Botley West Solar Farm

Preliminary Environmental Information Report

Volume 1

Chapter 14: Climate Change

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Approval for issue

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Glossary

Term	Meaning
UK Grid Carbon Intensity	Carbon intensity is a measure of how clean UK Grid electricity is. It refers to how many grams of carbon dioxide (CO_2) are released to produce a kilowatt hour (kWh) of electricity.
Future grid average	Projection of how clean the future UK Grid electricity is likely to be based on current policies. It refers to how many grams of carbon dioxide (CO_2) are released to produce a kilowatt hour (kWh) of electricity.
Life Cycle Assessment	The systematic analysis of the potential environmental impacts of products or services during their entire life cycle.
Marginal generation source	Accounts for sustained changes in energy consumption and generation sources for the purposes of cost-benefit analysis, including policy appraisal.
Scope 1 emissions	Direct greenhouse gas emissions from sources owned or controlled by the company (e.g. from combustion of fuel at an installation)
Scope 2 emissions	Caused indirectly by consumption of purchased energy (e.g. from generating electricity supplied through the UK Grid to an installation);
Scope 3 emissions	All other indirect emissions occurring as a consequence of the activities of the company (e.g. in the upstream extraction, processing and transport of materials consumed or the use of sold products or services).

Abbreviations

Abbreviations	Meaning
BEIS	The former Department for Business, Energy & Industrial Strategy
DESNZ	Department for Energy Security and Net Zero
DEFRA	Department for Environment, Food and Rural Affairs
EIA	Environmental Impact Assessment
ES	Environmental Statement
GHG	Greenhouse Gas
GWP	Global Warming Potential
LCA	Life Cycle Assessment
MOHC	Met Office Hadley Centre
NPPF	National Planning Policy Framework
NPS	National Policy Statement
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
RCP	Representative Concentration Pathway
UNFCCC	United Nations Framework Convention on Climate Change

Units

Unit	Description
%	Percentage
°C	Centigrade
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
$kgCO_2e$	Kilogrammes of Carbon Dioxide Equivalent
tCO_2e	Tonnes of Carbon Dioxide Equivalent
kWh	Kilowatt hour
MW	Megawatt
MWe	Megawatt electrical
MWh	Megawatt hour

14 Climate Change

14.1 Introduction

14.1.1 Overview

14.1.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) has been prepared by RPS on behalf of Photovolt Development Partners GmbH. (PVDP) for the Applicant, SolarFive Ltd. (SolarFive). SolarFive is a licence holder under the Electricity Act 1989. SolarFive is also a company registered in England and Wales (company no. 12602740).

14.1.1.2 PVDP intends to submit an application on behalf of SolarFive for development consent to the Planning Inspectorate (PINS) under the Planning Act 2008. The proposal is to install and operate approximately 840MWe of solar generation in parts of West Oxfordshire, Cherwell and Vale of White Horse Districts (the Project). The application will be accompanied by an Environmental Statement (ES) prepared in accordance with the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017, as amended (the EIA Regulations), and other required documents including a statement on pre-application consultation.

14.1.1.3 This PEIR summarises preliminary results of the assessment to date, before being further refined and reported within the Environmental Statement. The assessment was carried out in accordance with the approach set out in the Scoping Report. The purpose of the PEIR is to inform the statutory consultation process, enabling consultees to understand and comment on the likely significant effects of the Project.

14.1.1.4 Climate change in the context of EIA can be considered broadly in two parts:

- the potential effect of greenhouse gas (GHG) emissions caused directly or indirectly by the Project, which may have the potential to contribute to climate change; and
- the potential effect of changes in climate on the Project, which could affect it directly resulting in climate risk. However, climate risk has been scoped out of this assessment.

14.1.1.5 The climate change assessment also considers the potential effects of changes in climate on the Project, which could modify its other environmental impacts (i.e. in-combination climate change impacts). Such impacts will not be considered within this chapter. Consideration has been given within relevant topic chapters as to whether an effect is exacerbated by climate change such as Volume 1, Chapter 10: Hydrology and Flood Risk.

14.1.1.6 In particular, the PEIR chapter:

- sets out the existing and future environmental baseline conditions, established from desk studies, and consultation undertaken to date;
- presents the potential environmental impacts and likely significant effects of GHG emissions arising as a result of the Project, based on the

information gathered and the analysis and assessments undertaken to date;

- identifies any assumptions and limitations encountered in compiling the environmental information;
- highlights any necessary monitoring and/or mitigation measures that could prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process; and
- describes any monitoring required during construction or operation.

14.1.1.7 The assessment presented is informed by the following technical chapters:

- Volume 1, Chapter 9: Ecology and Nature Conservation;
- Volume 1, Chapter 10: Hydrology and Flood Risk;
- Volume 1, Chapter 17: Agricultural Land and Soils

14.1.1.8 This chapter also draws upon information contained within:

- Appendix 14.1 – Climate Change Policy; and
- Appendix 14.2 – Greenhouse Gas Calculations.

14.1.1.9 The PEIR will inform pre-application consultation. Following consultation, comments on the PEIR will be reviewed and taken into account, where appropriate, in preparation of the Environmental Statement (ES) that will accompany the application to the Planning Inspectorate for development consent.

14.2 Legislative and policy context

14.2.1.1 Further detail concerning relevant policy and legislation can be found in Appendix 14.1: Climate Change Policy. A summary of key policy and legislation relevant to this chapter is detailed below.

14.2.2 Legislation

14.2.2.1 The Climate Change Act 2008, as amended (2019), created a framework for setting a series of interim national carbon budgets and plans for national adaptation to climate risks. The Act requires the UK government to set carbon budgets[1] for the whole of the UK. The Climate Change Act 2008 (2050 Amendment) Order 2019 set a target of achieving net zero by 2050.

14.2.2.2 At present, the Third, Fourth, Fifth and Sixth Carbon Budgets, set through The Carbon Budget Orders 2009, 2011, 2016, and 2021 are 2.54 giga tonnes carbon dioxide equivalent ($GtCO_2e$) for 2018-2022, 1.95 $GtCO_2e$ for 2023-2027, 1.73 $GtCO_2e$ for 2028-2032 and 0.97 $GtCO_2e$ for 2033-2037 respectively. The Sixth Carbon Budget is the first Carbon Budget that is

[1] A carbon budget places restrictions on the total amount of GHGs that can be emitted. The budget balances the input of CO_2 to the atmosphere by emissions from human activities, by the storage of carbon (i.e. in carbon reservoirs on land or in the ocean).

consistent with the UK's net zero target, requiring a 78% reduction in GHG emissions by 2035 from 1990 levels.

14.2.2.3 The UK's nationally determined contribution (HM Government, 2020) under the Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC), submitted in December 2020, commits the UK to reducing economy-wide GHG emissions by at least 68% by 2030, compared to 1990 levels.

14.2.2.4 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (EIA Regulations), as amended, set out the requirements for EIA for NSIPs. Of particular relevant to climate change are the following points:

- "The EIA must identify, describe and assess in an appropriate manner, in light of each individual case, the direct and indirect significant effects of the proposed development on the following factors-… climate…"
- "A description of the factors specified in regulation 5(2) likely to be significantly affected by the development … air climate (for example greenhouse gas emissions, impacts relevant to adaptation) "
- ."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."

14.2.3 Guidance

14.2.3.1 The Climate Change Act 2008 also created the Committee on Climate Change, since renamed to the Climate Change Committee (CCC) to give advice on carbon budgets and report on progress. The CCC, through its Adaptation Sub-Committee, also gives advice on climate change risks and adaptation.

14.2.3.2 The CCC's Sixth Carbon Budget report makes the following policy recommendations, with regard to renewable energy deployment (Committee on Climate Change, 2020).

- Reducing demand and improving efficiency: require changes that will reduce carbon-intensive activities and the improvement of efficiency in the use of energy and resources.
- Take-up of low carbon solutions: phase out fossil fuel generation by 2035.
- Expansion of low carbon energy supplies: increasing renewables to 80% of generation by 2050.
- Electricity generation: will require a significant expansion of low carbon generation; this includes low cost renewables, with more flexible demand and storage.

14.2.3.3 Increasing the renewables penetration in the UK electricity mix to 80% by 2050 will largely be met with intermittent, non-dispatchable[2] generation types. In the Sixth Carbon Budget report, the CCC suggest that on average, 3 GW per year of solar generation will need to be installed to reach renewable supply targets.

14.2.3.4 The Net Zero Strategy: Build Back Greener (HM Government, 2021) sets out the UK's plans to achieve net zero emissions by 2050. Alongside this target is the ambition to fully decarbonise the UK's power system by 2035 through growth in renewable and nuclear power.

14.2.4 Planning policy context

National Policy Statements

14.2.4.1 There are currently six energy National Policy Statements (NPSs), three of which contain policy relevant to the Project, specifically:

- Overarching NPS for Energy (NPS EN-1) which sets out the UK Government's policy for the delivery of major energy infrastructure (DECC 2011a);
- NPS for Renewable Energy Infrastructure (NPS EN-3) (DECC 2011b); and
- NPS for Electricity Networks Infrastructure (NPS EN-5) (DECC 2011c).

14.2.4.2 These NPS' are currently being updated and draft versions were published March 2023 (DESNZ, 2023a; DESNZ, 2023b, DESNZ; 2023c).

14.2.4.3 NPS EN-1, NPS EN-3, and NPS EN-5, as well as the updated draft iterations, include guidance on what matters are to be considered in the assessment and also highlight a number of factors relating to the determination of an application and in relation to mitigation. These are summarised in Table 14.1 below.

Table 14.1: Summary of designated and draft NPS document requirements relevant to climate change

Summary of NPS requirement	How and where considered in the PEIR
NPS EN-1	
This NPS sets out how the energy sector can help deliver the Government's climate change objectives by clearly setting out the need for new low carbon energy infrastructure to contribute to climate change mitigation (section 2.3 of NPS EN-1).	Volume 1, Chapter 5: Need for the Project & Alternatives Considered

[2] Non-dispatchable sources of electricity generate electrical energy but cannot be turned on or off in order to meet fluctuating demand. The two main types of non-dispatchable sources are solar power and wind power.

Summary of NPS requirement	How and where considered in the PEIR
GHG assessments should include *"A whole life GHG assessment showing construction, operational and decommissioning GHG impacts…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"* (paragraph 5.3.4 of NPS EN-1).	This chapter provides an assessment of the construction and operational emissions in section 14.9, with justification provided for the scoping out of decommissioning emissions associated with the Project in Table 14.5. Emissions associated with the Projects operation are contextualised within the UK carbon budgets in paragraphs 14.9.3.12 to 14.9.3.18, to detail how the Project will impact efforts to limit climate change. Section 14.10 details the cumulative impact of the Project on climate change, in combination with relevant developments.
Draft NPS EN-1	
With regards specifically to mitigation: *"a GHG assessment should be used to drive down GHG emissions at every stage of the Project and ensure that emissions are minimised as far as possible for the type of technology", (paragraph 5.3.5 of Draft NPS EN-1)*	Committed mitigation measures to reduce emissions associated with the Project, particularly by embodied carbon reductions, are detailed at section 14.7.
"Applicants should include a carbon assessment as part of their ES, including a whole life carbon assessment (including the carbon impacts from construction, operation, and decommissioning). Alongside this, applicants should explain any steps taken to reduce climate change impacts at each of these stages" (paragraph 5.3.4 in the draft NPS EN-1).	This chapter provides an assessment of CO_2e emissions and other relevant greenhouse gases of the Project.
NPS EN-3	
Provides the primary policy for decisions by the Secretary of State on applications they receive for nationally significant renewable energy infrastructure defined at section 2.6 of NPS EN-3.	Volume 1, Chapter 5: Need for the Project & Alternatives Considered
Paragraph 3.4.10 of NPS EN-3 states that *'Solar photovoltaic (PV) sites may also be proposed in low lying exposed sites. For these proposals, applicants should consider, in particular, how plant will be resilient to:* • *increased risk of flooding; and* • *impact of higher temperatures.*	This chapter provides justification for not assessing the impact of higher temperatures in relation to its impact on the Project any further within Table 14.5. Consideration of flood risk shall be addressed within Volume 1, Chapter 10: Hydrology and flood risk of the PEIR.
NPS EN-5	
With regards to climate change adaptation, applicants must consider how the development is vulnerable to, and how it has been designed to be resilient to the increased risks of flooding, wind and storm events, heightened temperatures, and subsidence resulting from climate change (paragraph 2.3.1 of NPS EN-5).	Consideration of this, and justification for its scoping out of further consideration within this chapter, has been set out within Table 14.5.

Summary of NPS requirement	How and where considered in the PEIR
Draft NPS EN-5	
"The climate-warming potential of SF6 is such that applicants should, as a rule, avoid the use of SF6 in new developments. Where no proven SF6-free alternative is commercially available, and where the cost of procuring a bespoke alternative is grossly disproportionate, the continued use of SF6 is acceptable, provided that emissions monitoring and control measures compliant with the F-gas Regulation and/or its successors are in place" (paragraph 2.14.2 in the Draft NPS EN-5).	SF6 has been considered in this chapter in paragraph 14.8.5.5
(Paragraph 2.6.1 of Draft NPS EN-5) *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* • *Higher average temperatures leading to increased transmission losses* • *earth movement or subsidence caused by flooding or drought (for underground cables)*	This chapter provides justification for not assessing these impacts in relation to its impact on the Project any further within Table 14.5. Consideration of flood risk shall be addressed within Volume 1, Chapter 10: Hydrology and flood risk of the PEIR. Consideration of higher average temperatures leading to transmission losses has been laid out within Volume 1, Chapter 6: Project Description, in relation to solar PV manufacturing standards.

National Planning Policy Framework

14.2.4.4 The National Planning Policy Framework (NPPF) was published in 2012 and updated in 2018, 2019, 2021 and 2023 (Department for Levelling Up, Housing and Communities, 2023). The NPPF sets out the Government's planning policies for England.

14.2.4.5 **Table 14.2** sets out a summary of the NPPF policies relevant to this chapter.

Table 14.2: Summary of NPPF requirements relevant to this chapter

Policy	Key provisions	How and where considered in the PEIR
14. Meeting the challenge of climate change, flooding and coastal change	*'The planning system should support the transition to a low carbon future in a changing climate… Plans should take a pro-active approach to mitigating and adapting to climate change'.*	Section 14.9 provides an assessment of the GHG emissions associated with the Project.

Local Policy

14.2.4.6 Detail of local policy relevant to Chapter 14: Climate Change can be found in Volume 3, Appendix 14.1: Climate Change Policy.

14.3 Consultation and engagement

14.3.1.1 On 15 June 2023, the Applicants submitted a Scoping Report to the Planning Inspectorate, which described the scope and methodology for the technical studies being undertaken to provide an assessment of any likely significant effects for the construction, operation and maintenance and decommissioning phases. It also described those topics or sub-topics which are proposed to be scoped out of the EIA process and provided justification as to why the Project would not have the potential to give rise to significant environmental effects in these areas.

14.3.1.2 Following consultation with the appropriate statutory bodies, the Planning Inspectorate (on behalf of the Secretary of State) provided a Scoping Opinion on 24 July 2023. Key issues raised during the scoping process specific to climate change are listed in **Table 14.3**, together with details of how these issues have been addressed within the PEIR.

Table 14.3: Summary of scoping opinion, and Applicant responses

Comment	How and where considered in the PEIR
Planning Inspectorate	
ID – 3.8.4: GHG emissions – Decommissioning. *"Scoping Report paragraph 7.8.37 states that GHG emissions during decommissioning will be minimised through the recycling of PV modules and components where possible.* *The Inspectorate would expect to see a Decommissioning Plan, agreed with the Local Authority, secured through the inclusion of an Outline Decommissioning Plan or similar with the Application. The ES should clearly set out if and how impacts from GHG emissions will be assessed for the decommissioning "phase."*	Justification for the scoping out of in-depth consideration of decommissioning effects can be found within **Table 14.5**. It should be noted that an outline decommissioning plan will be submitted at ES stage alongside the application, in line with scoping opinion (ID – 3.8.4)
ID – 3.8.1: *"Risks from climate change are proposed to be scoped out on the basis that impacts are not likely to be considered significant during the Proposed Development's lifetime of 42 years. Mitigation will be embedded in the design and technology of the solar array to account for extreme weather events such as storms, high winds, and increased ambient temperatures.* *On the premise that the ES explains how and to what degree the design and technology accounts for these events, the Inspectorate agrees to scope this matter out."*	Justification for the scoping out of in-depth consideration of climate risk can be found within **Table 14.5**. Within the table, the PEIR lays out varying standard manufacturing standards applicable to the Project that mitigate for the matters raised in the scoping opinion (ID – 3.8.1). Consideration of risks such as extreme weather events and increased ambient temperatures has been laid out within Volume 1, Chapter 6: Project Description, in relation to solar PV manufacturing standards.

14.3.1.3 No further consultation or engagement has taken place with regard to climate change since the scoping stage.

14.4 Baseline methodology

14.4.1 Relevant guidance

14.4.1.1 The main guidance used for the assessment of GHG emissions in this PEIR chapter is the Institute of Environmental Management and Assessment (IEMA) guide 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (IEMA, 2022), in line with standard practice in EIA.

14.4.1.2 Additional guidance used for the quantification of GHG emissions includes:

- the Greenhouse Gas Protocol suite of documents (World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), 2004); and
- UK Government GHG Conversion Factors for Company Reporting (Department for Energy Security and Net Zero (DESNZ) and Department for Environment, Food and Rural Affairs (Defra), 2023).

14.4.2 Scope of the assessment

14.4.2.1 The scope of this PEIR has been developed in consultation with relevant statutory and non-statutory consultees as detailed in **Table 14.3.**

14.4.2.2 Taking into account the scoping and consultation process, **Table 14.4** summarises the issues considered as part of this assessment.

Table 14.4: Issues considered within this assessment

Activity	Potential effects scoped into the assessment
Construction phase	
Manufacturing and installation of the solar panels and associated infrastructure.	GHG emissions arising from such activity would contribute to global GHG emissions concentrations and climate change.
Operation and maintenance Phase	
Electricity export to the UK Electricity Grid	The Project would export energy to the grid that is zero-carbon at the point of generation (aside from the emissions associated with the construction phase), thereby displacing the marginal generating source that would be providing energy in the absence of the Project, in effect resulting in 'avoided' GHG emissions, which have been quantified within this chapter. Further context is provided in paragraph 14.8.5.4.

14.4.2.3 Effects which are not considered likely to be significant have been scoped out of the assessment. A summary of the effects scoped out is presented in **Table 14.5**.

Table 14.5: Issues scoped out of the assessment

Issue	Justification
Climate Risk	
Climate Risk: General	Risks to the Project from climate change are proposed to be scoped out of the assessment, as these are not considered likely to be significant during the Project's operating lifetime.

Issue	Justification
Increased Ambient Temperatures	Increased ambient temperatures as a result of climate change are scoped out, as the manufacturing standards for PV modules IEC TS 63126:2020, IEC 62548 and IEC 61215-1:2021 require modules to be functional over a wide range of temperatures, humidity and UV radiation. As such, the potential for small system efficiency losses due to hotter temperatures during the Project's lifetime are not considered to have any potential to significantly affect the lifecycle GHG emissions and thus significantly reduce the environmental effect of the renewable electricity generation.
Extreme Weather Events	Extreme weather events such as storms with high winds are also possible in the existing and future baseline and the Project's design will need to account for this. Manufacturing standards for PV modules (IEC TS 63126:2020, IEC 62548 and IEC 61215-1:2021) require consideration for extensive weathering (such as from hailstorms) and extreme thermal fluctuations. As such, extreme weather events are not considered to cause significant environmental effects to the Project.
Flood Risk	Flood risk is assessed, with appropriate climate change allowance, in the Flood Risk Assessment (Volume 3: Appendix 10.1) for the Project and no separate assessment has been undertaken within the climate change chapter.
Land-Use Change	
Land-use change: Construction	GHG emissions resulting from land-use change during construction are likely to be insignificant. This is due to the current agricultural land use which has limited carbon storage value and minimal disturbance during installation of solar PV modules and BoS components.
Land-use change: Operation	Carbon sequestration through biogenic growth during the operational period of the Project would also likely be insignificant compared to the magnitudes of GHGs emitted and avoided during the construction and operational phase of the Project (Bai and Cotrufo, 2022). As such the impact of land-use changes on the carbon sequestration potential of the land is scoped out.
Decommissioning	
Decommissioning	The GHG emissions associated with the decommissioning of the Project are also scoped out. This is because the vast majority of emissions associated with solar PV developments arises in the construction stage, from the embodied carbon of the PV modules and BoS components (International Energy Agency, 2021), and as such GHG emissions from decommissioning will be minimal in comparison and as such, have not been assessed further.

14.4.3 Study area

14.4.3.1 The red line boundary for the Project represents the relevant geographical study area for climate change for the purpose of this assessment. The current land use, direct and indirect emissions resultant from project elements (solar

array, balance of systems etc.) within the redline boundary have formed the basis of this assessment.

14.4.3.2 Although, it should be noted that indirect emissions from transportation, embedded material emissions etc. have no specific geographical study area as this is dependent upon to supply chain procurement activities. Where relevant, supply chain distance or location assumptions have been detailed in the methodology and Appendix 14.2 – Greenhouse Gas Calculations for context. GHG emissions have a global (international) effect rather than directly affecting any specific local receptor. The impact of GHG emissions occurring due to the Project on the global atmospheric concentration of the relevant GHGs, expressed in CO_2-equivalents (CO_2e), is therefore considered within this assessment.

14.4.3.3 The climate change study area for cloud cover change is the UKCP18 climate projections 25 km grid cell in which the Project site is located (MOHC, 2023).

14.4.4 Methodology for baseline studies

Desk Studies

14.4.4.1 Desk studies were undertaken to determine the GHG emissions and abatement of UK electricity Grid carbon intensity resultant from the Project.

Site-specific surveys

14.4.4.2 No site-specific surveys have been undertaken to inform the EIA for climate change.

14.5 Baseline environment

14.5.1 Desk study

14.5.1.1 Information on climate change within the study area and wider supply chain was collected through a detailed review of existing studies and datasets. These are summarised at **Table 14.6**, noting that this list is not exhaustive.

14.5.1.2 With regard to current GHG emissions from the site, the current baseline is agricultural land, comprised of a series of agricultural fields of varying sizes. They are primarily used for pasture grazing and arable farming. This land is unlikely to have high soil or vegetation carbon stocks (e.g. peat) that would be subject to disturbance by construction.

14.5.1.3 With regard to the electricity export of the Project, the baseline is the current average grid electricity carbon intensity. This value has been taken from published benchmarks (DESNZ & DEFRA, 2023) and is 0.25694 $kgCO_2e/kWh$, which is inclusive of Well-to-tank (WTT) and WTT Transmission and Distribution (T&D) Losses.

Table 14.6: Summary of desk study sources used

Title	Source	Year	Author
UK Government GHG Conversion Factors for Company Reporting.	Department for Energy Security and Net Zero (DESNZ) and Department for Environment, Food and Rural Affairs (Defra)	2023	DESNZ and DEFRA
Evaluating the Environmental Performance of Solar Energy Systems Through a Combined Life Cycle Assessment and Cost Analysis	Sustainability Journal	2019	Milousi et al.
Life cycle greenhouse gas emissions of crystalline silicon photovoltaic electricity generation: systematic review and harmonization	Journal of Industrial Ecology	2012	NREL
Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book.	Gov.UK	2022	DESNZ and Department for Business, Energy & Industrial Strategy (BEIS)
Renewable sources of energy: 'Load factors for renewable electricity generation (DUKES 6.3)	Digest of UK Energy Statistics (DUKES)	2022	DESNZ & BEIS
Special Report on Solar PV Global Supply Chains.	International Energy Agency	2022	IEA
Future Energy Scenarios	ESO National Grid	2022	ESO National Grid

14.5.2 Site-specific surveys

14.5.2.1 No site-specific surveys have been undertaken to inform the EIA for climate change.

14.5.3 Future baseline conditions

14.5.3.1 The future baseline GHG emissions for existing land-use without the Project are expected to remain similar, with a decrease in agriculture-related emissions over time in line with the UK's national climate change policies.

14.5.3.2 The future baseline for electricity generation that would be displaced by the Project depends broadly on future energy and climate policy in the UK, and more specifically (with regard to day-to-day emissions) on the demand for renewable energy generation sources such as the operation of the Project

compared to other generation sources available, influenced by commercial factors and National Grid's needs.

14.5.3.3 Under the UK's climate targets and ambitions, the power system is intended to be fully decarbonised by 2035, as set out in the Net Zero Strategy: Build back greener (HM Government, 2021). Projections of this decarbonisation are provided by BEIS (long run marginal projections, further detail within Appendix 14.2) and are subject to the successful implementation of renewable energy generation projects such as this Project. These provide a valuable indicator of the rate of necessary – and expected – progress in reducing the carbon intensity of electricity generation as context for the Project's performance over its lifetime.

14.5.3.4 However, to solely assess the Project's impact against a decarbonisation scenario which effectively relies upon its own, or similar projects', development occurring would understate the potential avoided emissions.. Further, the long run marginal figures are only a future baseline projection and cannot be taken with certainty. Finally, the BEIS projections are for the operational carbon intensity of generation sources, not accounting for embodied carbon and the full life-cycle effects.

14.5.3.5 As such, the current grid average intensity figure of 0.25694 $kgCO_2e/kWh$ (DESNZ & DEFRA, 2023) will also be considered. It is a static figure that does not represent the likely scenario of an increasingly decarbonised grid over the Project's 31 year estimated operational lifespan.

14.5.3.6 It is likely that the true value of avoided emissions as a result of the Project will fall somewhere within the range of the two above scenarios. The current grid average represents a scenario that lacks future renewable energy deployment to the UK national grid, whereas the long run marginal accounts for future renewable energy installation, in line with current policy. Therefore, both the current grid average and long run marginal projections have been used to provide a range of values for the current baseline and future business-as-usual baseline against which the benefits of the Project have been calculated.

14.5.4 Key receptors

14.5.4.1 Table 14.7 identifies the receptors taken forward into the assessment.

Table 14.7: Key receptors taken forward to assessment

Receptor	Description	Sensitivity/value
Global atmospheric mass of the GHGs	GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in CO_2e has therefore been treated as a single receptor.	High sensitivity

14.6 Key parameters for assessment

14.6.1 Maximum design scenario

14.6.1.1 The maximum design scenarios identified in **Table 14.8** have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the Project Design Envelope provided in Volume 1, Chapter 6: Project description of the PEIR. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (e.g., different infrastructure layout), to that assessed here be taken forward in the final design scheme.

Table 14.8: Maximum design scenario considered for the assessment of potential impacts

Potential impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
The impact of GHG emissions arising from the manufacturing, transportation of materials, and installation of the Project.	Yes	No	No	**Construction phase** • The maximum capacity of solar generation that consent is being sought for – approximately 840 MWe • Indicative Number of Solar PV Modules – 2,300,000 PV modules • Maximum Watts peak (Wp) for solar modules – approximately 1350 MWp • Indication PV mounting structure material - Mix between galvanized steel and aluminium fixed tilt with stainless steel screws and clamps. • Indicative total number of piles – 2,500,000 (use of concrete shoes possible but only in areas of high archaeology interest) • Indicative number of Power Converter Stations (PCS) - 156 (PCS containing two inverters plus two MV transformers) • DC cables from solar PV modules to inverters – Length: TBD • NGET Substation: – Footprint: 180 x 150m (i.e. 27,000 m^2) – Height: 15m – Site area: 3.8ha • Secondary Substations – HV transformers (4 x 200 MVA, 1 x 80 MVA,1 x 60 MVA) – Footprint (per substation): 18 x 10m (i.e. 180 m^2) • Main Project Substation: – Footprint: 1 ha (i.e. 10,000 m^2) – HV transformers (2 x 500 MVA) • Power Control Stations (PCS) – 156 MV transformers (6 MVA), one per PCS – Footprint (per substation) 14 x 2.9 m (i.e. 40.6 m^2)	The maximum capacity of solar generation that consent is being sought for will equally result in the maximum consumption of fuel and materials arising from manufacturing and installation of the Project if it is capable of this capacity of generation, representing the greatest potential for GHG emissions.

Potential impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
				• AC cables from transformers to secondary substation: Length: TBD	
The impact of GHG emissions arising from the operation of the Project.	No	Yes	No	**Operation and maintenance phase** • The maximum capacity of solar generation that consent is being sought for approximately 840 MWe	The greatest generating capacity represents the greatest abatement of fossil fuels from the Grid. A capacity factor based on historic averages achieved across the UK and reasonable degradation factor ensures a conservative operational output for the lifetime Project. It is anticipated that in the future developments would achieve higher capacity factors and as such a higher operational output and subsequent abatement of fossil fuels from the Grid.

[a] C=construction, O=operational and maintenance, D=decommissioning

14.7 Mitigation measures intended to be adopted as part of the Project

14.7.1.1 For the purposes of the EIA process, the term 'Measures adopted as part of the Project' is used to include the following types of mitigation measures (adapted from IEMA, 2016):

- Primary (inherent) mitigation – measures included as part of the project design. IEMA describes these as '*modifications to the location or design of the development made during the pre-application phase that are an inherent part of the project and do not require additional action to be taken'*. This includes modifications arising through the iterative design process. These measures will be secured through the consent itself through the description of the project and the parameters secured in the Development Consent Order (DCO). For example, a reduction in footprint or height.
- Secondary (foreseeable) mitigation. IEMA describes these as '*actions that will require further activity in order to achieve the anticipated outcome'*. These include measures required to reduce the significance of environmental effects (such as lighting limits) and may be secured through an environmental management plan.
- Tertiary (inexorable) mitigation. IEMA describes these as '*actions that would occur with or without input from the EIA feeding into the design process. These include actions that will be undertaken to meet other existing legislative requirements, or actions that are considered to be standard practices used to manage commonly occurring environmental effects*'. It may be helpful to secure such measures through a Code of Construction Practice or similar.

14.7.1.2 For the purposes of this PEIR, mitigation measures set out are those considered to be appropriate for the Project at this time. They may evolve and/or be refined in response to the statutory consultation process and/or other considerations.

14.7.1.3 Where relevant, measures have been identified that may result in enhancement of environmental conditions. The mitigation measures relevant to this chapter are summarised in **Table 14.9**.

14.7.1.4 Primary and tertiary measures that are intended to form part of the final design (and/or are established legislative requirements/good practice) have been taken into account as part of the initial assessment presented in section 14.9 below (i.e., the initial determination of impact magnitude and significance of effects assumes implementation of these measures). This ensures that the measures that the Applicants are intending to commit to, are taken into account in the assessment of effects.

14.7.1.5 Where an assessment identifies likely significant adverse effects, further mitigation measures may be applied. These are measures that could further prevent, reduce and, where possible, offset these effects. They are defined by IEMA as actions that will require further activity in order to achieve the anticipated outcome and may be imposed as part of the planning consent, or through inclusion in the ES (referred to as secondary mitigation measures in

IEMA, 2016). For further or secondary measures both pre-mitigation and residual effects are presented.

Table 14.9: Mitigation measures intended to be adopted as part of the Project.

Mitigation number	Measure adopted	How the measure will be secured
14.1	As a renewable energy development, climate change mitigation is an inherent aim of the Project. In order to ensure maximum energy yield, and therefore maximum GHG emissions displacement, the solar array would be south facing, and rows of panels would be distanced between 3 and 6 m apart from one another so as to avoid inter-panel shading.	Committed within the Project design set out in: Volume 1, Chapter 6: Project Description
14.2	Where practicable, pre-fabricated elements would be delivered to the site ready for assembly, which will reduce on-site construction waste and reduce vehicle movements as part of the construction process.	Outline Code of Construction Practice (CoCP), to be submitted alongside the Environmental Statement.
14.3	Construction materials would be sourced locally where practicable, to minimise the impact of transportation.	Outline Code of Construction Practice (CoCP), to be submitted alongside the Environmental Statement.
14.4	Vehicles used in road deliveries of materials, equipment and waste arisings on- and off-site would be loaded to full capacity, wherever practicable, to minimise the number of journeys associated with the transport of these items.	Outline Code of Construction Practice (CoCP), to be submitted alongside the Environmental Statement.
14.5	All machinery and plant would be procured to adhere with relevant good practice emissions standards at the time of procurement, where feasible and should be maintained in good repair to remain fuel efficient.	Outline Code of Construction Practice (CoCP), to be submitted alongside the Environmental Statement.
14.6	When not in use, vehicles and plant machinery involved in site operations would be switched off to further reduce fuel consumption.	Outline Code of Construction Practice (CoCP), to be submitted alongside the Environmental Statement.
14.7	The volume of waste generated would be minimised, and resource efficiency maximised, by applying the principles of the waste hierarchy throughout the construction period. Segregated waste storage should be employed to maximise recycling potential for materials.	Outline Code of Construction Practice (CoCP), to be submitted alongside the Environmental Statement.
14.8	GHG emissions arising from the construction stage can be minimised via engagement with the supply chain and procurement decisions that consider GHG emissions performance as documented through Environmental Product Declarations. Where feasible, construction elements such as solar panel modules and associated components will be selected with consideration of minimising GHG impacts.	Outline Code of Construction Practice (CoCP), to be submitted alongside the Environmental Statement.

Mitigation number	Measure adopted	How the measure will be secured
14.9	Equipment and machinery requiring electricity would only be switched on when required for use. Procedures would be implemented to ensure that staff adhere to good energy management practices, e.g. through turning off lights, computers and heating/air conditioning units when leaving buildings.	Outline Code of Construction Practice (CoCP), to be submitted alongside the Environmental Statement.

14.8 Impact assessment methodology

14.8.1.1 The methodology used for the climate change impact assessment has followed the general principles set out in Volume 1, Chapter 4: Approach to Environmental Assessment of the PEIR. Topic specific guidance for GHG assessments for EIA (IEMA 2022) has informed the assessment of effect for GHG emissions as detailed below.

14.8.1.2 GHG emissions have been estimated by applying published factors to activities in the baseline and to those required for the Project. The emissions factors relate to a given level of activity, or amount of fuel, energy or materials used, to the mass of GHGs released as a consequence.

14.8.1.3 In order to undertake a climate change impact assessment, information gathered in Volume 3, Appendix 14.2: Greenhouse gas calculations of the PEIR has been utilised. This information is sourced from primary calculations and secondary sources to calculate the effect of the Project on climate change.

14.8.1.4 The GHGs considered in this assessment are those in the 'Kyoto basket'[3] of global warming gases expressed as their CO_2-equivalent global warming potential (GWP). This is denoted by CO_2e units in emissions factors and calculation results. GWPs used are typically the 100-year factors in the IPCC Fifth Assessment Report (IPCC, 2013) or as otherwise defined for national reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

14.8.1.5 Additional guidance used for the quantification of GHG emissions includes:

- UK Government GHG Conversion Factors for Company Reporting (DESNZ and DEFRA, 2023); and
- The Greenhouse Gas Protocol suite of documents (World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), 2004).

14.8.1.6 GHG emissions caused by an activity are often categorised into 'scope 1', 'scope 2' or 'scope 3' emissions, following the guidance of the WRI and the WBCSD Greenhouse Gas Protocol suite of guidance documents (WRI and WBCSD, 2004).

- Scope 1 emissions: direct GHG emissions from sources owned or controlled by the company (e.g. from combustion of fuel at an installation);
- Scope 2 emissions: caused indirectly by consumption of purchased energy (e.g. from generating electricity supplied through the UK Grid to an installation); and
- Scope 3 emissions: all other indirect emissions occurring as a consequence of the activities of the company (e.g. in the upstream extraction, processing and transport of materials consumed or the use of sold products or services).

[3] The 'Kyoto Basket' encompasses the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (SF_6).

14.8.1.7 This assessment has sought to include emissions from all three scopes, where this is material and reasonably possible from the information and emissions factors available, to capture the impacts attributable most completely to the Project. These emissions have not been separated out by defined scopes (scopes 1, 2 or 3) within this assessment.

14.8.1.8 Scope 3 emissions resulting from the manufacturing and construction of the solar panels, associated balance of system (BoS)[4] components have been calculated via published benchmark carbon intensities and published life-cycle assessment (LCA) literature regarding photovoltaic (PV) panel technology.

14.8.1.9 The assessment has considered (a) the GHG emissions arising from the Project, (b) any GHG emissions that it displaces or avoids, compared to the current or future baseline, and hence (c) the net impact on climate change due to these changes in GHG emissions overall.

14.8.1.10 The majority of the construction-stage GHG emissions associated with the manufacturing of components are likely to occur outside the territorial boundary of the UK and hence outside the scope of the UK's national carbon budget. However, in recognition of the climate change effect of GHG emissions (wherever occurring) and the need, as identified in national policy, to avoid 'carbon leakage' overseas when reducing UK emissions, the full life-cycle GHG emissions of the Project have been evaluated where possible when determining the significance of effects.

14.8.2 Receptor sensitivity/value

14.8.2.1 GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in CO_2e, has therefore been treated as a single receptor of **high sensitivity** (given the importance of the global climate as a receptor), as defined within IEMA's 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' guidance (IEMA, 2022).

14.8.3 Magnitude of impact

14.8.3.1 In accordance with the IEMA GHG in EIA Guidance (2022) GHG emissions have been quantified directly and expressed based on their GWP as tonnes of CO_2e emitted, the magnitude of impact is reported numerically. Where a quantifiable figure is not possible this is expressed qualitatively.

14.8.4 Significance of effect

14.8.4.1 The significance of the effect upon the climate has been determined by taking into account the sensitivity of the receptor and the magnitude of the impact.

[4] BoS components are predominantly comprised of inverters, electrical cabling and frames/mounting structures.

14.8.4.2 In all cases, the evaluation of receptor sensitivity, impact magnitude and significance of effect has been informed by professional judgement and is underpinned by narrative to explain the conclusions reached.

14.8.4.3 Assessment guidance for GHG emissions (IEMA, 2022) describes five levels of significance for emissions resulting from a development, each based on whether the GHG emission impact of the development will support or undermine a science-based 1.5 °C compatible trajectory towards net zero. To aid in considering whether effects are significant, the guidance recommends that GHG emissions should be contextualised against pre-determined carbon budgets, or applicable existing and emerging policy and performance standards where a budget is not available. It is a matter of professional judgement to integrate these sources of evidence and evaluate them in the context of significance.

14.8.4.4 Taking the guidance into account, the following have been considered in contextualising the Project's emissions:

- The magnitude of net GHG emissions as a percentage of national and local carbon budgets (where feasible).
- The GHG emissions intensity of the Project against current baseline emissions intensity for such energy generation and projections or policy goals for future changes in that baseline; and
- Whether the Project contributes to, and is in line with, the UK's policy for GHG emissions reductions, where these are consistent with science-based commitments to limit global climate change to an internationally-agreed level (as determined by the UK's nationally determined contribution to the Paris Agreement (HM Government, 2020))

14.8.4.5 Effects from GHG emissions are described in this chapter as adverse, negligible or beneficial based on the following definitions, which follows the examples in Box 3 of the IEMA guidance (IEMA, 2022) as follows:

- **Major adverse:** the Project's 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:** the Projects 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:** the Projects GHG impacts would be reduced through measures that go well beyond existing and emerging policy requirements and good practice design standards for projects of this type.
- **Negligible:** the Projects GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050.

- **Beneficial:** the Projects net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline.

14.8.4.6 Major and moderate adverse effects and beneficial effects are considered to be significant in EIA terms. Minor adverse and negligible effects are not considered to be significant in EIA terms.

14.8.4.7 GHG emissions associated with a proposed project are often reported as a whole life figure (net emissions) that takes account of all stages of the Project. The net whole life figure is the key element for determining the Project's whole life impact on climate change. However, it is noted in the IEMA guidance (2022) that due to the nature of GHG emissions, it is good practice to include a section that reports on the whole life GHG emissions associated with the Project, alongside the sections that assess construction, operation, and decommissioning effects in isolation. This approach has been taken for the purpose of this assessment.

14.8.5 Assumptions and limitations of the assessment

14.8.5.1 There is uncertainty about future climate and energy policy and market responses, which affect the likely future carbon intensity of energy supplies, and thereby the future carbon intensity of the electricity generation being displaced by the Project. UK Government projections consistent with national carbon budget commitments have been used in the assessment.

14.8.5.2 The construction-stage GHG implications are primarily based upon photovoltaic (PV) lifecycle GHG meta-analysis from 2012 (NREL, 2012), and further Solar PV LCA conducted by Milousi et al (2019). Given that the lifecycle GHG implications of PV systems are heavily dependent on the energy-intensive processes used in the manufacturing of the modules and BoS components, as well as the energy mix used in delivering that energy, the developments in the energy industry since 2012 could render the first source (NREL, 2012) out of date. The results of the two main sources referenced, NREL (2012), and Milousi et al (2019) are similar in terms of the stated carbon intensities of crystalline-silicone (c-Si) panels, thereby corroborating that the results obtained from the two sources are congruent, helping to negate the potential limitation of the relevance of the NREL (2012) study due to its age. The use of existing data regarding current technologies, supply chains and manufacturing processes is a conservative position. These technologies and manufacturing processes may well be improved upon.

14.8.5.3 Whilst the type of panels selected for the Project are still currently unknown, the Milousi et al (2019) study assesses mono c-Si panels, which is the more carbon intensive option and thus provides an appropriate conservative estimate in the absence of more detailed design information.

14.8.5.4 Regarding quantification of the associated operational GHG emissions from the Project, there are a number of uncertainties. These include, the unknown future development of climate policy and targets for renewables deployment actually being met and subsequent reductions in future UK electricity Grid carbon intensity as forecast within the BEIS (2022) long run marginal figures. The long run marginal figures are dynamic and show year-on-year

decarbonisation towards the UK's committed net zero 2050 pledge accounting for increases in renewable generation sources (such as Botley West Solar Farm) supplying the UK electricity Grid. As such comparison with the future long run marginal factors have the potential to understate the benefit of the Project's avoided emissions. As such, the current carbon intensity of UK electricity Grid can be used as a static point to represent the displacement of current generation sources making up the UK electricity Grid. Due to this, these two scenarios detail the potential range of avoided emissions displaced by the Project through its life time as described further in 14.5.3.5 and 14.5.3.6.

14.8.5.5 Sulphur hexafluoride (SF6) is a powerful greenhouse gas with a global warming potential of 23,900. Fugitive emissions of SF6 from certain electrical items such as gas insulated switchgear, as proposed as part of this Project, have historically been a significant source of emissions. Manufacturers of such equipment are now increasingly able to offer SF6-free components, and those that do continue to use SF6 are sealed-for-life with extremely low leakage rates (Widger & Haddad, 2018). For this reason, it is assumed that emissions of SF6 from the Project will be negligible and not material to the GHG assessment, as such, they have not been considered further.

14.8.5.6 The above uncertainties are integral to the assessment of climate change effects but a precautionary approach has been taken as far as practicable to provide a reasonable worst case assessment. On the basis of the above, it is considered that limitations to the assessment have been minimised and that the results provide a sufficiently robust estimate of the impacts of the Project to identify likely significant effects.

14.9 Assessment of effects

14.9.1.1 The impacts of the construction, operation and maintenance, and decommissioning phases of the Project have been assessed. The potential impacts arising from the construction, operation and maintenance and decommissioning phases of the Project are listed in **Table 14.8**, along with the maximum design scenario against which each impact has been assessed.

14.9.1.2 A description of the potential effect on receptors caused by each identified impact is given below.

14.9.1.3 The assessment of significant effects relating to climate change is assessing the effects of GHG emissions on climate change, with the effects of climate change risk scoped out of the assessment.

14.9.2 Impact 1 – GHG emissions arising from the manufacturing, transportation of materials and installation of the Project

14.9.2.1 The manufacturing, transportation of materials and installation of the Project would result in both direct and indirect GHG emissions.

Construction phase

Sensitivity of the receptor

14.9.2.2 GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in CO_2e, has therefore been treated as a single receptor of **high sensitivity** (given the severe consequence of global climate change and the cumulative contributions of all GHG emissions sources).

Magnitude of impact

14.9.2.3 The majority of the construction-stage impacts are 'Scope 3' (supply chain) emissions resulting from the extraction of raw materials and manufacturing of the PV cells, inverters, transformers and other BoS components.

14.9.2.4 Solar PV LCAs are complex, given the large number of materials and processes involved in the production of PV modules and BoS components. Furthermore, the associated GHG emissions are dependent on the location (and associated energy mix) of where these processes are occurring. As such, a site specific detailed LCA is beyond the scope of this assessment. Instead, a robust approach has been formulated by considering meta-analyses of published solar PV LCAs, thereby accounting for the likely range of magnitude of the Project's construction-stage GHG emissions.

14.9.2.5 The primary sources of emissions factors used in assessing the embodied carbon effects of the Project was NREL's (2012) 'Life Cycle Greenhouse Gas Emissions of Crystalline Silicon Photovoltaic Electricity Generation', an in-depth meta-analysis of over 397 LCAs regarding c-SI PV systems, and Milousi et al's (2019) more recently published 'Evaluating the Environmental Performance of Solar Energy Systems Through a Combined Life Cycle Assessment and Cost Analysis'.

14.9.2.6 Using the lower to upper limit ranges from the NREL (2012) study for lifecycle GHG intensity (39 – 49 gCO_2e/kWh), the projected construction stage GHG impact of the panels and associated BoS components is between 1,394,102 tCO_2e and 1,751,564 tCO_2e (lower to upper limits). This is detailed within **Table 14.10**, below.

Table 14.10: Construction stage GHG emissions

	Lower limit	Median	Upper limit
Lifecycle GHG intensity (gCO_2e/kWh)	39	44	49
Total GHG (tCO_2e/MW_p)	1,660	1,872	2,085
Capacity (MW_p)	840	840	840
Total Development GHG (tCO_2e)	**1,394,102**	**1,572,833**	**1,751,564**

14.9.2.7 To provide further confidence in the results expressed in **Table 14.10,** a recent study by Milousi et al (2019) was also considered. This study calculated the lifecycle GHG implications of 3 kW PV systems of varying panel technology in

Crete, which were therefore under similar irradiance conditions to the harmonized irradiance value expressed in the NREL study. The Milousi et al (2019) study concluded that mono-Si systems have a lifecycle GHG impact of 52.4 gCO_2e/kWh, whilst multi-Si systems have a lifecycle GHG impact of 44.3 gCO_2e/kWh. These results provide further confidence that the results expressed in **Table 14.10** are in the correct order of magnitude.

14.9.2.8 As the Milousi et al (2019) study is both the more recent study, as well as offering the most conservative estimation of the lifecycle GHG impact of panels at 52.4 gCO_2e/kWh, this has been used to establish the estimated construction GHG emissions of the Project to be 1,873,101 tCO_2e, for the solar array and associated BoS. Further information regarding the methodology and calculations can be found within Appendix 14.2.

14.9.2.9 Additional elements of the Project that are not included within the emissions total above include the transformers and housing associated with the Projects substations and Power Control Stations (PCS). These elements have been assessed in detail within Volume 3, Appendix 14.2: Greenhouse Gas Calculations, resulting in construction emissions of 30,504 tCO_2e.

14.9.2.10 The magnitude is therefore, considered to be is **1,903,605 tCO_2e** for the construction phase.

Significance of the effect

14.9.2.11 As stated in paragraph 14.8.1.8, the majority of construction-stage emissions are likely to occur from the PV cell supply chain outside the territorial scope of the UK's national carbon budget, so, it is not meaningful to contextualise emissions within this budget in order to assess their significance. However, carbon leakage (offshoring of emissions) has been identified as a risk in the UK's Net Zero Strategy (HM Government, 2021, page 122) and in advice published by the Committee on Climate Change (2020) with regard to industrial decarbonisation.

14.9.2.12 As GHG impacts are global, regardless of where the release point is geographically located, for the purpose of EIA the GHG impacts of the Project are assessed against the significance criteria in UK guidance and goals for emission reduction, despite occurring outside the UK's territory.

14.9.2.13 The majority of emissions occur at LCA stages A1-3. At this stage of planning and design, no embedded mitigation to reduce GHG emissions at the manufacturing stage of the PV cells has been specified, so it cannot be concluded that the GHG impacts at the construction stage are in keeping with current and emerging local and national climate policy regarding the transition towards net zero.

14.9.2.14 Considering the potential magnitude of GHG emissions set out in paragraph 14.9.2.10and absence of mitigation or reduction of emissions, based on the definitions in paragraphs 14.8.4.5 and 14.8.4.6 the magnitude of impact on the **high sensitivity** receptor would result in **moderate adverse** construction-stage effect, which is significant in EIA terms.

14.9.2.15 However, as the purpose of the Project is to provide a source of renewable energy, the construction-stage effects must be considered together with the

long-term operational effect in order to determine the overall lifetime effect of the Project. This is set out in the following sections, of which the operational GHG effects of the Project are stated in **Table 14.11.**

14.9.3 Impact 2 – GHG emissions associated with the operation of the Project

Operation phase

Sensitivity of the receptor

14.9.3.1 GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in CO_2e, has therefore been treated as a single receptor of **high sensitivity** (given the severe consequence of global climate change and the cumulative contributions of all GHG emissions sources).

Magnitude of impact

14.9.3.2 The proposed solar array would export energy, approximately 840 MWe, to the grid that is zero-carbon at the point of generation[5], thereby displacing the marginal generating source that would be providing energy in the absence of the Project.

14.9.3.3 The marginal source displaced may, in practice, vary from moment to moment depending on the operation of the capacity market, i.e., led by commercial considerations and National Grid's needs at any given time. For the purpose of this assessment, the current grid average figure of 0.25694 $kgCO_2e/kWh$ (DESNZ & DEFRA, 2023) has been used as the baseline for this assessment, alongside the long run marginal figures (BEIS, 2022), to present a potential range of carbon emissions saved in association with marginal generating source displacement as a result of the Project.

14.9.3.4 A range is provided, as the current grid average figure is a static figure that does not represent the likely scenario of an increasingly decarbonised grid over the Project's 31 year estimated operational lifespan. Whilst the long run marginal figures are dynamic and show year-on-year decarbonisation towards the UK's committed net zero 2050 pledge, it is only a future baseline projection and cannot be taken with certainty, hence, neither are perfect estimates. It is likely that the true value of emissions displaced from the national grid as a result of the Project will fall somewhere within this range However, due to uncertainties such as future developments to climate policy and targets for renewables deployment actually being met, a more precise estimation could not be considered robust.

[5] i.e. not including the embodied carbon emissions associated with the construction of the array discussed in the construction effects section.

14.9.3.5 The annual energy output of the Project has been calculated assuming a conservative load factor[6] of 10.7 % and taking into account the annual degradation of the PV modules. Further detail has been included within Appendix 14.2.

14.9.3.6 The total output (MWh) and total projected avoided emissions (tCO_2e) over the Project's 31 year operating lifetime are displayed within Table 14.11, below.

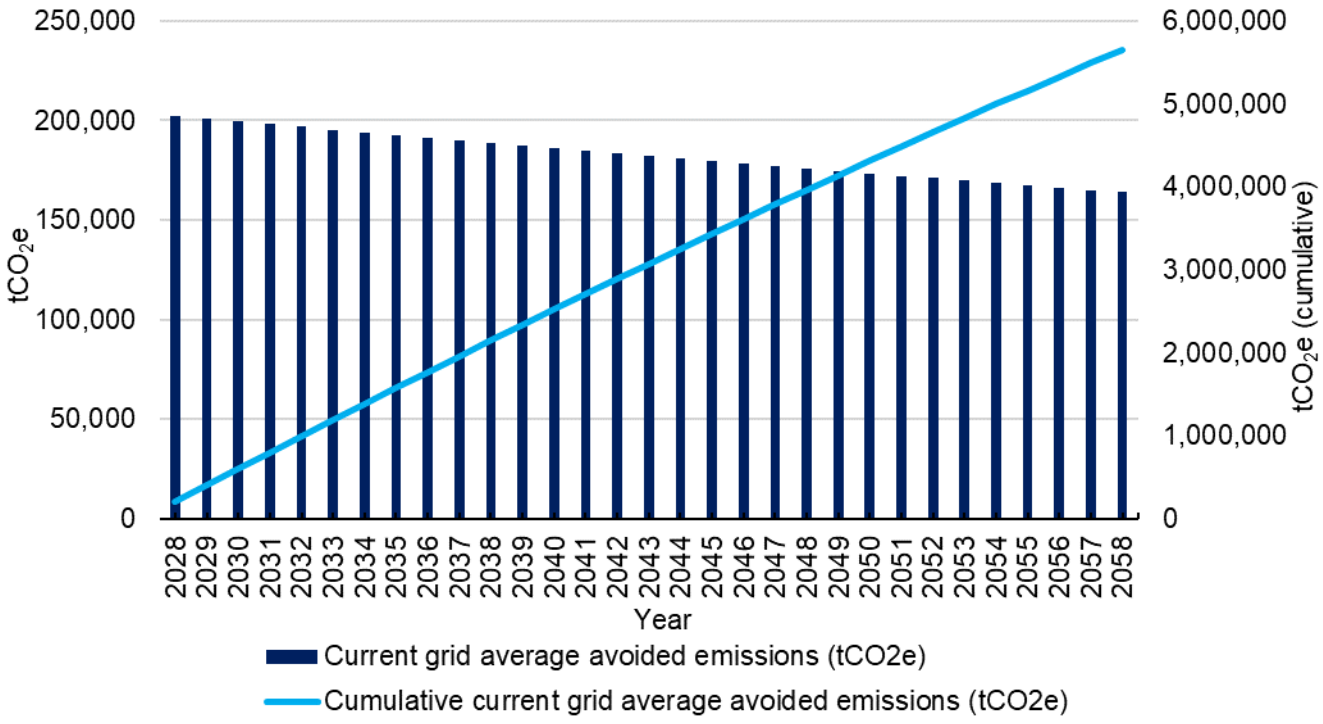
Table 14.11: Operational GHG effects

Operating years	Output (MWh)	Avoided emissions (tCO_2e)	
		Current grid average	Long run marginal
31	22,012,094	5,655,882	617,826

14.9.3.7 The magnitude is therefore, considered to be -5,655,882 to -617,826 tCO_2e for the operation and maintenance phase.

14.9.3.8 Graph 1 shows both the annual and cumulative avoided emissions that the Project provides, also accounting for the degradation of PV modules, under the current grid average scenario.

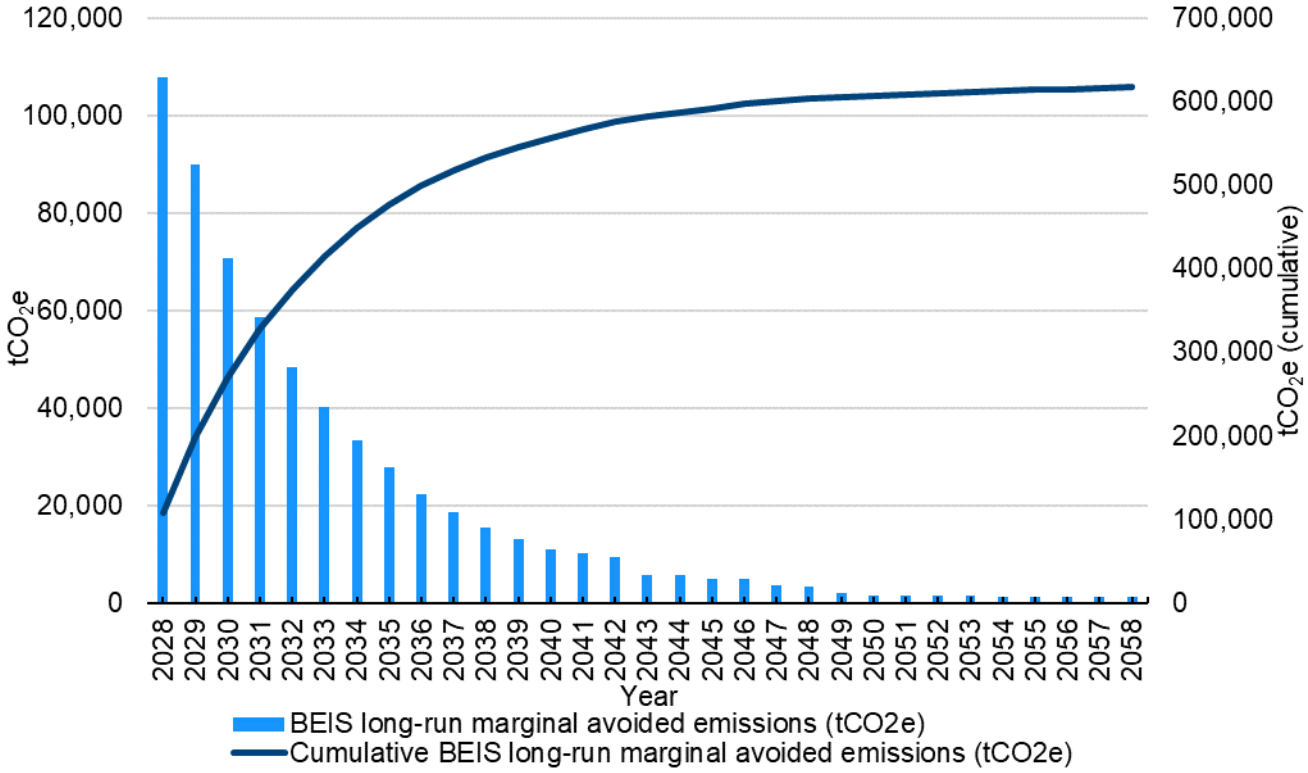
Graph 1: Annual and Cumulative GHG impacts (current grid average)



14.9.3.9 Graph 2 shows both the annual and cumulative avoided emissions for the Project, also accounting for the degradation of PV modules, under the long run marginal scenario.

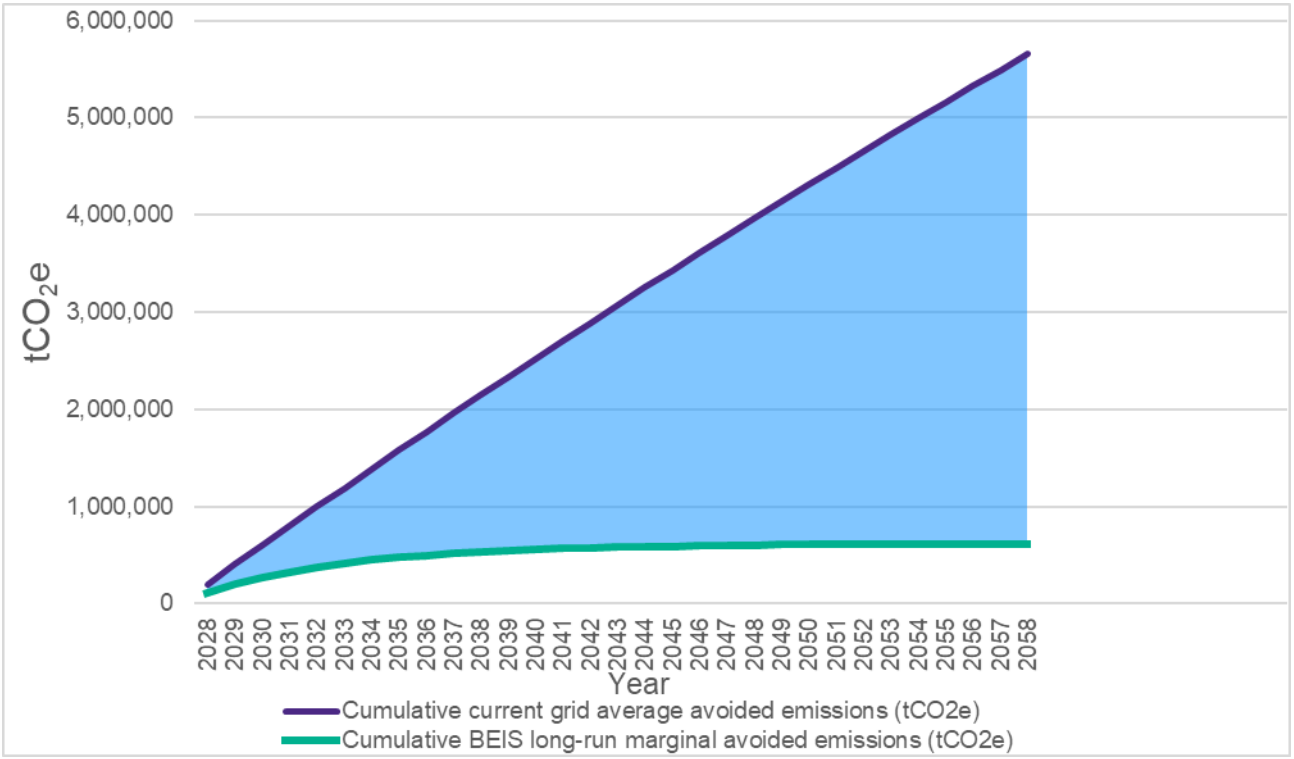
[6] The load factor refers to the total number of hours at which the facility is generating electricity at its rated capacity (i.e. approximately 840 MW) over the year. It is determined by irradiance conditions, performance ratio, and orientation and tilt of the panels.

Graph 2: Annual and Cumulative GHG impacts (BEIS long-run marginal)



14.9.3.10 Graph 3 below displays the cumulative impact of both scenarios, with shading to highlight the difference, representing the potential range of avoided emissions that the Project's operational phase will enable.

Graph 3: Current grid average and long-run marginal GHG emissions difference.



Significance of the effect

14.9.3.11 The nature and significance of effect has been characterised as set out in paragraphs 14.8.4.4 and 14.8.4.5, by contextualising the Project's operational GHG impacts within the UK carbon budget, in comparison with the carbon intensity of electricity supply in the baseline, and with regard to its compliance with the UK's net zero trajectory, local and national climate-related policy, legislation and guidance.

Carbon Budget Context

14.9.3.12 The Project's operational-stage emissions have been contextualised in the context of the UK's fourth, fifth and sixth carbon budgets. The Project's GHG impacts given within **Table 14.12** represents national carbon budget expenditures respectively that would have occurred in the absence of the Project and have therefore been avoided. As the Project is a nationally significant infrastructure project (NSIP), subject to the Development Consent Order (DCO) process, it has been contextualised at the national scale only, and not regional, as it would not be appropriate to do so.

14.9.3.13 **Table 14.12** displays the UK national carbon budgets and how the Project's operational GHG impacts relate to them.

Table 14.12: GHG Impact in the Context of the UK's Carbon Budgets

Time period	2028-2032	2033-2037	Total[7]
UK carbon budget (tCO_2e)	1,730,000,000	960,000,000	2,690,000,000
Current grid average			
Project GHG impacts (tCO_2e)	-997,546	-963,117	**-1,960,663**
Project avoided emissions as percentage of UK carbon budget	- 0.0577%	- 0.1003%	**- 0.0729%**
Long run marginal			
Project GHG impacts (tCO_2e)	-375,278	-142,056	**-517,335**
Project avoided emissions as percentage of UK carbon budget	- 0.0217%	- 0.0148%	**- 0.0192%**

14.9.3.14 As can be seen from Table 14.12, when both the current grid average and long run marginal scenarios are considered, in terms of contextualising avoided emissions within the UK's carbon budgets, a saving somewhere within the range of 0.0192% - 0.0729%, through avoided emissions, would occur as a result of the Project across the three budget periods. This would provide a measurable contribution from a single project towards avoiding potential carbon budget expenditure on the national level.

[7] This is the total during the budget periods, not the total for the Project's assumed lifetime.

Climate Policy, Legislation and Guidance

14.9.3.15 The Project is in line with the NPS EN-3's principle of supporting new renewable and low carbon energy developments, in addition to their associated infrastructure, in order to contribute to reductions in GHG emissions.

14.9.3.16 Further, the Project is supported by national energy and climate change policy (including the National Infrastructure Strategy, Sixth Carbon Budget, Net Zero Strategy, and British Energy Security Strategy, detailed within Appendix 14.1) which collectively highlights the need for an end to the use of unabated fossil fuel generation, whilst also significantly ramping up electricity generation capacity in order to meet the demands of increased electrification of transport, heat and industry. As such, government policy recognises that large-scale deployment of renewable energy generators such as the Project are necessary in order to meet GHG reduction targets.

14.9.3.17 By facilitating the expansion of renewable energy supply, the Project would assist the UK Government target of achieving a fully decarbonised power system by 2035, as well as the UK Government's target to become net zero by 2050.

14.9.3.18 By aiding the delivery of the expansion of renewable energy generation, the Project is in line with UK-wide planning policy and legislation.

Future Cloud Cover Change

14.9.3.19 The Met Office Hadley Centre (MOHC) published both probabilistic climate change projections and downscaled global circulation model outputs for the UK at various spatial scales. This is called the UK Climate Projections 2018 (UKCP18) dataset, first published in November 2018 and at v2.8.0 (MOHC, 2023) at the time of writing. The projections are based on representative concentration pathway (RCP) scenarios used by the IPCC. The RCP scenarios (four scenarios presented in the IPCC fifth Assessment report which are included within the UKCP18 database) describe different climatic futures, all of which are considered possible depending on the volume of GHGs emitted. These provide the basis for future assessments of climate change and possible response strategies, thereby giving a low-high range in potential global GHG reduction initiatives and resulting rate of climatic effects over a given period.

14.9.3.20 The probabilistic projections published at a 25 km grid cell scale are considered the most useful for this assessment, being designed to show a range of projection values that reflect uncertainty in modelled outcomes. Projections for the global emissions RCP 8.5 have been utilised, this is a high-emissions scenario assuming 'business as usual' growth globally with little additional mitigation to combat climate change.

14.9.3.21 Whilst an assessment of the effect of a changing climate on the Project has not been assessed, as justified within Table 14.5, future changes to cloud cover as a result of climate change have been considered. The total cloud anomaly from the UKCP18 probabilistic dataset averaged over the 2040-2069 time period relative to a 1981-2010 baseline for the 25 km grid square within

which the Project site is located is included within Table 14.13 below. This period provides good coverage of the operational period of the Project, when changes in cloud cover may impact annual yields.

Table 14.13: Future cloud cover change

Cloud cover change (%) for RCP8.5			
	10th Percentile	**Median**	**90th Percentile**
2040-2069	-8.22	-3.60	0.77

14.9.3.22 The total annual cloud cover has a direct relationship with the total annual solar insolation being received by the solar array, thereby effecting the total annual energy yield. As shown within Table 14.13, cloud cover is anticipated to decrease during the Project's operating lifetime. This has positive implications for increased energy generation potential and demonstrates that the Project's technology would be resilient to, and benefit from, potential climate change in this respect. An increase in annual yield from the Project would increase avoided emissions and reduce the payback period, increasing the benefits seen from the Project.

Effect

14.9.3.23 Using the definitions in paragraph 14.8.4.5, which sets out how effects from GHG emissions are described in line with IEMA (2022) guidance, the impact of GHG emissions from the operational phase of the Project on the **high sensitivity** receptor would result in a **beneficial** effect, which is significant in EIA terms.

14.9.3.24 This is on the basis that, during its operational period, the Project will not result in any GHG emissions (aside from negligible energy use during maintenance activities). The Project will provide renewable energy, thereby enabling the continued decarbonisation of grid electricity and the displacement of higher-emitting energy sources, which is identified in both policy and expert guidance as essential to facilitate the UK's 1.5°C-aligned trajectory towards net zero.

14.9.3.25 By reducing the need for electricity generation from existing sources with higher carbon intensity in the current and future business-as-usual baseline, the Project indirectly causes GHG emissions that would otherwise have occurred to be avoided.

14.9.3.26 As such it is considered to cause a net reduction in GHG emissions that would be released to the atmosphere compared to the baseline over its operating lifetime (under the current grid average scenario), which meets the definition of a significant beneficial effect.

14.9.4 Net whole life GHG emissions

14.9.4.1 As set out in paragraph 14.8.4.7, consideration of the Projects' whole life impact is an important consideration when assessing the Projects' impacts and subsequent effects on climate change.

14.9.4.2 Consistent with the assessment of operational effects, the lifetime effects assessment is made on the basis that the Project will displace higher-emitting energy sources that would have continued in the business-as-usual baseline,

whilst also considering projected future energy scenarios. This has been calculated using both the current grid average carbon intensity of generation (DESNZ & DEFRA, 2023), and the long run marginal projection from BEIS (2022), treating the former as remaining consistent in the future baseline without the Project[8], and the latter as a robustly calculated estimation of the pathway the UK national grids carbon intensity will move towards, if projects such as the Project continue to be consented and implemented in line with UK policy aims for renewable deployment.

14.9.4.3 The whole-life GHG emissions (total construction- and operational-stage emissions) resulting from the Project is shown in Table 14.14. This is shown alongside the anticipated carbon payback period for the Project.

Table 14.14: Project Net GHG Impacts

	Value	Unit
Construction stage emissions	1,890,463	tCO_2e
Operational stage emissions*	-5,655,882	tCO_2e
Net (whole life) emissions*	-3,765,419	tCO_2e
Earliest carbon payback period*	10	Years

*Based on current grid average scenario.

14.9.4.4 Notwithstanding the GHG emissions resulting from the construction stage of the Project, the magnitude of avoided emissions resulting from the operational-stage achieves a carbon payback from its 10th year of operation under the current grid average scenario, which should be considered the earliest year in which this could take place. It is likely that the payback period will increase as the grid decarbonises, reducing the intensity of energy generation that the Project will displace. The extent of this cannot be robustly estimated at present as it is dependent on the future reality of grid emission reductions.

14.9.4.5 Using the definitions in paragraphs 14.8.4.4 and 14.8.4.5, the impact of whole-life GHG emissions from the Project on the **high sensitivity** receptor is considered to meet the definition of a **beneficial** effect that is **significant** in EIA terms. Although a significant initial carbon cost of manufacturing and installation is incurred, by achieving a carbon payback period of 10 years (at the earliest) and providing net negative emissions compared to the business-as-usual baseline over its remaining operating period, this will be in line with the decarbonisation of electricity generation by 2035 as targeted in UK climate policy under the Sixth Carbon Budget. It will provide an immediate contribution to the UK's ambitions to increase renewable energy capacity, and its net emission savings would be material at the scale of recommended 1.5°C compatible UK carbon budgets. It would therefore be consistent with the

[8]This is considered to be a balanced assumption: on the one hand it does not assume displacement by the Project of future grid average or marginal generators with a projected decreasing carbon intensity (which would be a circular argument, as the projected decrease in grid-average and marginal carbon intensity can only be achieved with renewable projects such as the project as proposed); but on the other it does not assume displacement of higher carbon intensity sources such as gas-fired generation, due to differences in the position with respect to baseload and dispatchability of renewable generation.

definition of a 'beneficial' effect that achieves decarbonisation in line with or sooner than required by policy and would have minimal residual emissions trending to net negative emissions over its operating life. As the Project's emissions would become negative, its net GHG emissions would be below zero, meaning the Project would substantially exceed net zero requirements.

14.9.4.6 It should be noted that, as set out on page 26 of the IEMA guidance, a 'negligible' or indeed 'minor adverse' effect which is nevertheless below the threshold of significance is considered to be a high bar and indicative of good development performance, it being very challenging under present day conditions for any development to have zero residual emissions at any lifecycle stage or to only cause emissions to atmosphere to be removed/avoided.

14.9.4.7 In the long term, following its carbon payback period, the ongoing avoided emissions from the operation of the Project are likely to meet the definition of a significant beneficial effect (as was set out in the operational effects section when this lifecycle stage was considered in isolation). However, given the increasing uncertainty of current baseline emissions as a comparator over time, and the policy expectation of grid-average emissions trending to net zero well before 2050, it is considered (conservatively) that the effect of the Project does not fully meet the definition of 'significant beneficial' as put forwards in the IEMA guidance over its lifecycle stages considered together in the whole-life assessment.

Future monitoring

14.9.4.8 No monitoring to test the predictions made within the impact assessment is proposed as there is no monitoring that would be relevant to the climate change topic.

14.10 Cumulative effect assessment methodology

14.10.1.1 As is detailed within the IEMA (2022) GHG in EIA Guidance all developments that emit greenhouse gas (GHG) have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a cumulative impact on climate change irrespective of geographic location. Consequently, cumulative effects due to other specific local development projects cannot be individually identified and assessed. When evaluating the impact of the Project the atmospheric mass of GHGs has been defined as a high sensitivity receptor. This approach is consistent with the IEMA (2022) GHG in EIA Guidance.

14.11 Cumulative effects assessment

14.11.1.1 As is detailed in paragraph, 14.10.1.1, no relevant cumulative effects assessment has been completed for this climate change chapter.

14.12 Transboundary effects

14.12.1.1 As confirmed within the IEMA GHG in EIA Guidance (IEMA, 2022) all developments which emit GHGs have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a transboundary impact on climate change. Consequently, transboundary effects due to other specific

international development projects are not individually identified but would be taken into account when considering the impact of the Project by defining the atmospheric mass of GHGs as a **high sensitivity** receptor. Each country has its own policy and targets concerning carbon and climate change which are intended to limit GHG emissions to acceptable levels within that county's defined budget and international commitments.

14.13 Inter-related effects

14.13.1.1 Inter-relationships are the impacts and associated effects of different aspects of the Project on the same receptor. These are as follows.

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the Project (construction, operation and maintenance, and decommissioning), to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three phases (e.g., construction noise effects from piling, operational substation noise, and decommissioning disturbance).
- Receptor led effects: Assessment of the scope for all effects (including inter-relationships between environmental topics) to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on climate change, such as direct habitat loss or disturbance, may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short term, temporary or transient effects, or incorporate longer term effects.

14.13.1.2 Inter-related effects methodology is provided in Chapter 19: Cumulative Effects and Inter-relationships of the PEIR and will be assessed further at the ES stage.

14.14 Summary of impacts and monitoring

14.14.1.1 Information on climate change within the study area was collected through desktop review.

14.14.1.2 The potential impact of GHG emissions arising from to the Project on the global atmospheric GHG concentration that contributes to climate change, has been assessed and reported in this chapter.

14.14.1.3 **Table 14.15** presents a summary of the potential impacts and residual effects on climate change. The impacts assessed include:

- The impact of GHG emissions arising from the manufacturing and installation of the Project during construction.
- The impact of GHG emissions arising from the operation of the Project.

14.14.1.4 It is concluded that there will be the following likely significant effects arising from the Project during the construction, operation and maintenance phases:

- Construction phase: emissions from the manufacturing and installation of the Project would, without mitigation measures, result in emissions of up to 1,903,605 tCO_2e. This would be a **moderate adverse** effect which is significant in EIA terms with a residual effect of minor adverse, which is

not significant in EIA terms, when accounting for further mitigation. The construction phase must also be evaluated in terms of whole life time emissions from the Project.

- Operations and maintenance stage: The operational phase of the Project would enable the generation renewable electricity and thereby assist in the displacement of fossil fuels as a generation source. This would result in a positive GHG impact. When considering the avoided emissions, the operational impact results in the order of approximately -5,655,882 tCO_2e savings over the Projects 31 year operational life time (under the current grid average scenario). This would result in a **beneficial** effect which is significant in EIA terms.

14.14.1.5 Despite the GHG emissions resulting from the construction-stage of the Project, the magnitude of avoided emissions resulting from the operational-stage of the development allows the Project to enable avoided emissions from year 10 of operation (carbon payback period).

14.14.1.6 Over the lifetime of the Project, it would result in -3,752,277 tCO_2e of avoided emissions (under the current grid average scenario).

14.14.1.7 Consideration of the Project's net emissions performance can be considered with the following contextualisation:

- it would contribute to reducing carbon budget expenditure at a national level; and
- it would contribute towards meeting UK energy and climate policy goals.

14.14.1.8 The Project is in line with the NPS EN-3's principle of supporting new renewable and low carbon energy developments, in addition to their associated infrastructure, in order to contribute to reductions in GHG emissions.

14.14.1.9 Further, the Project is supported by national energy and climate change policy (including the National Infrastructure Strategy, Sixth Carbon Budget, and Net Zero Strategy) which highlight the need for an end to the use of unabated fossil fuel generation, whilst also significantly ramping up electricity generation capacity in order to meet the demands of increased electrification of transport, heat and industry. As such, government policy recognises that large-scale deployment of renewable energy generators such as the Project is necessary in order to meet GHG reduction targets.

14.14.1.10 By enabling the expansion of renewable energy supply by providing additional renewable energy generation capacity, the Project would assist the UK Government's target of achieving a fully decarbonised power system by 2035 as well as the aim to become net zero by 2050.

14.14.1.11 As is detailed within the IEMA (2022) GHG in EIA Guidance all developments that emit greenhouse gas (GHG) have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a cumulative impact on climate change irrespective of geographic location. Consequently, cumulative effects due to other specific local development projects cannot be individually identified and assessed in accordance with the IEMA GHG in EIA Guidance

(IEMA, 2022). When evaluating the impact of the Project the atmospheric mass of GHGs has been defined as a high sensitivity receptor.

14.14.1.12 No potential transboundary impacts have been identified in regard to effects of the Project.

Table 14.15: Summary of potential environmental effects and monitoring.

Description of impact	Phase[a]			Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O	D						
The impact of GHG emissions arising from the manufacturing and installation of the Project during construction.	✓	⊘	⊘	1,903,605 tCO_2e	High	Moderate Adverse effect (Significant)	The Project is committed to exploring options to reduce construction related emissions. Areas to be explored by the Project could include: • Optimisation of construction activity to reduce emissions (e.g. potentially related to vehicle movements, co-ordination of delivery of materials and the identification energy efficiency mechanisms) • Identification of opportunities to reduce emissions in the supply chain • Inclusion of low carbon criteria within procurement activities	Minor adverse effect (not significant)	None
The impact of GHG emissions arising from the operation of the Project.	⊘	✓	⊘	-617,826 tCO_2e to -5,655,882 tCO_2e (avoided emissions)	High	Beneficial effect (Significant)	None	Beneficial effect (Significant)	None

[a] C=construction, O=operational and maintenance, D=decommissioning

14.15 Next steps

14.15.1.1 Where additional information concerning materials, transportation and other design development becomes available throughout the design evolution, updated calculations will be completed and presented within the Environmental Statement. The assessment will also consider potential further mitigation measures to reduce the significant adverse effects presented within the PEIR.

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