- **Appendix 15-2**: Methodology for Determining Significance of Effects;
- **Appendix 15-3**: GHG Footprint Methodology;
- **Appendix 15-4**: In-Combination Climate Change Impacts.

Context of Our Project in the Transition to Net Zero

15.7. In 2019, the UK Government made a legally binding commitment to reduce national GHG emissions to net zero by 2050. To achieve this target, there is a need to transition away from fossil fuels for energy (power and heating) and transport.

15.8. The UK has successfully reduced its reliance on coal for electricity generation to very low levels, but a significant portion of the UK's electricity supply (39% in the period April 2022 - March 2023[1]) is provided by natural gas. The UK is also heavily reliant on natural gas for heating and fossil fuels for transport. As heating systems are replaced with electricity-powered systems such as heat pumps, and road vehicles replaced with electric vehicles, the demand for electricity will greatly increase. It is therefore vital for both the UK's future energy security and commitment to net zero carbon, that it rapidly increases its capacity for renewable electricity generation through the development of new solar, wind and nuclear projects.

15.9. In supplying renewable, zero-carbon electricity per year (enough to power over 200,000 UK homes), our Project will provide a significant positive contribution to the UK's future energy security and transition to net zero.

Current Climate Conditions

Assessment Scope

15.10. GHGs are gaseous compounds that have been identified as contributing to a warming effect in the earth's atmosphere. The primary GHG of concern is carbon dioxide (CO_2) which is emitted from combustion sources such as vehicular transport and energy plant (and is therefore relevant in the energy required to manufacture goods and materials used to construct our Project). Other GHGs also contribute to climate change and these are accounted for based on their Global Warming Potential (GWP). The combined effect of all GHG emissions will be presented as carbon dioxide equivalent (CO_2e) and will account for the seven GHGs included in the United Nations Framework Convention on Climate Change's (UNFCCC) Kyoto Protocol. These are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

15.11. The UK EIA Regulations 2017 (as amended)[2] sets out the requirements to consider climate change in EIA. The Regulations require that an assessment provides: *"A description of the likely significant effects of the development on the environment resulting from, inter alia… (f) the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change".*

15.12. The assessment is presented in three parts:

[1] DESNZ (2023) Fuel mix disclosure data table: https://www.gov.uk/government/publications/fuel-mix-disclosure-data-table/fuel-mix-disclosure-data-table#fnref:2

[2] See https://www.gov.uk/guidance/environmental-impact-assessment#Preparing-an-Environmental-Statement1.

- **GHG assessment:** this provides a quantification of the GHG emissions resulting from our Project, and an assessment against the GHG emissions saved by our Project in providing renewable electricity which reduces reliance on fossil fuels such as natural gas;
- **Climate change resilience (CCR) assessment:** this is an assessment of ability of our Project to adapt to and be resilient to potential future changes in climate such as hotter dryer summers, warmer wetter winters and increased storminess; and
- **In-combination climate change impact (ICCI) assessment:** this is an assessment of the extent to which potential future climate change alters the environmental effects assessed by other EIA disciplines such as flood risk, air quality and noise and vibration.

Study Area

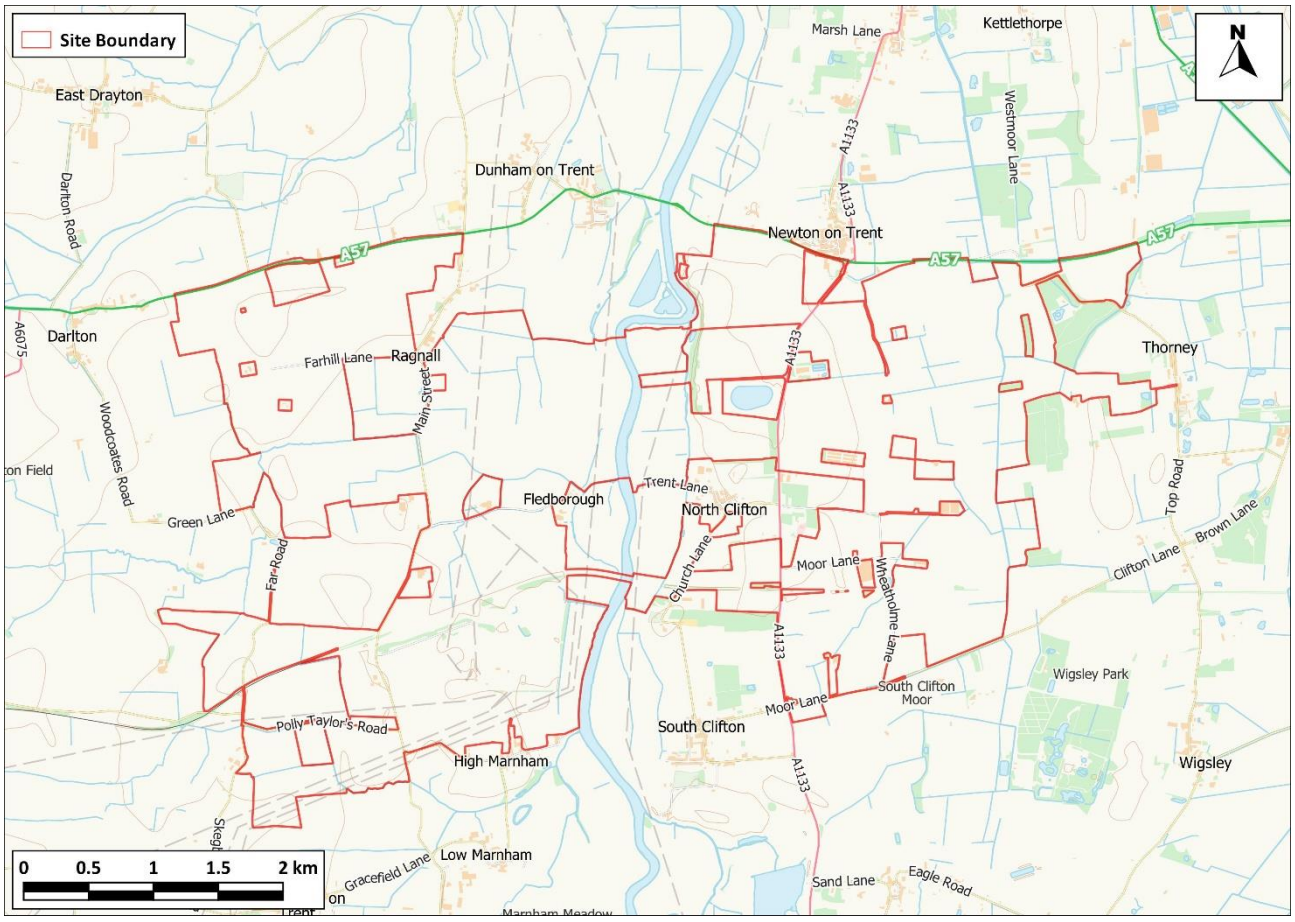
GHG Assessment

15.13. GHGs contribute to climate change, which is a global environmental effect and, as such, the study area for the assessment is not limited by any specific geographical scope or defined by specific sensitive receptors. Instead the GHG assessment focuses on the likely amount of GHG produced by our Project from construction, operation and decommissioning and compares against other forms of electrical energy generation (principally natural gas power stations as this remains the significant portion of energy generation in the UK).

CCR Assessment

15.14. The study area for CCR, unlike other disciplines, focuses on the impact that climate will have on our Project (as opposed to the impact of our Project on the environment). The study area is therefore the footprint of our Project, split into its constituent parts (receptors). The study area for the CCR assessment is shown in **Figure 15-1** below.

Figure 15-1: CCR Assessment Study Area



ICCI Assessment

15.15. The ICCI assessment considers the existing and projected future climate conditions (e.g. higher peak summer temperatures, more frequent droughts and higher flood water levels) for the geographical location and assessment timeframe, which is the period from operational commencement (2029) to project decommissioning in 60 years (anticipated to be 2089). It identifies the extent to which identified receptors in the surrounding environment are potentially vulnerable to and affected by these factors. The receptors for the ICCI assessment are those that will be impacted by our Project. These impacts will be assessed in liaison with the technical specialists responsible for preparing the applicable technical chapters.

Baseline Conditions

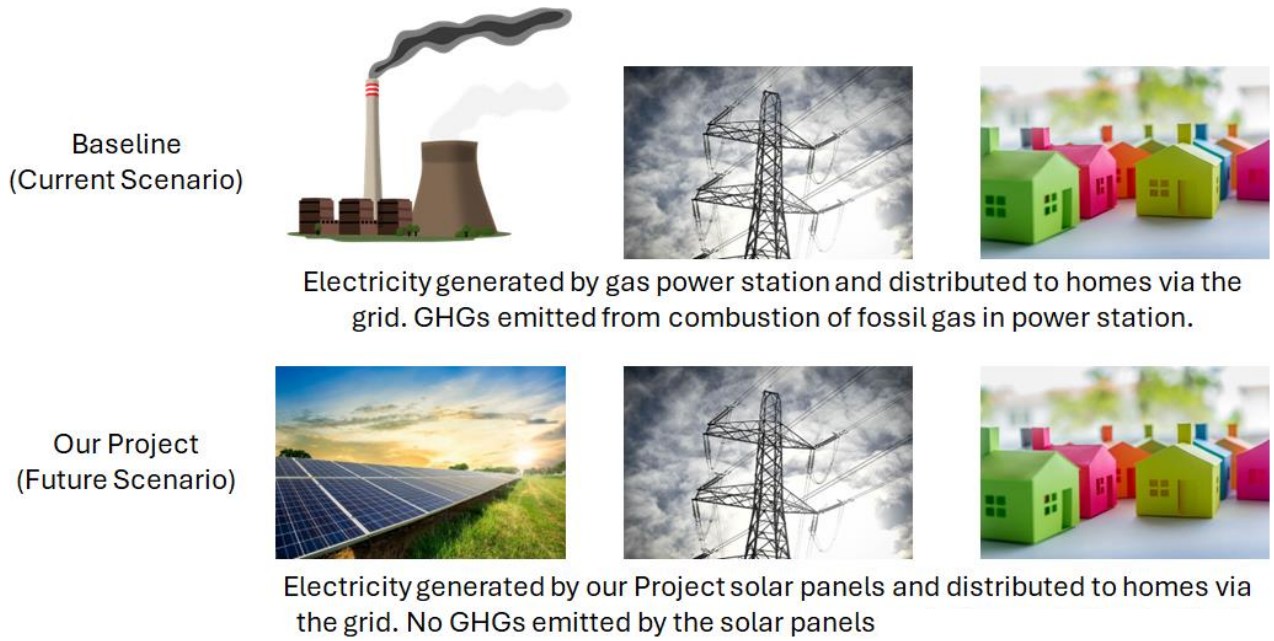
GHG Assessment

15.16. Our Site presently consists of arable managed land and thus there are agricultural activities that will result in GHG emissions. Agriculture is a net emitter of GHGs due to the emissions associated with farm machinery, soil erosion and use of products such as fertilisers and pesticides. Our Site currently hosts approximately 1,300 Ha of agricultural land, and approximately 200 Ha consists of natural and semi-natural habitats such as woodland, grassland, scrub and hedgerows. These land uses sequester carbon by absorbing carbon dioxide from the atmosphere which is stored in the soil. Our Site's baseline GHG emissions therefore are the total of emissions from agricultural activities, less the carbon sequestered by natural and semi-natural habitats.

15.17. Current GHG emissions from our Site resulting from the existing agricultural land uses and natural and semi natural habitats are estimated to be around 450 tonnes CO_2e per year. The calculation of these emissions is provided in **Appendix 15-3** in a **2**.

15.18. Although the existing land use is one way to consider baseline emissions within a GHG assessment, it is also appropriate to consider the baseline emissions as an alternative project or scenario. For GHG assessments in the renewable energy sector it is common practice to consider the baseline emissions associated with generation of electricity using gas fired power stations. The reason for this is that in order for the UK to transition its energy supply to net zero by 2050 and decarbonise the national electricity grid, there must be a substantial shift from use of fossil fuelled power stations towards renewable energy generation. Over the past two decades the UK has seen considerable reductions in grid average carbon intensity which is driven largely by the development of renewable energy projects such as our Project allowing the reduced use and eventual shutdown of numerous coal and other fossil-fired power stations. Natural gas remains a major contributor to UK electricity and for the decarbonisation trend to continue, many more renewable energy projects will be required. As such the electricity generated by our Project and other renewable projects like it directly contribute to enabling the UK to close its existing fossil fuelled power stations and reduce the national GHG emissions from energy generation. This is consistent with the approach agreed in the Scoping Report (See **Volume 2: Scoping Consultation**.

Figure 15-2 – Our Project in the Context of the GHG Assessment Baseline



15.19. Our Project will generate and export an estimated 1,000 GWh (gigawatt hours) of renewable electricity each year. The standard unit of measurement of electricity is the kilowatt hour (kWh). The 1,000 GWh generated by our Project equates to 1,000,000,000 (one billion) kWh per year.

15.20. The GHG emissions released by generation of electricity using natural gas in a Combined Cycle Gas Turbine (CCGT) power station is 371 gCO_2e/kWh (371 grams per kilowatt hour)[3]. This means that generating 1,000 GWh of electricity using gas CCGT results in GHG emissions of 371,000 tonnes CO_2e per year.

CCR Assessment and ICCI Assessment

15.21. The current baseline for the CCR review and ICCI assessment is the current climate at our Site. Historic climate data has been obtained from the Met Office website, recorded by the closest Met Office station to our Site which is at RAF Waddington near Lincoln, approximately 15 km southeast of our Site. Historic climate data for the 30-year period of 1981-2010 (the standard baseline for climate data), is summarised in **Table 15-1** below.

Table 15-1: Historic Climate Data Summary

Climate Factor	Month	Value

[3] DESNZ (2023) Fuel mix disclosure data table: https://www.gov.uk/government/publications/fuel-mix-disclosure-data-table/fuel-mix-disclosure-data-table

Warmest month on average (Average daily mean temp °C)	July	16.9
Coldest month on average (Average daily mean temp °C)	January	4.0
Mean annual rainfall levels (mm)	-	51.1
Wettest month on average (Average monthly rainfall mm)	August	60.3
Driest month on average (Average monthly rainfall mm)	February	36.8

15.22. The Met Office historic 10-year averages for Waddington station identify gradual warming in both the winter and summer periods between 1973 and 2022, with no clear trends in average rainfall. Information on average daily mean temperatures (°C) and mean monthly rainfall (mm) is summarised in **Table 15-2**.

Table 15-2: Historic 10-year Averages for Temperature and Rainfall for Waddington Region

Climate Period	Climate Variables			
	Average Daily Mean Temperatures (°C)		Mean Monthly Rainfall (mm)	
	Winter (Oct-Mar)	Summer (Apr-Sep)	Winter (Oct-Mar)	Summer (Apr-Sep)
1973-1982	5.4	13.1	53.0	50.3
1983-1992	5.7	13.2	47.3	50.2
1993-2002	6.3	13.7	50.7	52.7
2003-2012	6.3	14.3	45.7	59.9
2013-2022	6.8	14.4	51.9	49.8

Further Data Collection

15.23. The following work will be undertaken in relation to the current climate conditions for presentation in the final ES:

- The estimate of current emissions from generation of electricity using CCGT will be refined based on the latest Government data on carbon intensity from CCGT power stations, and final energy modelling data for our Project; and
- The estimate of current GHG emissions from our Site will be refined once further baseline habitats surveys are completed and more data on existing sitewide habitats are determined.

Future Climate Conditions

GHG Assessment

15.24. Future baseline emissions for our Site are assumed to be the same as the current baseline, which assumes a 'business as usual' scenario whereby our Project is not implemented, and our Site continues to be managed as agricultural land.

15.25. Over the 60-year lifetime of our Project, the baseline emissions from our Site taking account of the agricultural uses and natural and semi-natural habitats that occupy our Site will be 27,000 tonnes CO_2e.

15.26. There may be slight improvements (reductions) in GHG emissions as farming techniques and technologies improve in the future, but there are no resources which allow any such changes to be quantified.

15.27. In the absence of our Project, it is assumed that the electricity generated by our Project would continue to be generated using natural gas fired CCGT power stations. It is likely that by the 2050, when the UK Government has committed to net zero, that any residual gas fired CCGT stations will have been decarbonised through the installation of carbon capture and storage technologies. At present there are no power stations in the UK operating with carbon capture, and it is not certain when carbon storage networks will be sufficiently developed to enable this. Therefore, for the purposes of this PEIR, it is assumed that natural gas CCGT will be used to 2050, which represents the first 21 years of operation of our Project. Over this 21-year period, this equates to 21,000,000,000 kWh generated, and 7,791,000 tonnes of CO_2e.

15.28. This value does not account for decarbonisation of large CCGT power stations, which may occur in the future.

CCR Assessment and ICCI Assessment

15.29. The future baseline climate is expected to differ from the present-day baseline described above. United Kingdom Climate Change Projections 2018 (UKCP18)[4] provides probabilistic climate change projections for predefined 30-year periods for annual, seasonal and monthly changes to mean climatic conditions over land areas. For the purpose of the assessment, UKCP18 probabilistic projections for the climate variables set out in **Table 15-3** have been obtained.

Table 15-3: Future Projected Climate Variables

Temperature	Rainfall
Mean annual temperature	Mean annual rainfall
Mean summer temperature	Mean summer rainfall
Mean winter temperature	Mean winter rainfall

15.30. Projected temperature and precipitation variables are presented in **Tables 15-4** and **15-5** respectively. UKCP18 probabilistic projections have been analysed for the 25 km^2 grid square within which our Project is located. These figures are expressed as temperature/rainfall anomalies in relation to the 1981-2000 baseline.

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

15.32. As the design life of our Project is expected to be at least 60 years, the CCR assessment has considered a scenario that reflects the potential change in climate resulting from the highest predicted level of global warming (8.5 degree increase in global average temperatures) in the time horizon of 2080-2099 to assess the impact of climate change over the lifetime of our Project.

15.33. The tables below show projected changes in temperature (expected to increase) and rainfall (expected to increase in winter and decrease in summer). The climate projections do not take account of our Project.

Table 15-4: Projected changes in temperature variables (°C)

Temperature Variable	Change in Temperature between 1981-2000 and 2080-2099 (°C)

[4] Met Office (2018) UK Climate Projections (UKCP): https://www.metoffice.gov.uk/research/approach/collaboration/ukcp

Mean annual air temperature	4.1
Mean summer air temperature	5.2
Mean winter air temperature	3.4

Table 15-5: Projected changes in precipitation variables (%)

Rainfall Variable	Change in Rainfall between 1981-2000 and 2080-2099 (%)
Summer average rainfall	-35
Winter average rainfall	19

Further Data Collection

15.34. The following work will be undertaken in relation to the future climate conditions for presentation in the final ES:

- The estimate of lifetime electricity generated and exported by our Project will be refined to reflect a small amount of degradation (i.e. reduction in the amount of electricity generated by the solar panels as they age) and the benefit of panel replacements during the lifetime of our Project;
- Estimate of emissions from the gas fired CCGT power station baseline will be refined to account for the potential introduction of carbon capture and storage technologies, at some point prior to 2050, based on the latest evidence on likely timescales for large-scale carbon storage networks in the UK;
- The estimate of future GHG emissions from our Site (in the absence of our Project) will be refined once further baseline habitats surveys are completed and more accurate data on existing sitewide habitats are determined; and
- Further detailed analysis of the UKCP18 data will be undertaken to better define the likely future climate at our Site.

Environmental Measures

15.35. As detailed in **Appendix 4-1 in Chapters 1-6**, our Project has established a set of Design Principles. This includes a Design Principle relating to Climate; which considers the measures that will be implemented to ensure climate change and carbon emissions are reduced as far as practical. This includes the following specific principles:

- Maximise the volume of clean energy that can be provided to the national grid;
- Seek to reduce embodied carbon throughout our Project lifecycle; and
- Craft a scheme that is resilient to the effects of climate change.

15.36. These design principles will ensure that during further design works, following DCO consent, the latest technologies, material and methods are employed to reduce the impact on carbon and climate change.

Potential Likely Significant Effects Scoped Out

The following GHG emissions sources are scoped out:

- SF6;
- Waste; and
- Water supply and treatment.

15.37. The Scoping Opinion requests that SF6 use and losses are considered in the GHG assessment if SF6 is proposed for use in switch gear systems (Scoping Opinion ID 2.1.4). Our Project will not use switch gear systems which use SF6 gas and will instead use switch gear with no potential GHG emissions. SF6 emissions are not associated with any other parts of the construction, operation or decommissioning of our Project and as such are scoped out.

15.38. There will be minimal waste and water as part of the construction and operation of our Project and as such their contribution to the lifetime GHG emissions will be very small and will not materially affect the GHG assessment as explained in the Scoping Report. The principle of scoping waste and water out of the assessment is agreed in the Scoping Opinion (Scoping Opinion ID 3.9.1). Evidence will be provided in the ES to justify the exclusion of waste and water from our Project's GHG footprint.

15.39. Our Project has a sustainability target to ensure 100% of waste avoids landfill and is recycled. Consideration will be given in the ES to good practice construction and decommissioning waste management procedures and measures to be included in the Outline Construction Environmental Management Plan and Outline Decommissioning Environmental Management Plan (see **Chapter 4: Our Project** for further details).

Preliminary Environmental Assessment

GHG assessment

Approach

15.40. The GHG assessment considers emissions from the following lifecycle stages of our Project: construction, operation and maintenance, and decommissioning.

15.41. Where data are available, the expected GHG emissions have been quantified using a calculation-based methodology as per the following equation, as stated in the methodology paper accompanying the conversion factors for company reporting published by the UK Government[5]:

Activity data x GHG emissions factor = GHG emissions value

15.42. Where data are not available, a qualitative approach to addressing GHG impacts has been followed, in line with the IEMA guidance on assessing GHG emissions in EIA[6]. **Table 15-6** sets out in more detail what activities and sources of emissions are considered as part of the assessment.

Table 15-6: Potential sources of GHG emissions

Lifecycle Stage	Activity	Primary Emission Sources
Product Stage	Raw material extraction and manufacturing of products required to build the equipment for our Project. Due to the complexity of the manufacturing processes and design of the equipment, and the use of materials with high embodied carbon, this stage is expected to make a significant contribution to overall GHG emissions. Transportation of materials for manufacturing.	Embodied GHG emissions in extraction and production of raw materials. GHG emissions during manufacture of products. GHG emissions from vehicle use transporting raw materials from extraction to processing sites and on to product manufacture.
Construction process stage	On-site construction activity including emissions from construction compounds.	Energy (electricity, fuel, etc.) consumption from plant and vehicles, generators on-site, and construction worker commuting.

[5] Department for Environment, Food and Rural Affairs and the Department of Business, Energy and Industrial Strategy (2024). Conversion Factors 2023: Methodology.

[6] Institute of Environmental Management and Assessment (IEMA) (2022). Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance (2nd Edition).

	Transportation of construction materials (where these are not included in embodied GHG emissions). Due to the nature of the equipment required, this could require shipment of certain aspects over significant distances (e.g. imports from Asia). Transportation of construction workers.	Fuel consumption from transportation of materials to site (where these are not included in embodied GHG emissions). GHG emissions from transportation of workers to and from site.
Operation stage	Operation of our Project. Maintenance of our Project.	GHG emissions from operational transport (e.g. maintenance vehicle movements). Embodied GHG emissions from replacement panels and other componentry during the lifetime of our Project. Carbon sequestration by on-site habitats and ecological enhancements.
Decommissioning stage	On-site decommissioning activity. Transportation and disposal of waste materials. Transportation of workers.	Energy (electricity, fuel, etc.) consumption from plant, vehicles, and machinery on site. GHG emissions from disposal and transportation of waste. GHG emissions from transportation of workers to site. Emissions associated with the return of grassland to agricultural use at the end of our Project's lifetime.

Receptors and Receptor Sensitivity

15.43. The assessment of GHGs does not include identification of local sensitive receptors, as GHG emissions do not directly affect specific locations, but lead to indirect effects by contributing to climate change. Identification of sensitive areas for climate change has been undertaken by the IPCC, however specific impacts on these areas are not included within this assessment. The sensitive receptor with respect to GHG emissions is therefore the atmosphere, where GHGs contribute to increasing atmospheric temperatures and resultant climate change effects.

Defining Effects

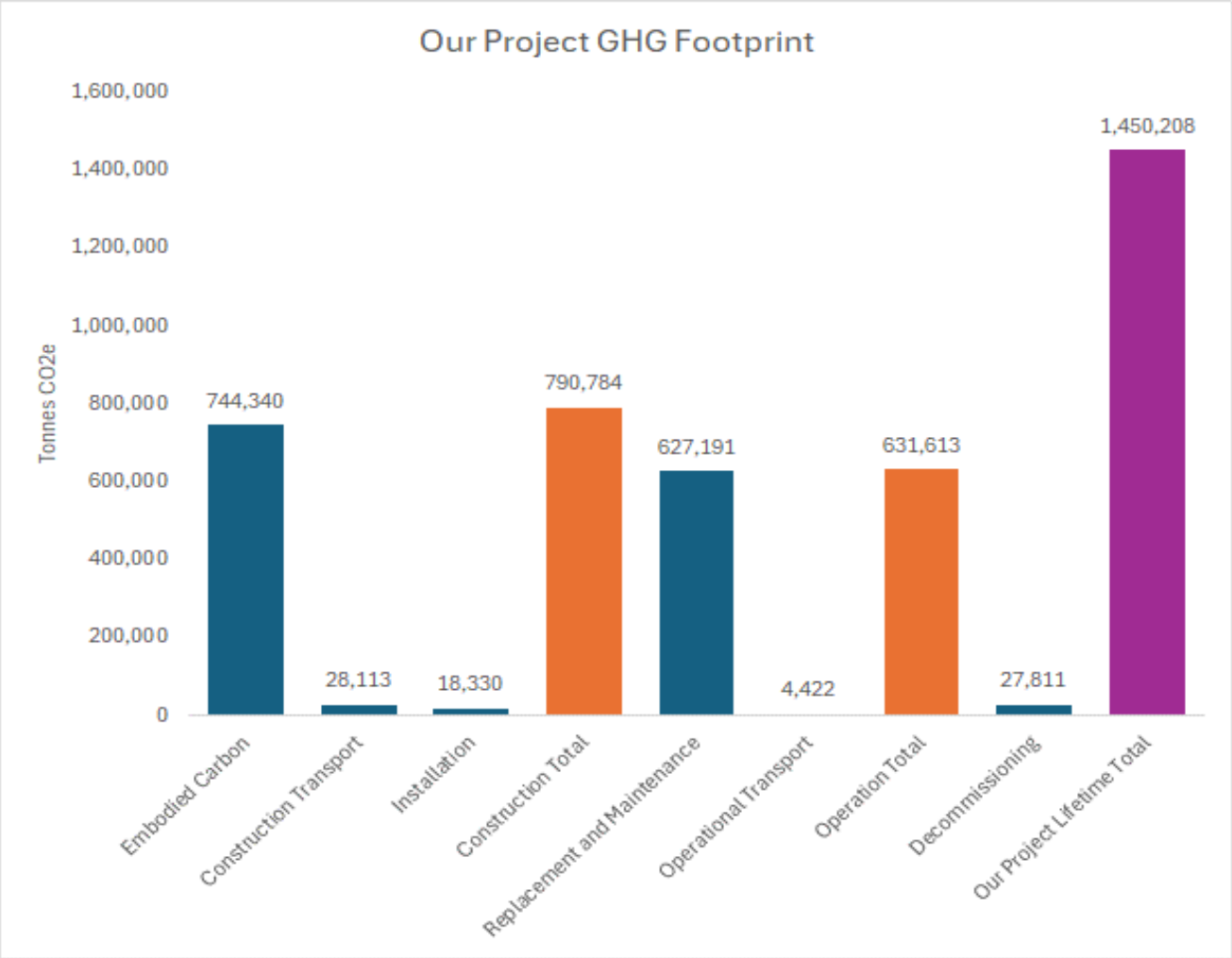
15.44. The assessment of effects for the GHG assessment considers the net emissions over the lifetime of our Project and the extent to which these support the UK's transition to net zero carbon. The net emissions are the lifetime emissions from our Project accounting for all construction, operation and decommissioning phase emissions, minus the operational emissions associated with the generation of an equal amount of electricity using gas fired CCGT.

15.45. The principles of IEMA guidance[7] have been followed in the assessment (see **Appendix 15.2**). The guidance applies substantial weight to projects that can demonstrate a net reduction or saving in GHGs, and recommends that for EIA, any net reduction in GHG emissions should be considered a significant beneficial effect.

Preliminary Assessment

15.46. A preliminary assessment of our Project's lifecycle GHG emissions (i.e. emissions from construction, operation (60-year operational life) and decommissioning) has been undertaken. The resulting GHG footprint for our Project is shown in **Figure 15-2** and details of the calculation method are provided in **Appendix 15-3**.

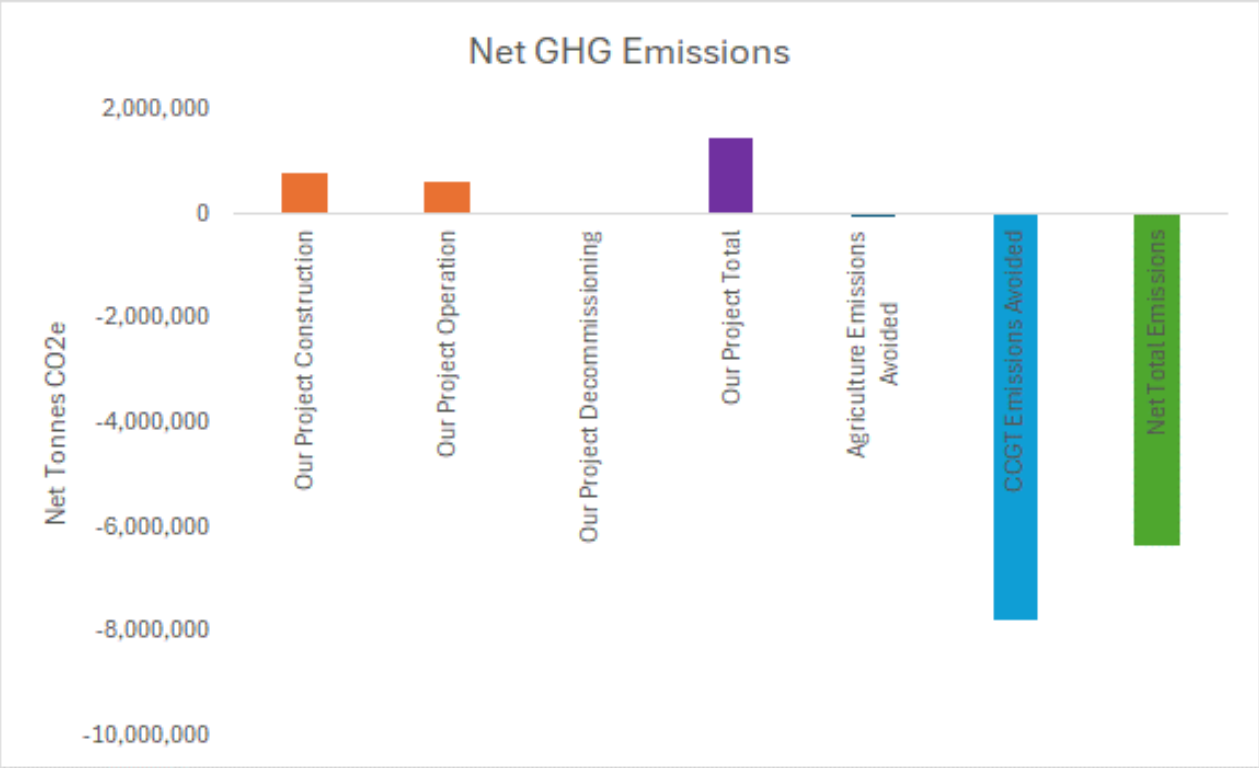
Figure 15-2 – Our Project Lifecycle GHG Footprint



15.47. The majority of emissions associated with our Project are associated with the embodied carbon in construction and operational replacement and maintenance. These emissions are not direct emissions from our Project, but result from the mining, refining and processing of metals and minerals used in the manufacture of solar panels, frames, cables, batteries and other components of our Project. There are no direct emissions from the operation of the solar panels themselves.

15.48. Figure 15-3 shows the net lifecycle GHG emissions taking account of the emissions saved from the reduced reliance on gas fired CCGT power stations.

Figure 15-3 – Net GHG Emissions



15.49. It can be seen from **Figure 15-3** that our Project will lead to a large net saving (approximately 6,300,000 tonnes) in GHG emissions over its lifetime. In accordance with IEMA guidance (see **Appendix 15.2**) this is considered to be a significant beneficial (positive) effect.

Next Steps

15.50. The next steps of the GHG assessment will be to further refine the GHG footprint for our Project and the CCGT baseline, to take account of further detailed design and quantification of key components of our Project such as solar panels, battery storage systems, and cables, and detailed assessment of material quantities for frames, substations, access, cable routes and other infrastructure.

15.51. Whilst this assessment does not consider any specific option in terms of BESS and substation location and river cable crossing. The geography of these options does not materially affect the GHG assessment. The final ES will be relevant to the final agreed BESS and substation location, and river cable crossing.

15.52. Consideration to the baseline GHG footprint will also be refined in the ES to take account of potential carbon capture on major UK CCGT power stations in the future.

CCR Assessment

Approach

15.53. The EIA Regulations require the inclusion of information on the vulnerability of our Project to climate change. Consequently, an assessment of CCR for our Project has been undertaken which identifies potential climate change impacts in accordance with IEMA Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation[7].

Receptors and Receptor Sensitivity

15.54. The receptor for the review of CCR is our Project itself, including all infrastructure, assets, and workers on-site during operation, and decommissioning. The sensitivity of the receptor does not require definition in following the assessment approach in line with UK industry (IEMA) guidance. In practical terms it can be interpreted that the sensitivity of all receptors in the CCR assessment is 'high'.

15.55. The key receptors identified for inclusion in the preliminary CCR assessment are:

- Renewable energy infrastructure – PV arrays, BESS units and inverters;
- Site access; and
- Site staff/personnel.

Defining Effects

15.56. The significance of CCR is determined as a function of the likelihood of a climate change risk occurring and the consequence to the receptor if the hazard occurs. Details of the approach are provided in **Appendix 15-2**.

Preliminary Assessment

15.57. The assessment of CCR considers the adaptation measures that are included with the design of our Project, such that our Project can respond to changes in climatic conditions.

15.58. The evaluation of future climate earlier in this Chapter identified that the likely trends will be hotter drier summers and warmer wetter winters, leading to the following key climatic hazards relevant to the preliminary assessment:

- Heatwaves;
- Drought; and
- Flooding.

[7] IEMA, (2020). Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation.

15.59. There is no evidence of increased storminess (i.e. winds and heavy rainfall) in future, however as a current climate hazard, the final ES will also consider extreme weather events in the CCR assessment (see Next Steps).

15.60. A preliminary CCR assessment is provided below in **Table 15-7** and **Table 15-8**. **Table 15-7** considers each of the climate hazards and receptors and the current or emerging design measures to mitigate any potential impacts. **Table 15-8** then provides a preliminary risk assessment.

Table 15-7: Climate Risks and Mitigation

Climate Variable	Receptor	Potential Impact	Design Measures to Mitigate Impacts
Summers Extreme Temperatures (Heatwaves)	Renewable energy infrastructure	Overheating of BESS units / inverters	Equipment rated to withstand higher temperatures; cooling capacity for BESS to be designed to accommodate high cooling demand.
Summers Extreme Temperatures (Heatwaves)	Site access	Damage from thermal action	Materials used to design and construct site accesses to consider heat resistance.
Summers Extreme Temperatures (Heatwaves)	Site staff	Overheating/ heatstroke	Appropriate H&S plans in place during construction, operation and decommissioning to avoid exposure to extreme heat and require appropriate clothing/PPE for exposed work in high temperatures.
Drought	Renewable energy infrastructure	Soil erosion/ instability/ cracking leading to damage	Key infrastructure such as BESS built on stable concrete base. Panel frames set into ground with ground screws to prevent movement.
Drought	Site access	Soil erosion/ instability/ cracking leading to damage	Site vehicular access routes to incorporate suitable subbase, base and surface layers to ensure stability and resistance to ground shrinkage.

Drought	Site staff	Water supply disruption	Minimal water demand during operation. Construction and decommissioning phase environment plans to consider water supply resilience during hot periods.
Flooding	All receptors	Tidal flooding	Our Site is inland and not susceptible to sea level rise tidal flooding.
Flooding	All receptors	Fluvial flooding from the River Trent	The design of our Project considers the fluvial flood risk of all areas within our Site and avoids development on areas of high flood risk. Where solar panels are located in areas of future projected climatic flood areas, they have been raised above the anticipated flood depths, to ensure the solar panels can still operate effectively and to allow the free movement of waters under the panels during flood events.
Flooding	All receptors	Groundwater / surface water flooding	The design of our Project includes Sustainable Drainage Systems (SuDS) which will be incorporated wherever possible and appropriate, to provide multi-functional benefits associated with water quantity, quality and biodiversity. For the larger areas of hardstanding (such as the BESS), it is proposed that a quantified drainage strategy will be produced, confirming the attenuation requirements in order to restrict runoff to match the greenfield rates before discharging to the surrounding watercourses.

Table 15-8: Climate Resilience Assessment

Climate Variable	Receptor	Potential Impact	Likelihood	Consequence	Significance
Summers Extreme Temperatures (Heatwaves)	Renewable energy infrastructure	Overheating of BESS units / inverters	Low	Moderate Adverse	Not Significant
Summers Extreme Temperatures (Heatwaves)	Site access	Damage from thermal action	Low	Minor Adverse	Not Significant
Summers Extreme Temperatures (Heatwaves)	Site staff	Overheating / heatstroke	Low	Moderate Adverse	Not Significant

Drought	Renewable energy infrastructure	Soil erosion/ instability/ cracking leading to damage	Low	Moderate Adverse	Not Significant
Drought	Site access	Soil erosion/ instability/ cracking leading to damage	Low	Minor Adverse	Not Significant
Drought	Site staff	Water supply disruption	Very Low	Minor Adverse	Not Significant
Flooding	All receptors	Tidal flooding	Very Low	Moderate Adverse	Not Significant
Flooding	All receptors	Fluvial flooding from the River Trent	Low	Moderate Adverse	Not Significant
Flooding	All receptors	Groundwater / surface water flooding	Medium	Minor Adverse	Not Significant

The preliminary CCR assessment has not identified any potentially significant effects in relation to our Project.

Next Steps

15.61. As the detailed design evolves the CCR assessment will be further developed with additional detail and in addition to the receptors and hazards considered in this preliminary assessment will also consider the impact of extreme weather events (i.e. winds and storms) on our Project and will include biodiversity as an additional receptor (associated with our Project's biodiversity and ecological enhancements. The CCR will also consider the specific impacts to individual stages of our Project (construction, operation and decommissioning) separately and will consider any specific risks and impacts related to final agreed options for BESS and substation locations, and river cable crossing.

ICCI Assessment

Approach

15.62. In-combination climate change impacts are the combined impacts of our Project and potential climate change impacts on the receiving environment. In simple terms this means considering whether future climate change will reduce or worsen any of our Project's environmental effects, for example air quality, noise or soils.

15.63. The aim of the ICCI is therefore to consider whether the effects on receptors considered throughout the ES (under the current conditions, without climate change) are likely to be different under an alternative future climate regime. In particular, consideration is given to whether the significance/degree of the effect remains the same or changes with future climate conditions.

Receptors and Receptor Sensitivity

15.64. In the ICCI assessment, sensitive receptors are determined by each socio-environmental discipline in their assessment. The ICCI assessment is undertaken by individual technical disciplines in regard to the identified sensitive receptors in each assessment.

Defining Effects

15.65. The significance of effects in the ICCI is determined as a function of the likelihood of future climate materially changing the significance of environmental effects identified at any receptor. Such a change may be adverse (greater environmental effect) or beneficial (a lesser environmental effect).

Preliminary Assessment

15.66. A preliminary assessment summary is provided in **Appendix 15.4**. The assessment identifies no potentially significant ICCI effects in relation to our Project and no additional mitigation required.

Next Steps

15.67. The next steps are to further develop the ICCI with further input from technical chapter authors as the various environmental assessments progress to final ES stage.

Conclusions

15.68. **Table 15-9** presents a summary of the preliminary likely significant effects, with the further information that will be collected also outlined. It also details the next steps that will be undertaken to inform our ES.

Table 15-9: Summary of Likely Significant Effects

Element	Result of Preliminary Assessment	Further Information	Next Steps

Greenhouse Gas (GHG) Assessment	Our Project is expected to have a significant beneficial effect on climate as a result of the zero-carbon electricity it will generate during operation and the fossil fuel electricity generation that it is expected to displace as part of the UK National Grid.	Our Project's GHG footprint will be further refined as more detailed design information is fed into the assessment.	The next steps of the GHG assessment will be to refine the GHG footprint of our Project and the baseline and define the effects.
Climate Change Resilience (CCR) Assessment	The findings of the preliminary CCR assessment are not significant.	The CCR assessment will be further developed as detailed design information emerges.	The next steps of the CCR assessment are to develop further detail in the assessment based on the detailed design and determination of any additional mitigation required.
In-combination Climate Change Impact (ICCI) Assessment	The preliminary ICCI assessment has not identified and significant effects.	The ICCI will be further developed with input from other technical Chapter authors as detailed assessment work is undertaken as part of the final ES.	The next steps include additional detail in the ICCI and determination of any additional mitigation required.

Appendices

Appendix 15-1: Climate Change Legislation, Planning Policy and Guidance

Appendix 15-2: Methodology for Determining Significance of Effects

Appendix 15-3: GHG Footprint Methodology

Appendix 15-4: In-Combination Climate Change Effects

Appendix 15-1: Climate Change Legislation, Planning Policy and Guidance

Review of Policy, Legislation and Relevant Guidance

Legislation, planning policy and guidance relating to carbon and climate change, and pertinent to the Proposed Development comprises:

Legislation

Climate Change Act 2008 76 and 2050 Target Amendment Order (2019)

The Climate Change Act 2008 was the first global legally binding commitment by a government to act on climate change. It required that emissions of CO2 and other greenhouse gas emissions were reduced, establishing a framework towards delivery of this. The overarching commitment was to reduce these emissions by 80% by 2050, compared to a 1990 baseline. The target amendment order (2019) amended this percentage to 100%, effectively committing the UK government to net-zero by 2050.

The Carbon Budget Order 2021

Carbon budgets set a maximum level of net UK carbon emissions that can occur within a five-year period, as part of the commitments made within the Climate Change Act 2008. This order sets the budget for the accounting period between 2033 and 2037, at 965 million tonnes of CO2e.

National Planning Policy

Overarching National Policy Statement for Energy (EN-1) (2023)

This provides overarching government policy on energy NSIPs, and the way in which any impacts and mitigation measures will be considered. Specific extracts relating to this Proposed Development are as follows:

Section 5.3 relates to "*Greenhouse Gas Emissions*" to which section 5.3.4 to 5.3.7 state that:

"5.3.4 All proposals for energy infrastructure projects should include a GHG assessment as part of their ES (See Section 4.3). This should include:

- *A whole life GHG assessment showing construction, operational and decommissioning GHG impacts, including impacts from change of land use.*
- *An explanation of the steps that have been taken to drive down the climate change impacts at each of those stages.*
- *Measurement of embodied GHG impact from the construction stage.*
- *How reduction in energy demand and consumption during operation has been prioritised in comparison with other measures.*

- *How operational emissions have been reduced as much as possible through the application of best available techniques for that type of technology.*
- *Calculation of operational energy consumption and associated carbon emissions.*
- *Whether and how any residual GHG emissions will be (voluntarily) offset or removed using a recognised framework.*
- *Where there are residual emissions, the level of emissions and the impact of those on national and international efforts to limit climate change, both alone and where relevant in combination with other developments at a regional or national level, or sector level, if sectoral targets are developed.*

5.3.5 A GHG assessment should 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, taking into account the overall objectives of ensuring our supply of energy always remains secure, reliable and affordable, as we transition to net zero.

5.3.6 Applicants should look for opportunities within the proposed development to embed nature-based or technological solutions to mitigate or offset the emissions of construction and decommissioning.

5.3.7 Steps taken to minimise and offset emissions should be set out in a GHG Reduction Strategy, secured under the development consent order. The GHG Reduction Strategy should consider the creation and preservation of carbon stores and sinks including through woodland creation, peatland restoration and through other natural habitats."

National Policy Statement for Electricity Networks Infrastructure (EN- 5) (2023)

This provides specific policy on electricity network NSIPs, which could also apply to the cabling and grid connection parts of the proposals, including how applications relating to electricity networks infrastructure will be assessed and determined, and the way in which any impacts and mitigation measures will be considered.

Paragraph 2.3.2 states that *"As climate change is likely to increase risks to the resilience of some of this infrastructure, from flooding for example, or in situations where it is located near the coast or an estuary or is underground, applicants should in particular set out to what extent the proposed development is expected to be vulnerable, and, as appropriate, how it has been designed to be resilient to:*

- *flooding, particularly for substations that are vital to the network; and especially in light of changes to groundwater levels resulting from climate change;*
- *the effects of wind and storms on overhead lines;*
- *higher average temperatures leading to increased transmission losses;*
- *earth movement or subsidence caused by flooding or drought (for underground cables); and*

- *coastal erosion – for the landfall of offshore transmission cables and their associated substations in the inshore and coastal locations respectively."*

National Planning Policy Framework (2023)

The National Planning Policy Framework (NPPF) is an overarching document which sets out government planning policy for development outside of the NSIP regime in England, and how this is expected to be applied by local authorities and developers. The NPPF can be an important and relevant consideration for NSIPs as well, but in the event of any conflict, the NPS policy prevails. The NPPF provides a framework for local sustainable development via local plans. Specific extracts relating to this Proposed Development are as follows:

Paragraph 158 states that *"Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for the possible future relocation of vulnerable development and infrastructure."*

Paragraph 159 states that *"New development should be planned for in ways that:*

(a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and

(b) can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the government's policy for national technical standards."

Local Planning Policy

Local planning policy relevant to our Site is set out below. Local policies can be an important and relevant consideration for NSIPs as well, but in the event of any conflict, the NPS policy prevails.

Newark and Sherwood District Council (2023), Local Development Framework, Allocations and Development Management, Development Plan Document (AADMDPD)

This amended local Development Plan Document (DPD) has been compiled to ensure that the wider development framework within Newark and Sherwood District Council sufficiently allocates land for development to meet the needs of the area, up until 2033. This DPD is currently under examination via the Secretary of State with an independent planning inspector and therefore cannot be currently given weight, but may be relevant to the final ES.

Specific policies within the AADMDPD relevant to the Proposed Development include Policy DM4 *"Renewable and Low Carbon Energy Generation"* which states that:

"In order to achieve the commitment to carbon reduction set out in Core Policy 10, planning permission will be granted for renewable and low carbon energy generation development, as both standalone projects and part of other development, its associated infrastructure and the retro-fitting of existing development, where its benefits are not outweighed by detrimental impact from the operation and maintenance of the development and through the installation process upon:

1. The landscape character or urban form of the district or the purposes of including land within the Green Belt arising from the individual or cumulative impact of proposals;

2. Southwell Views as defined in Policy So/PV or the setting of the Thurgarton Hundred Workhouse, as defined in Policy So/Wh;

3. Heritage Assets and or their settings;

4. Amenity, including noise pollution, shadow flicker, and electro-magnetic interference;

5. Highway safety;

6. The ecology of the local or wider area; or

7. Aviation interests of local or national importance."

Central Lincolnshire Local Plan (2023)

The Local Plan for the central Lincolnshire area sets out the approach to planning policy and overarching development allocations to drive growth in the area over a 20-year period. The Local Plan is contextualised into a wider vision, series of objectives and core policies toward delivery.

Specific policies detailed in the Local Plan and are relevant to the Proposed Development, as below.

Policy S11 "*Embodied Carbon*" states that:

"All development should, where practical and viable, take opportunities to reduce the development's embodied carbon content, through the careful choice, use and sourcing of materials.

Presumption against demolition: To avoid the wastage of embodied carbon in existing buildings and avoid the creation of new embodied carbon in replacement buildings, there is a presumption in favour of repairing, refurbishing, re-using and re-purposing existing buildings over their demolition. Proposals that result in the demolition of a building (in whole or a significant part) should be accompanied by a full justification for the demolition. For non-listed buildings demolition will only be acceptable where it is demonstrated to the satisfaction of the local planning authority that:

1. the building proposed for demolition is in a state of such disrepair that it is not practical or viable to be repaired, refurbished, re-used, or re-purposed; or

2. repairing, refurbishing, re-using, or re-purposing the building would likely result in similar or higher newly generated embodied carbon than if the building is demolished and a new building is constructed; or

3. repairing, refurbishing, re-using, or re-purposing the building would create a building with such poor thermal efficiency that on a whole life cycle basis (i.e. embodied carbon and in-use carbon emissions) would mean a lower net carbon solution would arise from demolition and re-build; or

4. demolition of the building and construction of a new building would, on an exceptional basis, deliver other significant public benefits that outweigh the carbon savings which would arise from the building being repaired, refurbished, re-used, or re-purposed.

Applications within the countryside relating to the re-use or conversion of existing buildings will only be acceptable where they also meet the requirements of Policy S5, S34, or S43 as applicable.

Major development proposals:

All major development proposals should explicitly set out what opportunities to lower a building's embodied carbon content have been considered, and which opportunities, if any, are to be taken forward.

In the period to 31 December 2024, there will be no requirement (unless mandated by Government) to use any specific lower embodied carbon materials in development proposals, provided the applicant has at least demonstrated consideration of options and opportunities available.

From 1 January 2025, there will be a requirement for a development proposal to demonstrate how the design and building materials to be used have been informed by a consideration of embodied carbon, and that reasonable opportunities to minimise embodied carbon have been taken. Further guidance is anticipated to be issued by the local planning authorities on this matter prior to 1 January 2025.

Bassetlaw District Council (2010) Local Development Framework, Publication Core Strategy and Development Management Policies

The Core Strategy for the Bassetlaw District sets out the overarching vision for the area up until 2026, including the policy approach to deliver this.

Policy DM10 *"Renewable and Low Carbon Energy"* is related to the Proposed Development and states:

"A. Carbon Reduction The Council will be supportive of proposals that seek to utilise renewable and low carbon energy to minimise CO_2 emissions. Such proposals will be expected to demonstrate regard to the Council's Energy Opportunities Diagram and Renewable and Low Carbon Energy Study (or subsequent replacement) when identifying options for achieving CO_2 emission reductions. Proposals for renewable and low carbon energy infrastructure will need to demonstrate that they:

- *are compatible with policies to safeguard the built and natural environment, including heritage assets and their setting;*
- *will not lead to the loss or damage to high-grade agricultural land;*
- *are compatible with tourism and recreational facilities;*
- *will not result in unacceptable impacts in terms of visual appearance; landscape character; noise; shadow-flicker; watercourse engineering and hydrological impacts; pollution; traffic generation; or loss of features of recognized importance for biodiversity;*
- *will not result in an unacceptable cumulative impact in relation to the factors above.*

Large-scale renewable and low carbon energy proposals must provide full details of arrangements for decommissioning and reinstatement of the site if/when it ceases to operate.

Draft Bassetlaw Local Plan (2023) 2020-2038: Main Modifications Version, August 2023

This Local Plan sets out Bassetlaw District's planning and policy framework, development strategy and site allocations to inform effective delivery of the overall vision up until 2038.

Policies set out in the Local Plan relate to the Proposed Development.

Policy ST50 *"Reducing Carbon Emissions, Climate Change Mitigation and Adaptation"* states that:

"All proposals, including the change of use of existing buildings and spaces, should be designed to improve resilience to the anticipated effects of climate change taking into account the design principles in the Bassetlaw Design Quality SPD and the Bassetlaw Design Code. Proposals should incorporate, where appropriate, the following measures that address issues of climate change mitigation and adaptation through:

a) *ensuring no unacceptable adverse impact on local air quality;*
b) *designing layouts so that the orientation of buildings and spaces maximise opportunities for solar gain;*
c) *providing space for habitats and species to move through the landscape and for the operation of natural processes to occur;*
d) *where possible, minimising the use of natural resources over the development's lifetime, such as minerals and consumable products, by reuse*

or recycling of materials in construction, and by making the best use of existing buildings and infrastructure;

e) *adapting surface materials and drainage design to reduce the risk of flooding to land, property and people as a result of more extreme rainfall in accordance with Policy ST50;*
f) *using integrated water management systems to manage runoff and provide a non potable water supply;*
g) *providing green/blue infrastructure, and where possible, retaining existing trees and woodlands to reduce the 'urban heating effect' during warmer summers; and*
h) *using urban greening methods within the design of new buildings.*

All new non-residential development of 1000sqm floorspace or more will be required to meet the BREEAM very-good-excellent standards or equivalent. All new residential development in the District should promote water efficiency by meeting the tighter Building Regulations optional requirement of 110 litres/person/day. All major development will be required to make provision for 5 trees per dwelling or per 1,000 sqm of non-residential floorspace on site, or if on site provision is not practicable then an equivalent financial contribution will be sought to enable provision of new native trees and/or the protection and enhancement of ancient and veteran woodland within the District."

Guidance

Planning Practice Guidance (2023) - Climate Change (2019)

This guidance sets out the key issues in implementing the policies which protect and enhance the natural environment, also taking into consideration any local requirements. This guidance gives further specific information on climate change and advises users on how to identify mitigation and adaptation measures to tackle the main effects of climate change. This guidance furthermore goes through the integration of measures, the importance of considering climate change and information on passive solar design.

Institute of Environmental Management and Assessment (IEMA) EIA Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022)

This practitioner guidance helps to assist with recognising greenhouse gas emissions within EIA projects. Following the statutory requirement to consider climate change as part of EIA, this guidance sets out items to integrate through all assessment stages, and looks at some of the key challenges.

IEMA (2020) EIA Guide to: Climate Change Resilience and Adaptation

This document is seen as a reference point for considering climate change within EIA. This guidance gives a 7-step process toward building climate resilience into a project or development.

Royal Institute of Chartered Surveyors (RICS) (2023) Whole Life Carbon Assessment for the Built Environment

This is a standard which aims to ensure consistency and accuracy for carbon measurement in the built environment. More specifically, the standard aims to give guidance on producing a whole life carbon assessment which should integrate carbon impacts into the entire project lifecycle.

PAS 2080:2023 Carbon Management in Buildings and Infrastructure.

This standard can be implemented by practitioners and project developers to demonstrate the management and reduction of carbon production within infrastructure. PAS 2080 supports sustainable development and encourages the optimisation of emissions within built environments across design, construction and use. PAS 2080 also asks key questions of practitioners, challenging developers to consider the implications of proposing development in the first instance. **Appendix 15-2: Methodology for Determining Significance of Effects**

Appendix 15-2: Methodology for Determining Significance of Effects

GHG

The IEMA guidance[6] identifies three underlying principles to inform the assessment of significance, as follows:

- GHG emissions from all projects will contribute to climate change, the largest interrelated cumulative environmental effect;
- the consequences of a changing climate have the potential to lead to significant environmental effects on all topics in the EIA Directive – e.g., population, fauna, soil, etc.; and
- GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant.

Based on these principles, IEMA conclude that:

- when evaluating significance, all new GHG emissions contribute to an adverse environmental impact, however, some projects will replace existing development or baseline activity that has a higher GHG profile. The significance of a project's emissions should therefore be based on its net impact over its lifetime, which may be positive, negative or negligible;
- where GHG emissions cannot be avoided, the goal of the EIA process should be to reduce our Project's residual emissions at all stages; and
- where GHG emissions remain significant, but cannot be further reduced, approaches to compensate our Project's remaining emissions should be considered.

The first point above is important in the context of our Project as it is designed to provide zero emission energy that will reduce the reliance upon high-emission forms of power generation such as use of fossil natural gas. The GHG assessment will therefore consider Our Project's lifecycle GHG emissions against a baseline or counterfactual scenario which is the generation of electricity using natural gas. The baseline will only consider the operational emissions and not hypothesise about the construction of any new fossil fuel power stations (i.e. it assumes there will be no construction-related emissions in the baseline). The resulting comparison will allow the GHG benefits (i.e. GHG savings) of Our Project to be contextualised.

In advising on the significance of any net change in GHG emission resulting from a development IEMA identify that in order to limit the adverse effects from climate change global temperature change needs to be limited to well below 2°C, aiming for 1.5°C. The implication of this objective is that global emissions need to fall to net zero by 2050.

The UK's response to limiting climate change is enshrined in law through the Climate Change Act 2008 which requires the UK economy to be net zero by 2050 following a trajectory set through five-yearly carbon budgets. The 2050 target (and interim budgets set to date) are, according to the CCC, compatible with the required magnitude and rate of GHG emissions reductions required in the UK to meet the goals of the Paris Agreement, thereby limiting severe adverse effects.

It follows, therefore, that the significance of any net change of GHG resulting from a development is not so much whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions consistent with a trajectory towards net zero by 2050.

To establish the significance of the GHG emissions from a development therefore requires judgements on:

- the consistency with policy requirements, since these have been specified to ensure the economy decarbonises in line with the UK's net zero target; and
- the degree to which the development has sought to mitigate its emissions.

Examining each of these dimensions allows the assessment to make professional judgement on the likely significance of effects based on a set of significance criteria established in the IEMA guidance[6], summarised in **Table A15-2-1**.

Table A15-2-1: Significance Criteria for GHG Impact Assessment

Rating	Description	Criteria to Determine Significance of Net GHG Emissions
Major Adverse	A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards net zero.	Our Project's net GHG impacts are: • not mitigated or are only compliant with do-minimum standards set through regulation; and • do not provide further reductions required by existing local and national policy for projects of this type.
Moderate Adverse	A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards net zero.	Our Project's net GHG impacts are: • partially mitigated; and • may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type.

Minor Adverse	A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero.	Our Project's net GHG impacts are: • fully consistent with applicable existing and emerging policy requirements; and • in line with good practice design standards for projects of this type.
Negligible	A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions.	Our Project's net GHG impacts are: • reduced through measures that go well beyond existing and emerging policy; and • better than good practice design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050.
Beneficial	A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact.	Our Project's net GHG impacts are: • below zero; and • it causes a reduction in atmospheric GHG concentrations, whether directly or indirectly, compared to the without-project baseline.

The IEMA guidance[6] states:

"A project that is compatible with the budgeted, science based 1.5°C trajectory (in terms of rate of emissions reduction) and which complies with up-to-date policy and 'good practice' reduction measures to achieve that has a minor adverse effect that is not significant. It may have residual emissions but is doing enough to align with and contribute to the relevant transition scenario, keeping the UK on track towards net zero by 2050 with at least a 78% reduction by 2035 and thereby potentially avoiding significant adverse effects."

"A project that achieves emissions mitigation that goes substantially beyond the reduction trajectory, or substantially beyond existing and emerging policy compatible with that trajectory, and has minimal residual emissions, is assessed as having a negligible effect that is not significant. This project is playing a part in achieving the rate of transition required by nationally set policy commitments."

IEMA also advises that:

> Major adverse, moderate adverse and beneficial effects should be considered significant in the context of EIA. Minor adverse and negligible effects are considered to be not significant;

- In the case of large-scale developments, irrespective of the level of mitigation, if net GHG emissions exceed 5% of UK or devolved administrations carbon budget, that this is a level of change that is considered significant;
- Meeting the minimum standards set through existing policy or regulation cannot necessarily be taken as evidence of avoiding a significant adverse effect, and it is recommended therefore that the assessment also considers emerging policy/standards and the guidance of expert bodies such as the CCC on necessary policy developments, particularly for multi-phased projects with long timescales; and
- To aid decision making it is important to inform the decision maker about the relative severity of environmental effects such that they can be weighed in a planning balance. Therefore, it is essential to provide context for the magnitude of GHG emissions reported in the EIA in a way that aids evaluation of these effects by the decision maker. IEMA advise that context can be provided through comparison of the whole life GHG emissions resulting from the development with national, local and sectoral totals, as well as carbon budgets.

Therefore, the assessment of significance is established over two steps as follows:

Step 1: Establish Context of GHG Emissions

Context for decision making is provided by comparing the net change in the whole life GHG emissions resulting from Our Project, taking account of the counterfactual baseline scenario, and comparison of net emissions against national and sectoral GHG emissions totals, and carbon budgets.

In addition, a lifetime carbon intensity for the electricity generated by Our Project will be calculated (i.e. gCO_2e/kWh taking account of all construction, operational and decommissioning emissions) for comparison to other energy generation forms.

Step 2: Determine Significance of Effects

Significance of effects is established through applying the criteria detailed in **Table 13-8** based on professional judgement that considers:

- The consistency of the development with national, regional and local policies designed to limit GHG emissions and meet the UK's net zero target; and
- The robustness, timeliness and efficacy of mitigation measures proposed to avoid, reduce and compensate GHG emissions.

In terms of mitigation, IEMA recommends that mitigation should in the first instance seek to avoid GHG emissions. Where GHG emissions cannot be avoided, the development should aim to reduce the residual significance of a project's emissions at all stages. Where additional GHG emissions remain but cannot be further reduced at source, approaches should be considered that compensate our Project's remaining emissions, for example through offsetting.

CCR

The significance of CCR is determined as a function of the likelihood of a climate change risk occurring and the consequence to the receptor if the hazard occurs.

The assessment is carried out over four steps, as follows, in accordance with the IEMA Guidance.

Step 1: Identify Receptors

During this stage, relevant receptors in our Project which may be affected by climate change (e.g. change in average weather conditions and extreme events) are identified.

Step 2: Identify Potential Impacts of Climate Change on Receptors and Confirm Mitigation

This stage comprises identification of potential impacts of changes in a range of climate variables on the receptors identified in Step 1. This is undertaken using professional judgement, with reference to relevant supporting reports where appropriate (e.g. Flood Risk Assessment, Design and Access Statement, architectural designs, landscape strategy etc.), and identifies the design measures to mitigate the impacts.

Step 3: Assess the Significance of Effects of Climate Change on Receptors

This step assesses the significance of each hazard (using definitions in **Table A15-2-4**) based on scoring the likely consequence and likelihood of that hazard arising, using a five-point scale described in **Table A15-2-2** and **Table A15-2-3**. The assessment of significance and scoring of likelihood and consequence are based on IEMA guidance. The scoring of likelihood and consequence terminology has been taken from the IEMA guidance and is not directly transposable to the significance of effects.

Table A15-2-2: Qualitative Description of Consequence

Measure of Consequence	Description
Negligible	No damage to our Project, minimal adverse effects on health, safety and the environment or financial loss. Little change to service and disruption lasting less than one day.
Minor Adverse	Localised disruption or loss of service. No permanent damage, minor restoration work required: disruption lasting less than one day. Small financial losses and/or slight adverse health or environmental effects.

Moderate Adverse	Limited damage and loss of service with damage recoverable by maintenance or minor repair. Disruption lasting more than one day but less than one week. Moderate financial losses. Adverse effects on health or the environment.
Large Adverse	Extensive damage and severe loss of service. Disruption lasting more than one week. Early renewal of 50-90% of our Project. Permanent physical injuries and/or fatalities. Major financial loss. Significant effect on the environment, requiring remediation.
Very Large Adverse	Permanent damage and complete loss of service. Disruption lasting more than one week. Early renewal of our Project >90%. Severe health effects or fatalities. Extreme financial loss. Very significant loss to the environment requiring remediation and restoration.

Table A15-2-3: Qualitative Description of Likelihood

Measure of Likelihood	Description
Very High	The event occurs multiple times during the lifetime of our Project e.g., approximately annually.
High	The event occurs several times (approximately 12 events) during the lifetime of our Project.
Medium	The event occurs limited times (approximately 4 events) during the lifetime of our Project.
Low	The event occurs once during the lifetime of our Project.
Very Low	The event may occur once during the lifetime of our Project or may not occur at all.

These determinants are combined to assess the significance of effects on receptors, as shown in **Table A15-2-4**. The assessment is qualitative and uses expert judgement based on knowledge of similar schemes, engagement with the wider Project Team, and a review of relevant literature.

The assessment of significance follows the approach outlined in IEMA guidance and takes embedded mitigation / adaptation into account. Embedded mitigation / adaptation has been identified through consultation with our Project Team.

Table A15-2-4: Significance of Effects Matrix

Likelihood of Hazard Occurring	Consequence of Hazard Occurring				
	Negligible	Minor Adverse	Moderate Adverse	Large Adverse	Very Large Adverse
Very High	Not Significant	Significant	Significant	Significant	Significant
High	Not Significant	Not Significant	Significant	Significant	Significant
Medium	Not Significant	Not Significant	Significant	Significant	Significant
Low	Not Significant	Not Significant	Not Significant	Significant	Significant
Very Low	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Step 4: Establish Further Adaptation Measures and Determine Residual Effects

In the fourth step, further adaptation measures for any significant effects are identified through expert opinion, based on knowledge of similar schemes, and any residual effects of climate change on receptors are assessed using the criteria set out in **Table A15-2-2** to **Table A15-2-4**.

Appendix 15-3: GHG Footprint Methodology

Introduction

This appendix sets out the methodology for the calculating the baseline Greenhouse Gas (GHG) footprint, and GHG footprint for our Project. It covers the following GHG emissions sources:

Construction: embodied carbon, construction transport and site plant and machinery;

Operation: repair, maintenance and replacement, and transport; and

Energy intensity/energy offset.

The GHG footprint has been calculated for the lifetime of our Project, which includes a 2-month construction period (assumed to occur between 2027 and 2029) and then a 60-year operation period from 2029 onwards.

Details of the methodology to calculate the GHG emissions from each of the emission sources included in the GHG footprint is provided in the following sections.

Construction Phase

Embodied Carbon

Embodied carbon emissions from the construction phase of our Project have been estimated based on initial designs and the likely number of solar panels to be installed at our Site.

A detailed inventory of components and materials required to construct our Project is not yet available and so the embodied carbon emissions are based on the likely number of solar panels (which contribute the single largest portion to total embodied carbon emissions), supplemented with data from other similar projects.

In total, it is estimated that 1,400,000 PV panels will be installed as part of our Project, which will have an estimated annual generation capacity of 1,000,000 MWh. To estimate embodied emissions from the PV panels, a GHG emissions factor has been derived from an Environmental Performance Declaration (EPD) for Jolywood JW-HD156N-158.75 monocrystalline solar panels (manufactured in China)[8]. It is not specifically proposed to use these particular panels in our Project, but for the purposes of the PEIR they provide a reasonable estimate of the embodied carbon. The GHG emissions factor used, as derived from the EPD is 260.52 kgCO_2e/MWh.

[8] Environmental Performance Declaration (2020) Jolywood N-type Bifacial Double Glass PV Modules, valid to Nov 2025: https://pvsky.pl/wp-content/uploads/2021/12/Jolywood-JW-HD144N-445-470W-Raport-EPD.pdf

This leads to an estimate of embodied carbon from PV panels of 260,519 TCO_2e.

Based on experience of other large scale solar projects, it is estimated that the PV panels contribute 35% to total embodied carbon emissions. The total embodied carbon emissions have then been estimated based on this ratio and are 744,340 TCO_2e.

An estimated breakdown of embodied carbon emissions by each key component of our Project is presented in **Table 15-3.1**.

Table 15-3.1 Embodied Carbon Summary

Component	% of Total Embodied Carbon	Embodied Carbon (TCO_2e)
PV Panels	35.0%	260,519
PV Frames	10.0%	74,434
Mounting Structures	8.5%	63,269
Cables	7.0%	52,104
Inverters	10.0%	74,434
Transformers	1.0%	7,443
Switchgear	0.1%	744
DC-DC Converters	0.4%	2,977
Battery Cells	20.0%	148,868
HVAC Systems	0.3%	2,233
Battery Containers	3.0%	22,330
Substations	1.5%	11,165
Fencing	0.1%	744
CCTV	0.1%	744
Hard Surfacing	3.0%	22,330
TOTAL EMBODIED CARBON	**100.0%**	**744,340**

Construction Transport

Emissions from construction transport include transport of construction materials to our Project, as well as construction staff commuting to and from our Site.

Emissions from construction transport are informed by initial information available at PEIR stage in relation to construction transport and staff volumes and are based on the following assumptions, which will be further refined at ES stage:

construction vehicle movements will involve a mixture of articulated and rigid HGVs and smaller vans;

construction staff travel will be predominantly by private car;

average construction vehicle movements will be 70 miles within the UK;

key materials including PV panels, BESS and cables will be imported from China, with an estimated shipping distance of 10,000 nautical miles; and

construction staff average commuting distance will be 30 miles, covering a large number of Nottinghamshire and Lincolnshire towns and cities including Lincoln and Nottingham.

GHG factors for transport have been obtained from Department of Energy Security and Net Zero (DESNZ) GHG factors for company reporting, published for 2023[9].

GHG emissions from construction transport are estimated to be 28,113 TCO_2e.

Construction Site Plant and Machinery

Emissions from diesel consumed by construction site plant and machinery has been estimated based on data from the applicant in relation to the types of machinery to be used for the construction works. A detailed plan of plant requirements for each of the phases of the work has been obtained from ES **Chapter 5: Construction and Decommissioning Methodology**.

Fuel consumption for each machine/plant has been obtained from data in the European Environment Agency/EMEP emissions inventory guidebook[10]. The data provides fuel consumption per hour.

Emissions factors for diesel fuel consumption have been obtained from DESNZ data.

Construction site emissions are estimated using the following assumptions:

Numbers of each machine/plant have been estimated based experience of previous projects;

Site operating hours are 7:00 to 19:00 Monday to Saturday;

[9] Department for Energy Security and Net Zero (2023) Greenhouse gas reporting: conversion factors 2023: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023

[10] EEA/EMEP (2019) Air pollutant emissions inventory guidebook 2019, Part 1.A.4 Non road mobile machinery.

Each machine/plant operates for 50% of available site hours on average; and

Average engine loading during operation is 50% of full load/power.

The estimate of construction phase emissions from site plant and machinery are 18,330 TCO_2e.

Operation

Repair, Maintenance and Replacement

Repair, maintenance and replacement of our Project over its 60-year operational lifetime is predominated by the embodied carbon associated with parts and products used for repairs and replacements.

In order to be conservative, the assessment ignores the potential future decarbonisation of the mining, processing and manufacturing sectors and is based on current day carbon emissions data.

The following assumptions have been made in order to estimate lifetime emissions from repair, maintenance and replacement:

there will be one full replacement of all PV panels within our Project's lifetime;

the remaining components will be replaced and repaired at varying intervals, with lifetime emissions equivalent to 75% of embodied carbon emissions during construction.

The estimate of emissions from repair, maintenance and replacement are 627,191 TCO_2e.

Transport

During operation, there will only be a small number of vehicle movements associated with ongoing service and maintenance of our Project. Emissions from operational transport are based on 10 vehicles attending our Site each day for service and maintenance (on average).

It is assumed that each operational vehicle makes a 100 km round trip to visit our Project and that the typical vehicle used for operational service and maintenance is a van.

GHG emissions factors for transport have been obtained from DESNZ data and to be conservative no future decarbonisation is assumed.

The lifetime operational transport emissions are estimated to be 4,422 TCO_2e.

Decommissioning

There is little data with which to calculate decommissioning phase emissions for this PEIR. An estimate of decommissioning emissions has therefore been made using information on the scale and geography of our Project, and applying experience from other large scale solar schemes.

The estimate of decommissioning phase emissions considers emissions from the following sources:

Site Plant and Machinery;

Staff Transport; and

Waste Transport and Disposal

The decommissioning phase emissions are estimated to be 27,811 TCO_2e.

Energy Intensity/Offset

The calculation of the lifecycle energy intensity of our Project is calculated using the total lifecycle carbon emissions and the total expected lifetime electricity export. To calculate the lifetime electricity exported, the annual (opening year) value has been extrapolated over 60 years, assuming a PV panel degradation rate of 0.45% per annum. This is conservative as it ignores any replacement of the panels during our Project's lifetime.

A summary of the energy intensity calculation is provided in **Table 15-3.2**.

Table 15-3.2 Energy Intensity Calculation

Parameter	Value	Unit	Notes
Total Annual Electricity Export	1,000,000	MWh	Provided by Applicant.
Annual Degradation Rate	0.45	%	Assumption.
Total Lifetime (60-year) Electricity Export	52,035,000	MWh	
Total Lifetime GHG Emissions	1,450,208	TCO_2e	
Lifecycle Carbon Intensity	27.9	gCO2e/kWh	

Appendix 15-4: In-Combination Climate Change Effects

A summary of the in-combination effects of our Project is provided in **Table 15-4** below.

Table 15-4 Review of Potential In-Combination Climate Change Impacts and Effects

PEIR Technical Topic	Summary of Effects Identified in PEIR	In-Combination Climate Change Effect	Potential Effect
Biodiversity	There are no likely significant effects on biodiversity. Our Project will include grassland, wildflower meadows, hedgerow planting and tree planting; and existing habitats will be enhanced.	Future changes in climate will affect the created habitats indiscriminately between the future baseline and with our Project, until decommissioning. Ongoing management of the habitats within our Project, as set out within the Outline Landscape and Ecology Management Plan, will enhance their resilience to future climate change.	No likely significant effects
Hydrology and Hydrogeology	There are no likely significant effects on hydrology and hydrogeology. Our Project includes a design fluvial flood event as the 1 in 100 year plus 39% climate change scenario. This has resulted in solar panels being located outside of Flood Zone 3b and the base of solar panels being raised up to 1.8m above ground level (taking into account a 300mm freeboard). During construction appropriate management plans will be implemented to ensure water and contamination is controlled.	Future changes in climate change have already been considered within the design of our Project. The management plans, including the Outline Environmental Management Plan, will ensure any future changes in climatic conditions are effectively managed.	No likely significant effects

Land and Soils	There are no likely significant effects on contaminated land, groundwater or soil and agricultural land.	Changes to future climate such as higher peak temperatures or more intense rainfall may affect soil structure and/or soil quality. The management plans, including the Soil Resource Management Plan and Outline Environmental Management Plan, will ensure any future changes in climatic conditions are effectively managed such that any changes will not result in significant effects.	No likely significant effects
Buried Heritage	There are no likely significant effects on buried heritage assets.	Future climate change is not likely to buried heritage.	No likely significant effects
Cultural Heritage	There are likely significant (adverse) effects considered for designated heritage assets within 1km of our Site.	Changes to future climate such as higher peak temperatures or more intense rainfall may affect the overall structure of the asset (such as increased weathering of stonework) to a small degree over a long period of time, without regular management and maintenance in place, though not to the extent that these could be quantified or materially alter the identified effects. In addition, changes in climate change may affect our Projects boundary landscape planting, although the Outline Landscape and Ecology Management Plan, will enhance their resilience to future climate change.	No likely significant effects
Landscape and Visual	There are likely significant (adverse) effects considered for selected viewpoints and a change in the local character area.	As above, changes in climate change may affect our Projects boundary landscape planting, although the Outline Landscape and Ecology Management Plan, will enhance their resilience to future climate change.	No likely significant effects

Traffic and Access	There are no likely significant effects of severance, pedestrian, cyclist and driver delays and road safety.	Future climate change is not likely to directly affect road usage and as such will not impact upon severance or delays to pedestrians, cyclists and drivers. The UK Climate Projections (UKCP18) published by the Met Office predicts an increased frequency in winter storms, which may have a small impact on road safety, but the changes will not be sufficiently substantial to lead to significant effects on road safety.	No likely significant effects
Air Quality	There are no likely significant effects from the generation of dust or from emissions during constriction and decommissioning on human health or ecological sites.	Air quality is predicted to improve in the future, owing to lower emissions from road vehicles and heating and cooling plant as progressively lower emission technologies become available. As such air quality will not be significantly affected by future climate change.	No likely significant effects
Noise and Vibration	There are no likely significant effects of noise and vibration from construction, decommissioning or operation.	There are no climate change variables that materially affect the noise and vibration assessment. Changes to future climate such as higher peak temperatures or more intense rainfall may influence the baseline noise and vibration conditions to a small degree over a long period of time, though not to the extent that these could be quantified or materially alter the identified effects.	No likely significant effects

Human Health	There is a likely significant positive effect associated with climate change mitigation and adaption. Our Project contributes towards a positive effect on climate anxiety experienced by the population through the generation of clean energy.	The assessment has considered changes in climate conditions and as such no further assessment is required.	No likely significant effects
Socio-Economics	There are likely significant positive effects associated with increases in local employment and economy, and use of public right of ways.	Changes to future climate such as higher peak temperatures or more intense rainfall may influence the populations' ability to travel, work and the economy overall. Policy is in place to ensure the UK meets Net Zero by 2050. These climatic changes on population cannot be quantified or are likely to alter the identified effects.	No likely significant effects

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