8 CLIMATE CHANGE

Introduction

8.1 This chapter of the ES presents the findings of the EIA concerning the potential environmental effects of the Proposed Development on climate change.

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

- the impact of greenhouse gas emissions (GHGs) caused directly or indirectly by the Proposed Development, which contribute to climate change; and
- the potential impact of changes in climate on the Proposed Development, which could affect it directly or could modify its other environmental impacts.

8.3 This chapter is supported by the following appendices:

- **Appendix 8.1** – Climate Change Policy Review;
- **Appendix 8.2** – Climate Risk Assessment; and
- **Appendix 8.3** – GHG Calculations.

Assessment Methodology

Planning Policy Context

8.4 A summary of relevant policy is given in this section. Full references are provided in **Appendix 8.1**: Climate Change Policy Review.

8.5 PPW11 (published in 2021) highlights the importance of Wales's transition to a low carbon future in a changing climate and sets out the goal of generating at least 70% of its electricity consumption from renewable sources by 2030.

8.6 It sets out the duty of planning authorities to facilitate renewable and low carbon energy developments. Paragraph 5.9.1 states *"local authorities should seek to ensure their area's full potential for renewable and low carbon energy generation is maximised and renewable energy targets are achieved"*.

8.7 With regard to local policy, the Rhondda Cynon Taf LDP (2011) supports renewable energy development within Policy AW12: Renewable & Non-Renewable Energy. This policy states: *"The provision of electricity from renewable sources, coupled with energy efficiency and conservation measures, are key elements of the UK energy policy and have the potential to make an important contribution to meeting the challenges of climate change. Proposals that encourage the harnessing of renewable energy from a range of sources … will be supported. In considering proposals, the need to harness energy from renewable sources will be carefully balanced with the impact on local communities, the landscape and ecological interest."*

Relevant Guidance

Legislation

8.8 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.

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

8.10 The UK's Nationally Determined Contribution (NDC) (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.

8.11 The Environment (Wales) Act (2016) provides Welsh ministers with powers to put in place statutory emissions reduction targets, including an aspiration to achieve net zero GHG emissions by 2050.

8.12 The Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021 regulates two carbon budgetary periods; the period of 2021-2025 limits GHG emissions to an average of 37% lower than the 1990 baseline (this is updated from 33% as stated within the 2018 Regulations), and the period of 2026-2030 limits GHG emissions to an average of 58% lower than the baseline.

Guidance and Recommendations

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

8.14 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.

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

[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).

[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.

8.16 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.

8.17 Further to this, Net Zero Wales (NZW) plan sets the ambition to increase renewable energy capacity by 1 GW by 2025 in order to progress towards a decarbonised energy system.

8.18 The main guidance used for the assessment of GHG emissions in EIA is the Institute of Environmental Management and Assessment (IEMA) guide 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (IEMA, 2022).

8.19 The main guidance document with regard to climate risk and resilience assessment within the context of EIA is the Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation (IEMA, 2020).

8.20 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);
- Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book (Department for Business, Energy and Industrial Strategy (BEIS), 2021); and
- UK Government GHG Conversion Factors for Company Reporting (BEIS and Department for Environment, Food and Rural Affairs (Defra), 2022).

GHG Emissions Calculations – Overview and Assessment Boundary

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

8.22 The GHGs considered in this assessment are those in the 'Kyoto basket[3]' of global warming gases expressed as their CO_2-equivalent (CO_2e) 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 Intergovernmental Panel on Climate Change Fourth Assessment Report (Forster *et al,* 2007) or as otherwise defined for national reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

8.23 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 WBSCD, 2004).

- Scope 1 emissions: released directly by the entity being assessed, e.g. from combustion of fuel at an installation;
- Scope 2 emissions: caused indirectly by consumption of imported energy, e.g. from generating electricity supplied through the national grid to an installation; and
- Scope 3 emissions: caused indirectly in the wider supply chain, e.g. in the upstream extraction, processing and transport of materials consumed or the downstream disposal of waste products from an installation.

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

8.24 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 Proposed Development.

8.25 Scope 3 emissions resulting from the manufacture and construction of the solar panels, associated balance of system (BoS)[4] components and site infrastructure (including access tracks, monitoring house, and storage and welfare facilities) have also been calculated via published benchmark carbon intensities and published lifecycle analysis (LCA) literature regarding photovoltaic (PV) panel technology.

8.26 The assessment has considered (a) the GHG emissions arising from the Proposed Development, (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.

8.27 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 Proposed Development, including construction-stage emissions, have been evaluated where possible when determining the significance of effects.

Climate Risks – Overview

8.28 Potential climatic conditions in the 2040-2069 time period at the site have been considered based on the Met Office Hadley Centre 'UKCP18' probabilistic projections (MOHC, 2021). Projections for the global emissions representative concentration pathway (RCP) 8.5 have been used as a worst-case approach, as this is a high-emissions scenario assuming 'business as usual' growth globally with little additional mitigation to combat climate change.

8.29 Further detail of the approach and data input is given in **Appendix 8.2**: Climate Risk.

8.30 A high-level screening risk assessment has been undertaken, considering the hazard, potential severity of impact on the Proposed Development and its users, probability of that impact, and level of influence the design can have on the risk.

8.31 Where potentially significant risks have been identified at the screening stage, further assessment has been undertaken with consideration of mitigation to determine whether significant residual risks are likely.

8.32 The assessment of flood risk, including increases in rainfall rates due to climate change, has been addressed as part of the planning application via a standalone Flood Consequence Assessment (FCA) and Drainage Strategy.

Study Area

8.33 GHG emissions have a global effect rather than directly affecting any specific local receptor. The impact of GHG emissions occurring due to the Proposed Development on the global atmospheric concentration of the relevant GHGs, expressed in CO_2-equivalents (CO_2e), is therefore considered within this assessment.

8.34 The climate change risk study area is the climate projections 25km grid cell in which the site is located.

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

Baseline Methodology

8.35 Published benchmarks have been used to establish the baseline of current and future grid average carbon intensity. The climatic baseline is that of existing weather patterns as likely to be modified by climatic trends during the Proposed Development's lifetime.

8.36 Baseline information has been gathered primarily from the following sources:

- BEIS (2021) Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book.
- BEIS and Defra (2022) UK Government GHG Conversion Factors for Company Reporting.
- MOHC (2021) UK Climate Projections User Interface v2.6.0.

Consultation

8.37 The Pre-Application Advice letter issued on 17 January 2022 does not make any reference to climate change or GHG emissions.

8.38 An EIA Scoping Request was made in March 2022 (**Appendix 4.1**), which included a section setting out the proposed scope and approach to the climate change section.

8.39 The EIA Scoping Direction was received from PEDW on 6 May 2022 (**Appendix 4.2**), in which they agreed with the proposed approach (reference ID.30 within the Scoping Direction).

Assessment Criteria and Assignment of Significance

Receptor Sensitivity/Value

8.40 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 tCO_2e, has therefore been treated as a single receptor of **high sensitivity** (given the importance of the global climate as a receptor).

Magnitude of Impact

8.41 As GHG emissions can be quantified directly and expressed based on their GWP as tonnes of CO_2e emitted, the magnitude of impact is reported numerically.

8.42 The magnitude of potential impacts to the development from a changing climate is reported using scoring of 1–3 for descriptive categories of severity, probability and influence of potential impacts. The descriptive definitions of the scoring are set out in **Appendix 8.2**.

Significance of Effects

8.43 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.

8.44 Taking the guidance into account, the following have been considered in contextualising the Proposed Development's GHG emissions:

- The magnitude of gross and net GHG emissions as a percentage of national and local carbon budgets (where feasible);

- The GHG emissions intensity of the Proposed Development against current baseline emissions intensity for such energy generation and projections or policy goals for future changes in that baseline; and
- Whether the Proposed Development 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 NDC to the Paris Agreement (HM Government, 2020)).

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

- **Major Adverse:** the GHG impacts would not be compatible with the UK's net zero trajectory. Its GHG impacts would not be mitigated, or would be compliant only with do-minimum standards set through regulation. The Proposed Developmentmay not provide further emissions reductions required by existing local and national policy for projects of this type.
- **Moderate Adverse:** the GHG impacts would not be fully compatible with the UK's net zero trajectory. Its GHG impacts would be partially mitigated and may partially meet the applicable existing and emerging policy requirements, however it would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type.
- **Minor Adverse:** the GHG impacts would be compatible with the UK's 1.5°C trajectory and would comply with up-to-date policy and 'good practice' emissions reduction measures. The Project would fully comply with measures necessary to achieve the UK's net zero trajectory.
- **Negligible:** the Proposed Developmentwould achieve emissions mitigation that goes substantially beyond existing and emerging policy compatible with the 1.5°C trajectory, helping to achieve this rate of decarbonisation sooner, and would have minimal residual net emissions. The Proposed Developmentwould provide exemplary design and performance standards with respect to GHG emissions for projects of this type.
- **Beneficial:** the Proposed Developmentwould result in emissions reductions from the atmosphere, whether directly or indirectly, compared to the without-project basline. As such, its net GHG emissions would be below zero. The Project would substantially exceed net zero requirements.

8.46 Major and moderate adverse effects and beneficial effects are considered to be significant. Minor adverse and negligible effects are not considered to be significant.

8.47 In accordance with IEMA's 2020 guidance for climate change risk and resilience or adaptation measures, a risk assessment has been undertaken, considering the hazard, potential severity of impact on the Proposed Development and its users (including their sensitivity and vulnerability), probability of that impact, and level of influence the design can have on the risk. The approach to this risk assessment is detailed in **Appendix 8.2**: Climate Risk. A risk score of five or more (the minimum score where more than one element of the risk assessment score is above 'low') has been defined as a risk that could lead to a significant effect. By considering the good practice design measures incorporated into the Proposed Development, professional judgement is used in determining whether impacts are likely to result in significant adverse or beneficial effects.

Limitations of the Assessment

8.48 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 Proposed Development. Government projections consistent with national carbon budget commitments have been used in the assessment.

8.49 Due to the early stage of development design, limited information is available regarding the particular solar panel technology type being used in the Proposed Development. As such, a range of construction-stage emission values have been stated. The range of construction-stage emissions have been based on published data for lifecycle emissions for both mono and multi crystalline silicon (*c*-Si) panel technology types.

8.50 The construction-stage GHG implications are primarily based upon a photovoltaic (PV) lifecycle GHG meta-analysis from 2012 (NREL, 2012). 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 balance of system (BoS) components, as well as the energy mix used in delivering that energy, the developments in the energy industry since 2012 could render this source out of date. According to research completed by the International Energy Agency (IEA, 2020), 72.4% of all panels installed in Europe are produced in China. The percentage of coal in Chinese electricity mix has marginally decreased from 76% in 2013 to 70% in 2020 (IEA, 2020) which would suggest that the carbon intensity of manufacturing PV panels in China has not decreased significantly since the year of publication of the primary source of information for the construction-stage assessment. Furthermore, to provide confidence, a more recent PV GHG LCA study (Milousi et al, 2019) was also considered. The results of this LCA, in terms of the stated embodied carbon intensities of crystalline-silicone (c-Si) panels, were similar to that of the NREL (2012) study, thereby corroborating the results obtained from the primary source.

8.51 Whilst the electricity mix in China may not have become significantly less carbon intensive since 2012, the efficiency of the manufacturing processes are likely to have improved. As such, this assessment represents a conservative 'worst-case' approach.

8.52 When assessing climate risks, uncertainty arises from both modelling uncertainty and natural variability in the potential magnitude of future changes in climate. Therefore, a high magnitude of change scenario and the high end of probabilistic projections have been used, to provide a precautionary worst-case approach. This is further discussed in **Appendix 8.2**: Climate Risk.

8.53 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 Proposed Development to identify significant effects.

Baseline Environment

8.54 With regard to current climate, the baseline is the local and regional climate and resulting weather patterns recorded in Met Office data. This is in the context, however, of wider trends in global climate changes affecting the UK climate, which at their present rates may be considered part of the known baseline. The change in baseline over time with climate change is set out in **Appendix 8.2**.

8.55 With regard to GHG emissions, the current baseline is agricultural land, comprised of grazing grassland with the western section of the site comprising lower lying wetter ground conditions.

8.56 With regard to the electricity export of the Proposed Development, the baseline is the current average grid electricity carbon intensity. This value has been taken from published benchmarks (BEIS, 2022) and is 0.21233 kgCO_2e/kWh.

Future Baseline Conditions

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

8.58 The future baseline for electricity generation that would be displaced by the Proposed Development 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 operation of the Proposed Development compared to other generation sources available, influenced by commercial factors and National Grid's needs.

8.59 Under the UK's climate targets and ambitions, the power system is intended to be fully decarbonised by 2035. Projections of this decarbonisation are provided by BEIS (detailed within **Appendix 8.3**) and are subject to the successful implementation of renewable energy generation projects such as the Proposed Development. 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 Proposed Development's performance over its lifetime.

8.60 However, it would not be logical to assess the Proposed Development's impact against a decarbonisation scenario which effectively relies upon for its own, or similar projects', development occurring, as this would be a circular argument. Without projects such as the Proposed Development, there would be no progression towards grid decarbonisation. In addition, the BEIS projections are for the operational carbon intensity of generation sources, not accounting for embodied carbon and the full life-cycle effects.

8.61 With respect to the operational phase impact of alternative electricity generation displaced by that exported from the Proposed Development, the current grid average figure of 0.21233 $kgCO_2e/kWh$ (BEIS, 2022) is therefore treated as the current baseline and future business-as-usual baseline against which the benefits of the Proposed Development are calculated.

Mitigation Measures Adopted as Part of the Proposed Development

8.62 As a renewable energy development, climate change mitigation is an inherent aim of the Proposed Development. 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 2 and 8m apart from one another so as to avoid inter-panel shading and dependent on site conditions.

8.63 Good working practices during the construction of the Proposed Development will be defined through a CEMP. The CEMP will ensure that, where possible, construction activities generating GHG emissions are undertaken efficiently in order to minimise emissions in the following ways.

- 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;
- construction materials should be sourced locally where practicable, to minimise the impact of transportation;
- vehicles used in road deliveries of materials, equipment and waste arisings on- and off-site would be loaded to full capacity to minimise the number of journeys associated with the transport of these items;
- all machinery and plant would be procured to adhere with emissions standards prevailing at the time and should be maintained in good repair to remain fuel efficient;
- when not in use, vehicles and plant machinery involved in site operations would be switched off to further reduce fuel consumption;
- where possible, local waste management facilities would be used to dispose of all waste arisings, to reduce distant travelled and associated emissions;
- 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; and

- equipment and machinery requiring electricity would only be switched on when required for use. Procedures should 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.

Assessment of Construction Effects

Assessment of Effects as a Result of Climate Change

8.64 Due to the relatively short construction programme (anticipated to take 6-8 months) variations in climatic parameters would be minimal compared to the present-day baseline. Construction work practices are adapted to existing climate conditions and weather in the UK. **Appendix 8.2** summarises potential changes in climatic parameters further into the future. These changes are likely to occur gradually, and it is considered that construction contractors will be able to adapt working methods over time if necessary, should the Proposed Development be built in later phases. For example, warmer winter conditions may extend the time certain construction activities, such as concrete pouring, can be carried out. A greater change of summer heatwave conditions may require adaptations, such as shading work areas or increased attention to construction dust control measures.

8.65 Short term **negligible** impacts and **no significant** construction-stage effects are predicted as a result of climate change.

Assessment of Effects on Climate Change

Magnitude of Impact

8.66 The manufacturing and installation of the Proposed Development would result in both direct and indirect GHG emissions.

8.67 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.

8.68 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 – and in the absence of greater detail regarding panel types and manufacturer specifications etc – a 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 Proposed Development’s construction-stage GHG emissions.

8.69 The primary source of emissions factors used in assessing the embodied carbon effects of the Proposed Development 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.

8.70 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 49,789 tCO_2e and 62,556 tCO_2e (lower to upper limits). This is detailed within **Table 8.1**, below, and further information regarding the methodology and calculations can be found within **Appendix 8.3**.

Table 8.1 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)	30	30	30
Total Development GHG (tCO_2e)	**49,789**	**56,173**	**62,556**

8.71 Additional elements of the Proposed Development that are not included within the emissions total above include the housing of the substation. In comparison with the magnitude of emissions associated with the PV cells and BoS components, it is estimated that the emissions associated with the substation construction will be in the order of hundreds to low thousands of tCO_2e at most, and hence will make a non-material contribution to the construction stage total. As such, these have not been assessed in further detail.

Sensitivity of Receptor

8.72 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_2-equivalents, 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).

Significance of Effect

8.73 As stated previously, 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.

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

8.75 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 whether 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 or not.

8.76 Considering the potential magnitude of GHG emissions set out in **Table** 8.1 and absence of mitigation or reduction of emissions, based on the definitions set out previously, the magnitude of impact on the **high sensitivity** receptor would result in **significant major adverse** construction-stage effect, taking a conservative approach.

8.77 However, as the purpose of the Proposed Development 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 Proposed Development. This is set out in the following sections.

Further Mitigation

8.78 Construction-stage GHG impacts could be further mitigated through sustainable procurement practises and close engagement with the supply chain, to ensure that any products used in the construction of the Proposed Development are manufactured in conditions with minimised GHG impacts (e.g. via the use of renewable energy and efficient resource consumption).

8.79 As a first step, greater transparency into the GHG impacts of products being specified for the Proposed Development can be achieved by requesting environmental product declarations (EPD) from PV panel manufacturers; this can be used to support procurement decisions for lower-carbon producers and/or for further engagement with suppliers.

Residual Effect

8.80 With implementation of the proposed mitigation measures during detailed design, the Proposed Development's construction-stage climate change impacts – through direct and indirect greenhouse gas emissions – have the potential to be reduced compared to a typical business-as-usual approach and could therefore contribute to the goals set out in local and national policy for decarbonisation. However, it is unlikely that significant residual emissions from the PV panel supply chain can be fully avoided.

Future Monitoring

8.81 No future monitoring of construction phase GHG emissions is considered to be required.

Accidents and/or Disasters

8.82 It not considered likely that there will be any GHG-related construction-stage accidents and/or disasters, nor that there will be any construction-stage accidents and/or disasters that would cause significant GHG emissions.

Assessment of Operational Effects

Assessment of Effects as a Result of Climate Change

Sensitivity of the Receptor

8.83 As detailed within **Appendix 8.2**, the severity of effect score for each identified risk considers the potential consequences of the hazard and the sensitivity of the receptor(s) affected. Given the variability in the nature of the potential effects of climate change on the development, receptors have been identified on a risk-specific basis, whereby all receptors relate to the continued safe and effective operation of the Proposed Development. In line with IEMA (2020) guidance, the receptor vulnerability and susceptibility have been considered in determining the severity of risk. As such, sensitivity is detailed for each identified risk within **Appendix 8.2**.

Magnitude of Impact

8.84 The magnitude is the degree of a change from the relevant baseline conditions which derives from the operation of the Proposed Development. The magnitude has been expressed in **Appendix 8.2** as a combination of probability, which has been informed by potential climatic changes from the UKCP18 probabilistic dataset, and degree of influence for each identified risk.

Significance of Effect

8.85 **Appendix 8.2** summarises the potential climatic changes in the coming decades and considers the potential consequences for the Proposed Development in a risk assessment format. The most significant risk from climate change is likely to arise from flooding. This is assessed as part of the planning application via a standalone FCA and Drainage Strategy. Appropriate flood management and resilience measures have been provided, including an allowance for climate change effects.

8.86 The risk assessment in **Appendix 8.2** considers in its scoring the level of influence the design, construction and operation of the Proposed Development can have upon the risks, in addition to its severity and probability. Those risks over which the developer has little or no influence are therefore typically not considered significant effects of the Proposed Development, save where the severity and/or probability are highest.

8.87 With the exception of flood risk, the impacts of climate change are unlikely to pose significant risk to the Proposed Development over the course of its lifetime. Projections of future cloud cover change may result in beneficial impacts, with increased output from the Proposed Development over its lifetime as cloud cover decreases.

8.88 Overall, the risk assessment identified one out of the four assessed effects as potentially significant prior to resilience or adaptation measures to mitigate the risks. Given this significant effect will be mitigated through the incorporation of good practice design measures, the effect on the Proposed Development has been determined to be **negligible**. Good practice design measures include the following:

- Compliance with Building Regulations Approved Document A: Structure (HM Government, 2013), for ensuring resilience to extreme weather events and ground movement.
- Statutory requirements for network operators keeping overhead power lines clear from vegetation, in order to minimise damages to transmission network (Dawson et al, 2016).

Assessment of Effects on Climate Change

Magnitude of Impact

8.89 The Proposed Development would export energy 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 Proposed Development.

8.90 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, current grid average has been used, with the current grid average figure being 0.21233 kgCO_2e/kWh (BEIS, 2022).

8.91 The annual energy output of the Proposed Development has been calculated assuming a conservative load factor[6] of 9.91% and taking into account the annual degradation of the PV modules. Further detail has been included within **Appendix 8.3**.

8.92 The total output (MWh) and total projected avoided emissions (tCO_2e) over the Proposed Development's 40-year operating lifetime are displayed within **Table 8.2**, below.

Table 8.2: Annual Operational GHG Effects (Year One)

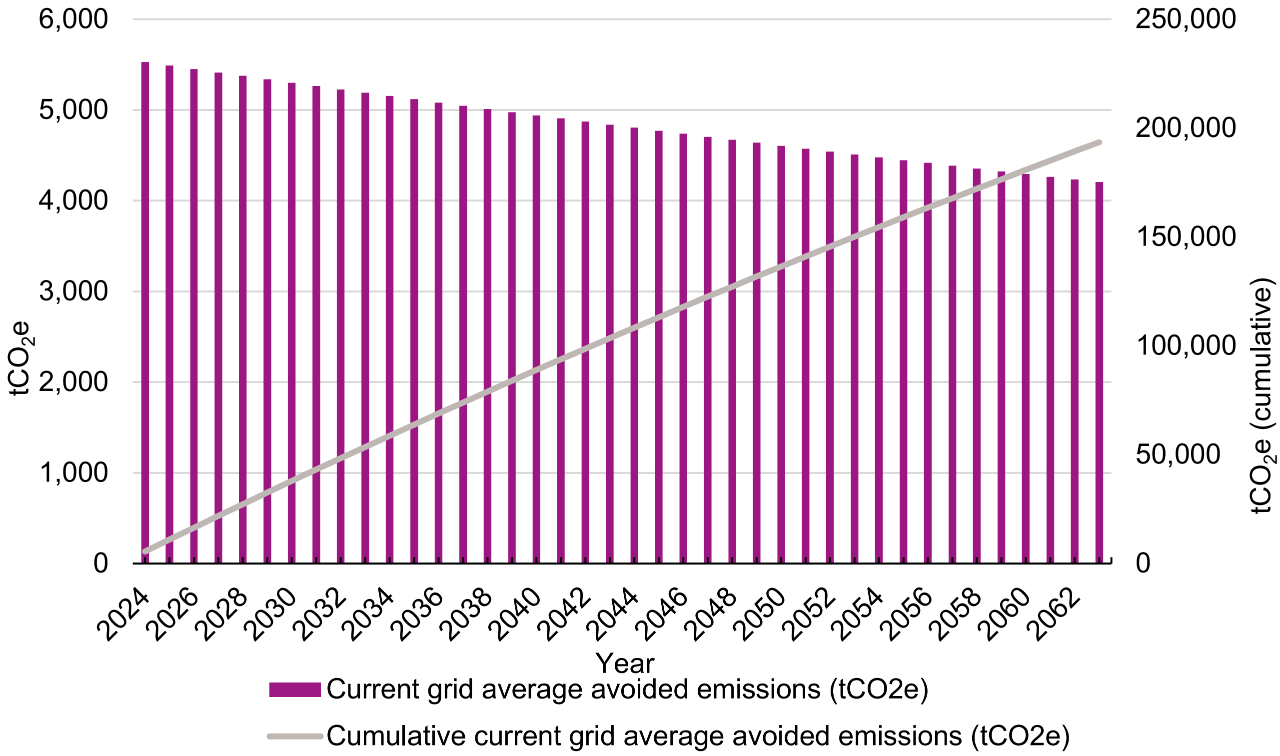
Operating years	Output (MWh)	Current grid average avoided emissions (tCO_2e)
	911,183	44,963

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

[6] The load factor refers to the total number of hours at which the facility is generating electricity at its rated capacity (i.e. 30 MW) over the year. It is determined by irradiance conditions, performance ratio, and orientation and tilt of the panels.

8.93 **Graph 8.1** shows both the annual and cumulative avoided emissions that the Proposed Development provides, also accounting for the degradation of PV modules.

Graph 8.1: Annual and Cumulative GHG Impacts



Sensitivity of Receptor

8.94 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_2-equivalents, has therefore been treated as a single receptor of **high sensitivity** (given the consequences of global climate change and the cumulative contributions of all GHG emissions sources).

Significance of Effect

8.95 The nature and significance of effect has been characterised as set out previously, by contextualising the Proposed Development'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.

National Carbon Budget

8.96 The Proposed Development's operational-stage emissions have been contextualised in the context of the UK's fourth, fifth and sixth carbon budgets. The GHG impacts given within **Table 8.3** and **Table 8.4** represent carbon budget expenditures that would have occurred in the absence of the Project and have therefore been avoided. **Table 8.3** displays the UK national carbon budgets and how the Proposed Development's operational GHG impacts relate to them.

Table 8.3 GHG Impacts in the Context of the UK's Carbon Budgets

Time period	2023-2027	2028-2032	2033-2037	Total[7]
UK carbon budget (tCO_2e)	1,950,000,000	1,730,000,000	960,000,000	4,640,000,000
Project GHG impacts (tCO_2e)	-16,470	-26,691	-25,769	**-68,930**
Development avoided emissions as percentage of UK carbon budget	0.0008%	0.0015%	0.0027%	**0.0015%**

8.97 Additionally, the Tyndall Centre for Climate Change Research (2022) has recommended district-specific carbon budgets up to 2100 that, in its research, are considered to be compatible with a 1.5°C aligned trajectory for the UK. The Proposed Development's operational GHG impacts were considered in terms of Rhondda Cynon Taf's Tyndall Centre-derived carbon budget.

8.98 The Tyndall Centre carbon budgets are more stringent than the UK national budgets (as advised by the CCC); the carbon budget for Rhondda Cynon Taf would result in achieving zero or near zero carbon by 2042[8]. The Tyndall Centre carbon budgets expressed below are for energy-related CO_2 emissions only.

8.99 **Table 8.4** displays the Rhondda Cynon Taf -specific carbon budgets and how the Proposed Development operational GHG impacts relate to them.

Table 8.4 GHG Impacts in the Context of the Rhondda Cynon Taf Carbon Budgets

Time period	2023-2027	2028-2032	2033-2037	Total[7]
Rhondda Cynon Taf carbon budget (tCO_2e)	2,200,000	1,100,000	500,000	**3,800,000**
Project GHG impacts (tCO_2e)	-16,470	-26,691	-25,769	**-68,930**
Development avoided emissions as percentage of Rhondda Cynon Taf carbon budget	0.749%	2.426%	5.154%	**1.814%**

8.100 As can be seen from **Table 8.4**, the Proposed Development would make a measurable contribution to avoiding potential carbon budget expenditure at the Rhondda Cynon Taf scale.

Climate Policy, Legislation and Guidance

8.101 The Proposed Development is in line with the PPW11'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.

8.102 Further, the Proposed Development is supported by national energy and climate change policy (including the National Infrastructure Strategy, Sixth Carbon Budget, Net Zero Strategy, and Net Zero Wales, detailed within **Appendix 8.1**) 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, UK government policy dictates that large-scale deployment of renewable energy generators such as the Proposed Development are necessary in order to meet GHG reduction targets.

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

[8] The Tyndall Centre defines zero or near zero carbon as achieving CO_2 levels >96% lower than in the Paris Agreement reference year (2015)

8.103 By facilitating the expansion of renewable energy supply, the Proposed Development would assist the UK Government target of achieving a fully decarbonised power system by 2035, and both the UK and Welsh Government's aim to become net zero by 2050.

8.104 As a facilitator of the expansion of renewable energy generation, the Proposed Development is in line with UK-wide, and Wales-specific, planning policy and legislation as well as carbon and energy-related policy stated in the Rhondda Cynon Taf LDP (2011).

Effect

8.105 The impact of GHG emissions from the operational phase of the Proposed Development on the **high sensitivity** receptor would result in a **significant beneficial** effect.

8.106 This is on the basis that, during its operational period, the Proposed Development will not result in any GHG emissions (aside from negligible energy use during maintenance activities). The Proposed Development 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 and Wales's 1.5°C-aligned trajectory towards net zero.

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

8.108 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, which meets the definition of a **significant beneficial** effect.

Further Mitigation

8.109 As a result of the above, no further operational-stage mitigation has been proposed.

Future Monitoring

8.110 No future monitoring of operational phase GHG emissions is considered to be required.

Accidents/Disasters

8.111 It is not considered likely that there will be any GHG-related operational-stage accidents and/or disasters, nor that there will be any operational-stage accidents and/or disasters that would cause significant GHG emissions.

Potential Changes to the Assessment as a Result of Climate Change

8.112 A climate risk assessment has been undertaken and detailed within **Appendix 8.2**. The most significant risk from climate change to the Proposed Development is likely to arise from flooding. This is assessed as part of the planning application via a standalone FCA and Drainage Strategy.

8.113 The future changes to cloud cover as a result of climate change were considered. The total cloud anomaly from the UKCP18 probabilistic dataset averaged over the 2040-2069 time period relative to a 1961-1990 baseline for the 2 km grid square in which the site is located is included within **Table 8.5**, below. Further details of the UKCP18 data can be found in **Appendix 8.2**.

Table 8.5 Future Cloud Cover Change

Cloud cover change (%) for RCP8.5			
	10th Percentile	**Median**	**90th Percentile**
2040-2069	-8.64	-4.04	0.55

8.114 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 8.5,** cloud cover is anticipated to decrease during the Proposed Development's operating lifetime. This has positive implications for increased energy generation and demonstrates that the Proposed Development's technology would be resilient to, and benefit from, potential climate change in this respect. An increase in annual yield from the Proposed Development would increase avoided emissions and reduce the payback period, increasing the benefits seen from the Proposed Development.

Assessment of Whole-Life Effects

Significance of Effect

8.115 Consistent with the assessment of operational effects, the lifetime effects assessment is made on the basis that the Proposed Development will displace higher-emitting energy sources that would have continued in the business-as-usual baseline. This has been calculated using current grid average carbon intensity of generation, treating this as remaining consistent in the future baseline without the Proposed Development[9].

8.116 The whole-life GHG emissions (total construction- and operational-stage emissions) resulting from the Proposed Development are shown in **Table 8.6**. This is shown alongside the anticipated carbon payback period for the Proposed Development.

Table 8.6 Project Net GHG Impact

	Value	Unit
Construction-stage emissions	56,173	tCO_2e
Operational-stage emissions	-193,472	tCO_2e
Net emissions (lifetime)	-137,299	tCO_2e
Carbon payback period	11	Years

8.117 Notwithstanding the GHG emissions resulting from the construction stage, the magnitude of avoided emissions resulting from the operational-stage allows the Proposed Development to achieve net reduced emissions from its 11th year of operation (carbon payback period).

8.118 Within the context of the UK and Rhondda Cynon Taf Carbon Budgets (as detailed within **Table 8.3** and **Table 8.4**), the net avoided emissions result in 0.0015% and 1.814% avoided potential carbon budget expenditures, respectively.

8.119 Using the definitions in paragraphs 8.44 and 8.45, the impact of whole-life GHG emissions from the Proposed Development on the **high sensitivity** receptor is considered to meet the definition of a

[9] This is considered to be a balanced assumption: on the one hand it does not assume displacement by the proposed development 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 development 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.

negligible effect that is **not significant**. Although a significant initial carbon cost of manufacturing and installation is incurred, by achieving a carbon payback period of 11 years 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 Net Zero Wales plan to increase renewable energy capacity by 1 GW by 2025, and its net emission savings would be material at the scale of recommended 1.5°C compatible carbon budgets for Rhondda Cynon Taf. It would therefore be consistent with the definition of a 'minor adverse' or 'negligible' 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, and is judged to lie at the 'negligible' end of the scale

8.120 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.

8.121 In the long term, following its carbon payback period, the ongoing avoided emissions from operation of the Proposed Development 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 Proposed Development 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.

Assessment of Cumulative Effects

8.122 All developments that emit GHGs have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a cumulative impact on climate change. Consequently, cumulative effects due to other specific local development projects are not predicted but are taken into account when considering the impact of the Proposed Development by defining the atmospheric mass of GHGs as a **high sensitivity** receptor. The operational phase **significant beneficial effect** assessment of the Proposed Development takes account of cumulative changes in GHG emissions from other generation sources.

Inter-relationships

8.123 Consideration of climate change is provided in each topic chapter of this ES. The main areas where there is a potential for inter-related effects, subject to assessment, are considered to be:

- Landscape and Visual – the likely ranges of change in climatic parameters including precipitation, temperature, wind speed, humidity and frequency of extreme weather may affect the native flora. Whilst this would not increase the sensitivity of receptors, it may affect the magnitude of impact, e.g. the Proposed Development may be more visible to people who only have semi-screened views at present, or it may increase the number of receptors, where loss of trees could enable views not currently possible. However, as the effects of climate change are uncertain, it is difficult to predict the significance of effect with any confidence.
- Biodiversity – potential changes in the sensitivity of habitats or species to development impacts in the future due to the effects of climate change has been considered where applicable.

8.124 No further inter-related effects are considered likely.

Table 8.7 Summary of Likely Environmental Effects on Climate Change

Receptor	Sensitivity of receptor	Description of impact	Short / medium / long term	Magnitude of impact	Significance of effect	Significant / Not significant
Construction phase						
Atmospheric concentration of GHG emissions	High	Changes to atmospheric concentration of GHG emissions	Long term	56,173 tCO_2e	Major adverse	Significant
Effects as a result of climate change	High	Risks to construction activities due to extreme weather conditions	Short term	See risk assessment	See risk assessment	Not significant
Operational phase						
Atmospheric concentration of GHG emissions	High	Changes to atmospheric concentration of GHG emissions	Long term	-193,472 tCO_2e (avoided emissions)	Beneficial	Significant
Effects as a result of climate change	High	Storms affecting power transmission and building damage	Long term	See risk assessment	See risk assessment	Not significant
Whole life						
Atmospheric concentration of GHG emissions	High	Changes to atmospheric concentration of GHG emissions	Long term	-137,299 tCO_2e (avoided emissions) and 11 year payback period	Negligible	Not significant

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