Chapter 5: Climate Change

CLIMATE CHANGE	
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SUPPORTING APPENDIX	**ES Volume 3: Appendix: Climate Change** Annex 1: Trium Climate Change Note Annex 2: Policy and Guidance Background Annex 3: Greenhouse Gas Calculations
KEY CONSIDERATIONS	**PART A** Climate Change Resilience and Adaptation This part of the ES chapter addresses climate change resilience and adaptation and considers the potential for climate change to affect the Proposed Development. **PART B** Greenhouse Gas Emissions Assessment The Proposed Development will lead to the indirect avoidance of greenhouse gases (GHG) throughout the operation of the Proposed Development. This part of the ES chapter follows the approach undertaken by RPS on behalf of the Applicant for other BESS schemes in respect of operational GHG emissions. The approach estimates the avoided GHG emissions associated with the quantity of electricity generation from peaking plants to meet times of high demand and thus the electricity generation that will be displaced, in combination with the renewable energy use/grid electricity enabled, through the operational Proposed Development. This is the effect of the operational Proposed Development on climate change.
CONSULTATION	An EIA Scoping Report was submitted to South Oxfordshire District Council (SODC) on 16th December 2022 and is provided within **ES Volume 3, Appendix: Introduction and EIA Methodology – Annex 4**. An EIA Scoping Opinion was received from SODC on 30th January 2023 and is provided within **ES Volume 3, Appendix: Introduction and EIA Methodology – Annex 5**. The EIA Scoping Opinion confirmed acceptability of the scope and method proposed for the climate change assessment.

5.1 The EIA Regulations require that assessment provides: *"A description of the likely significant effects of the development on the environment resulting from, inter alia… (f) the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change".*

5.2 This ES chapter is separated into two 'parts' in order to address the requirements of the EIA Regulations with regards to the vulnerability of the Proposed Development to climate change (i.e., Part A of this ES chapter), and the impact of the Proposed Development upon climate change with regards to the nature and magnitude of greenhouse gas emissions (i.e., Part B of this ES chapter).

PART A CLIMATE CHANGE RESILIENCE AND ADAPTATION

5.3 The approach to assessing the potential climate change impacts has been undertaken in accordance with the IEMA guidance '*Climate Change Resilience and Adaption*' (2020)'[1], which presents a framework for the consideration of climate change resilience and adaption in the EIA process. It recognises a need for a proportionate approach to the assessment, due to the uncertainties associated with predicting how the environment will respond to climate change.

5.4 The guidance advises on *inter alia*, defining the future climate scenario, the integration of climate change adaption into the design, and the process for EIA. The guidance also provides advice on the execution of the impact assessment across the technical topics, including the identification of the climate related parameters which are likely to influence the project in question, and the anticipated changes to those parameters under a future climate scenario.

5.5 Consistent with the guidance, a future climate scenario has been developed through the use of the future climate projections published by the Met Office (through the UK Climate Projections (UKCP18) website). The results include projections for variables including annual mean temperatures, and annual changes in summer and winter precipitation – refer to **ES Volume 3, Appendix: Climate Change – Annex 1**.

5.6 To describe the predicted future climate, a medium emissions scenario (RCP8.5) for 2060-2079 has been utilised as the future baseline. RCP8.5 has been used as it represents the most reasonable emissions scenario with regards to climate policy, land use, and technological development. The timeslice 2060-2079 is the timeframe considered most relevant to the Proposed Development given the anticipated 40-year operational lifespan of the BESS. The projected change to the range of climatic conditions has adopted the 50% probability level, which is a central estimate adopted given the level of uncertainty associated with predicting the modelled scenarios.

5.7 The future climate change scenario has been considered within each of the technical topics covered in this ES, and the level of assessment and methodology is proportional to the available evidence base. The aim of the assessment has been to consider whether the residual effect on receptors (under the current condition, without climate change) are likely to be different under an alternative future climate regime; in particular, to identify whether the potential impacts and residual effects of the Proposed Development will be worse or improve under the future baseline, and therefore if these changes alter the significance of effects identified for the Proposed Development under the current condition (without climate change). A key aspect of the assessment (for each of the technical topics considered) has been to identify the likely effect of those receptors considered more vulnerable to changes in climate, having taken into account the resilience and adaptive measures (being either design or management) which are proposed for the Proposed Development in order to mitigate the risk presented by climate change. Therefore, the first part of this section presents the adaptation and resilience measures proposed as part of the Proposed Development. Based upon this, the second part then presents the likely effects of climate change on the effects concluded in each technical assessment.

5.8 Due to the level of uncertainty in both the future climate projections and how the future climate conditions may affect sensitive receptors, the assessment is qualitative, based on professional judgement.

Climate Change Adaptation and Resilience

5.9 The Proposed Development (as set out in **ES Volume 1, Chapter 2: Alternatives, Design Evolution and the Proposed Development**) will adapt to and be resilient to climate change through the implementation of deign measures such as:

- Measures to minimise the risks of increased flood risk and surface water run-off affecting the site or others, through the provision of attenuation basins on-site; and
- Selection of native and resilient planting for incorporation into the landscaping to reduce potential future maintenance / replacement.

Cultural Heritage (Archaeology and Built Heritage)

Archaeology

5.10 Based on future climate projection data as presented by the RCP8.5 climate scenario (refer to **ES Volume 3, Appendix: Climate Change – Annex 1**), the South-East is due to experience drier summers with a reduction in rainfall. If there was an overall reduction in rainfall, there is the potential for the water table to reside at a level lower to its current position. As such any currently preserved organic remains may decay if the water table were reduced for prolonged periods of time.

5.11 Whilst a reduction in rainfall may have the ability to adversely impact any preserved organic remains, none of the buried heritage assets identified as sensitive receptors would be subject to impacts through climate change.

5.12 Considering the effects of climate change in relation to archaeology, it has been determined that the future assessment scenario would not be impacted by climate change effects. As such, the conclusions made for this topic within **ES Volume 1, Chapter 3: Cultural Heritage** will remain the same.

Built Heritage

5.13 There are no climatic variables that would have a material impact on the assessment of built heritage considerations relevant to the Proposed Development, e.g., potential direct effects on the Nuneham Courtenay Conservation Area, Nuneham Courtenay Registered Park and Garden, Nuneham House and the garden structures within, Thame Lane Bridge and the buildings of Culham Station, or through change to the setting of other receptors. Accordingly, there would be no changes to the identified importance of the relevant built heritage assets (HA's) in terms of their sensitivity to change (or heritage significance). There are not likely to be any changes to the identified magnitude of impact on the relevant built heritage assets during the construction phase or following completion of the Proposed Development having regard to the potential effects of climate change. As such, the conclusions made for this topic within **ES Volume 1, Chapter 3: Cultural Heritage** will remain the same.

[1] *IEMA (2020). Climate Change Resilience and Adaption (website: https://www.iema.net)*

Land Take and Soils

5.14 The effect on Best and Most Versatile (BMV) agricultural land will occur as a one-off impact during the enabling and construction of the Proposed Development and the identified effect will not be altered by climate change.

5.15 Climate change could however affect the ongoing functioning of soils on the site and their continued ability and effectiveness in meeting the various ecosystem functions identified for them in the scheme design, such as the storage of water and carbon, and acting as a medium for plant growth.

5.16 The specific impacts of climate change on soil resources are difficult to predict but may include such effects as increased susceptibility to wind erosion through drier periods, and increased susceptibility to waterlogging and development of anaerobic conditions throughout wetter periods, which will subsequently impact on biological and chemical attributes of the soil.

5.17 Soil resources which are disturbed and displaced by the Proposed Development will have lower resilience to these potential impacts of climate change than undisturbed soil resource. This is due to factors such as the structural integrity of soil potentially being lost or reduced during handling, and disturbance of the micro- and macro-biology, should soils stored within bunds develop anaerobic conditions.

5.18 The Construction Environmental Management Plan (CEMP) will take into account the measures set out in the Defra Construction Code of Practice for the Sustainable Use of Soils[2], which includes the most appropriate re-use for the different types of soils within the site, as relevant, and the proposed methods for handling and storing soils on-site. The adoption of these measures will ensure that the soil resources on-site will be able to continue to fulfil their various ecosystem services and functions.

5.19 As such, the conclusions made for this topic within **ES Volume 1, Chapter 4: Land Take and Soils** will remain the same.

Landscape and Visual

5.20 The likely effects of the Proposed Development are defined under the current climate conditions, which may alter under a future climate scenario. The EIA Regulations require that the change in impact magnitude and a receptor's 'vulnerability' (i.e., susceptibility or resilience to change) are considered in respect of a future climate condition.

5.21 The likely projected future conditions for each of temperature, precipitation, wind speed and cloud cover have been considered, whereby the landscape receptors and visual receptors representative views are considered to be of low vulnerability to such climatic factors.

5.22 Changes expected from climate change, such as increased rainfall levels and temperatures, are unlikely to impact on the appearance of the Proposed Development in views and its relationship to landscape character during the period of enabling and constructions works, or when the Proposed Development is completed and operational. Therefore, it is considered that the magnitude of impact and resultant nature and scale of the effects of the Proposed Development will not be changed under the future climate conditions. As such, the conclusions made for this topic within **ES Volume 2** will remain the same.

PART A LIKELY SIGNIFICANT EFFECTS

5.23 In conclusion, under the future climate scenario, the residual effects of the Proposed Development would remain consistent with the effects identified as described throughout this ES and summarised in **ES Volume 1, Chapter 8: Summary and Conclusions** under the current climate conditions. No additional or different likely significant climate change effects (in terms of the effect of climate change on the Proposed Development) have been identified.

PART B GREENHOUSE GAS EMISSIONS ASSESSMENT

5.24 This section of the ES chapter provides a Greenhouse Gas (GHG) assessment for the operational Proposed Development, as described in **ES Volume 1, Chapter 2: Alternatives, Design Evolution and the Proposed Development**.

5.25 GHGs are gases which have the potential to increase atmospheric temperatures and which contribute to climate change. The Proposed Development will lead to the indirect avoidance of GHGs throughout its operational lifetime. This assessment estimates the avoided GHG emissions associated with the quantity of electricity generation from peaking plants to meet times of high demand and thus the electricity generation that will be displaced, in combination with the renewable energy use enabled, through the operation of the Proposed Development – i.e., the effect of the operational Proposed Development on climate change. This part of the ES chapter follows the approach undertaken by RPS on behalf of the Applicant for other BESS schemes with respect to operational GHG emissions, such as the Grendon Lakes BESS GHG assessment[3].

Assessment Methodology

Legislation, Policy and Guidance

5.26 Full details of relevant legislation, policy and guidance are provided in **ES Volume 3, Appendix: Climate Change – Annex 2**. The relevant legislation, policy and guidance considered in this assessment includes:

- Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment[4]
- National Planning Policy Framework (2021)[5];
- Climate Change Act (2008)[6];
- Climate Change Act 2008 (2050 Target Amendment) Order 2019[7];
- Energy Act (2013) [8]
- Climate Change and Sustainable Energy Act (2006)[9];
- The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting [10]
- The Clean Growth Strategy[11];
- Energy White Paper: Powering Our Net Zero Future (2020)[12];
- National Infrastructure Strategy (2020)[13];
- The Sixth Carbon Budget: The UK's Path to Net Zero (2020)[14];
- Policies for the Sixth Carbon Budget and Net Zero (2020)[15];
- Industrial Decarbonisation: Net Zero Carbon Policies to Mitigate Carbon Leakage and Competitiveness Impacts (2020)[16];

[2] *Department for Environment, Food and Rural Affairs (Defra) (2009). Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-construction-sites*
[3] *RPS (2022) Grendon Lakes Battery Storage Facility. Environmental Statement Chapter 8: Climate Change. Prepared for Statera Energy Limited*
[4] *European Commission (2013) Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment.*
[5] *HM Government. 2021. National Planning Policy Framework*
[6] *Her Majesty's Stationery Office (2008), 'Climate Change Act 2008'*
[7] *https://www.legislation.gov.uk/ukdsi/2019/9780111187654*
[8] *Her Majesty's Stationery Office (2013) Energy Act 2013.*
[9] *https://www.legislation.gov.uk/ukpga/2006/19/data.pdf*
[10] *Defra (2018) The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting.*
[11] *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf*
[12] *HM Government (2020). Energy White Paper: Powering our Net Zero Future. [Online] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf*
[13] *HM Treasury (2020). National Infrastructure Strategy. [Online] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938049/NIS_final_web_single_page.pdf.*
[14] *Committee on Climate Change (2020a). The Sixth Carbon Budget: The UK's path to Net Zero. [Online] https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf.*
[15] *Committee on Climate Change (2020b). Policies for the Sixth Carbon Budget and Net Zero. [Online] https://www.theccc.org.uk/wp-content/uploads/2020/12/Policies-for-the-Sixth-Carbon-Budget-and-Net-Zero.pdf*
[16] *Sturge, D (2020) Industrial Decarbonisation: Net Zero Carbon Policies to Mitigate Carbon Leakage and Competitiveness Impacts. [Online] https://www.theccc.org.uk/wp-content/uploads/2020/12/Energy-Systems-Catapult-Industrial-Decarbonisation-and-Mitigating-Carbon-Leakage.pdf*

- Environmental Audit Committee: Carbon Border Tax Measures (2021)[17];
- Net Zero Strategy: Build Back Greener (2021)[18]; and
- IEMA Assessing Greenhouse Gas Emissions and Evaluating their Significance[19].

5.27 The National Planning Policy Framework (NPPF) highlights the importance of the UK's transition to a low carbon future in a changing climate, and stresses the need for the increased use and supply of renewable and low carbon energy.

5.28 Paragraph 152 states that the planning system should "*support renewable and low carbon energy and associated infrastructure*" and "*shape places in ways that contribute to radical reductions in greenhouse gas emissions*".

5.29 With regard to local policy, the South Oxfordshire Local Plan[20] 2035 Policy DES9 (Renewable Energy) encourage schemes for renewable and low carbon energy generation and associated infrastructure at all scales.

5.30 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*'.

5.31 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[21] for the whole of the UK.

5.32 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.

5.33 The UK's Nationally Determined Contribution (NDC)[22] 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.

5.34 Furthermore, the UN Climate Change Conference (COP26) in October 2021 set the new target to limit global warming to below 1.5°C, which was previously below 2°C under the Paris Agreement. COP27, held in November 2022, reaffirmed this commitment.

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

5.36 The CCC's Sixth Carbon Budget report makes the following policy recommendations with regard to renewable energy deployment[23]:

- 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; and
- Electricity generation: will require a significant expansion of low carbon generation; this includes low cost renewables, with more flexible demand and storage.

5.37 Increasing the renewables penetration in the UK electricity mix to 80% by 2050 will largely be met with intermittent, non-dispatchable[24] generation types (the CCC suggest that up to 140 gigawatts (GW) of offshore wind should be deployed by 2050). In order to facilitate such a high penetration of intermittent energy sources, the CCC emphasises the requirement for a flexible energy network, including the use of battery energy storage systems.

5.38 The Net Zero Strategy: Build Back Greener 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 in addition to an increase in energy storage capacity.

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

- the Greenhouse Gas Protocol suite of documents[25];
- Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book[26]; and
- UK Government GHG Conversion Factors for Company Reporting[27].

Impact Assessment Methodology

5.40 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.

5.41 The GHGs considered in this assessment are those in the 'Kyoto basket'[28] 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[29] or as otherwise defined for national reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

5.42 GHG emissions caused by an activity are often categorised into 'Scope 1', 'Scope 2' or 'Scope 3' emissions, following the guidance of the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol suite of guidance documents[25]:

- Scope 1 emissions: released directly, 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.

5.43 In construction, GHG emissions will be caused by construction traffic and plant and embodied in the materials and products consumed. However, on a lifecycle basis these are expected to be very minor relative to the GHG reduction benefits of the Proposed Development. Furthermore, the decommissioning activities of the Proposed Development will be no greater than those at construction phase, whereby following the decommissioning, the GHG emissions will be negligible.

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[17] *UK Parliament (2021) EAC launches new inquiry weighing up carbon border tax measures. [Online] https://committees.parliament.uk/committee/62/environmental-audit-committee/news/157728/eac-launches-new-inquiry-weighing-up-carbon-border-tax-measures/.*
[18] *HM Government (2021) Net Zero Strategy: Build Back Greener. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf*
[19] *IEMA. 2022. Assessing Greenhouse Gas Emissions and Evaluating their Significance – 2nd Edition*
[20] *South Oxfordshire District Council. (2020). The South Oxfordshire Local Plan 2011-2035. Available at: https://www.southoxon.gov.uk/south-oxfordshire-district-council/planning-and-development/local-plan-and-planning-policies/local-plan-2035/adopted-local-plan-2035 /*
[21] *A carbon budget places restrictions on the total amount of GHGs that can be emitted. The budget balances the input of CO2 to the atmosphere by emissions from human activities, by the storage of carbon (i.e., in carbon reservoirs on land or in the ocean).*
[22] *HM Government (2020) United Kingdom of Great Britain and Northern Ireland's Nationally Determined Contribution. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943618/uk-2030-ndc.pdf*
[23] *Climate Change Committee (2020) The Sixth Carbon Budget: The UK's path to Net Zero. https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-pathto-Net-Zero.pdf.*
[24] *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.*
[25] *WRI and WBCSD (2004) The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. Revised edition, Washington and Geneva: WRI and WBCSD*
[26] *Department for Business, Energy and Industrial Strategy (BEIS) (2021) Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book.*
[27] *BEIS (2021) Greenhouse gas reporting: Conversion factors 2021. https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021.*
[28] *This accounts for six key greenhouses gasses: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).*
[29] *Forster, P. et al. (2007) Changes in Atmospheric Constituents and Radiative Forcing. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the IPCC. Cambridge: Cambridge University Press.*

5.44 Due to the nature of the Proposed Development – importing and exporting electricity from the grid for storage purposes – its gross GHG emissions total is significantly dominated by avoided Scope 2 emissions. As such, emissions from activities related to the construction and decommissioning of the Proposed Development have been scoped out of the assessment, as set out in **ES Volume 3, Appendix: Introduction and EIA Methodology – Annex 4**.

5.45 It is expected that in the absence of the Proposed Development, periods of low renewable energy supply and high demand would be met via gas-fired peaking plants. As such, the avoided Scope 2 emissions considered in this assessment are those that would have occurred as a result of alternative technology, in this case typical peaking plant operation.

Study Area

5.46 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.

Defining the Baseline

5.47 Published benchmarks and representative project examples have been used to establish the baseline of current and future carbon intensity of peaking plants and the grid-average carbon intensity. Baseline information for this, as well as other relevant activities for the Proposed Development have been informed via the following sources:

- Department for Business, Energy and Industrial Strategy (BEIS) (2021) Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book;
- RPS (2020) Thurrock Flexible Generation Plant. Environmental Statement Volume 6. Appendix 14.1: GHG Calculations. Prepared for Thurrock Power;
- VPI Immingham (2019) VPI Immingham OCGT. Environmental Statement: Volume I. Chapter 15: Sustainability and Climate Change. Document ref. 6.2.15;
- MOHC (2021) UK Climate Projections User Interface v2.6.0; and
- RPS (2022) Grendon Lakes Battery Storage Facility. Environmental Statement Chapter 8: Climate Change. Prepared for Statera Energy Limited.

Embedded Mitigation Measures

5.48 The primary purpose of the Proposed Development is to facilitate the deployment of greater amounts of renewable energy generation capacity, bridging the gap between fluctuations in supply and demand, and hence minimising reliance on high carbon intensity thermal power generation. Operation of the Proposed Development is therefore considered to inherently be a climate change mitigation measure.

Methodology for Defining Effects

Receptors and Receptor Sensitivity

5.49 The assessment of GHGs does not include identification of specific sensitive receptors, as GHG emissions do not directly affect specific locations or receptors but lead to indirect effects by contributing to climate change. Identification of sensitive areas for climate change has been undertaken by the IPCC[30]. Impacts on specific areas are not included within this assessment, since the impacts of GHG emissions will affect the global atmosphere, and therefore need to be considered in a total context, rather than on localised areas.

5.50 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).

Magnitude of Effect

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

Defining the Effect

5.52 IEMA's *'Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance'*[31] describes five levels of significance for emissions resulting from a development, each based on how a project contributes towards achieving net zero by 2050. To aid in considering whether effects are significant, the guidance recommends that resultant GHG emissions should be contextualised against pre-determined carbon budgets, or emerging policy and performance standard 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.

5.53 Taking the guidance into account, the following factors 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); 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[32]).

5.54 Effects from GHG emissions are described in this ES chapter as adverse, negligible or beneficial based on the definitions set out in Table 5.1 below, as stated within IEMA guidance[33].

Table 5.1 GHG Scale and Nature of Effect Criteria

Scale and Nature of Effect	Criteria
Major Adverse	The Proposed Development's GHG impacts would not be compatible with the UK's net zero trajectory. It's GHG impacts would not be mitigated, or would be compliant only with dominimum standards set through regulation. The Proposed Development may not provide further emissions reductions required by existing local and national policy for projects of this type.
Moderate Adverse	The Proposed Development's GHG impacts would not be compatible with the UK's net zero trajectory. It's 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 Proposed Development's 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 Proposed Development would fully comply with, or exceeds, measures necessary to achieve the UK's net zero trajectory.
Negligible	The Proposed Development would achieve emissions mitigation that goes substantially beyond existing and emerging policy compatible with the 1.5°C trajectory, and would have minimal emissions. The Proposed Development would be fully consistent with good practice design standards for projects of this type.
Beneficial	The Proposed Development would result in emissions reductions from the atmosphere, whether directly or indirectly, compared to the without-Proposed Development baseline. As such it's net GHG impacts would be below zero. The Proposed Development would substantially exceed net zero requirements.

Categorising Likely Significant Effects

5.55 Major and moderate adverse effects are both significant for the purposes of assessment, and it is down to professional judgement to differentiate between the 'level' of significant adverse effects. Beneficial effects are also considered to be significant. Minor adverse and negligible effects are not considered to be significant.

[30] *The Intergovernmental Panel on Climate Change (2014), 'AR5 Climate Change 2022: Impacts, Adaptation, and Vulnerability'*
[31] *IEMA. 2022. Assessing Greenhouse Gas Emissions and evaluating their significance – 2nd Edition*
[32] *HM Government (2020) United Kingdom of Great Britain and Northern Ireland's Nationally Determined Contribution. [Online] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943618/uk-2030-ndc.pdf*
[33] *IEMA. 2022. Assessing Greenhouse Gas Emissions and Evaluating their Significance – 2nd Edition*

Assumptions and Limitations

5.56 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. As detailed at paragraph 5.45, this assessment assumes that the Proposed Development would displace energy generated by gas-fired peaking plants. Associated emissions arising from such a generation source have been calculated using reported emissions intensities (sources listed at paragraph 5.47). In order to provide a conservative assessment, and not overstate the potential benefits of the Proposed Development, potential trends in decarbonisation of the peaking power supply in the future baseline scenario have been considered. The assessment assumes a linear decarbonisation to converge with BEIS long run marginal projected grid intensity in 2035, when UK grid electricity should be fully decarbonised (see **ES Volume 3, Appendix: Climate Change – Annex 3** for further detail).

5.57 This methodology assumes that peaking plant decarbonisation is successful and is achieved in line with national decarbonisation targets. Should peaking plants not decarbonise in line with such targets, the associated generated electricity from peaking plants would maintain a higher emissions intensity than that included in the assessment presented in this ES chapter. Avoided emissions resulting from the displacement of peaking plant-generated electricity from projects such as the Proposed Development would likely be greater than those reported in this assessment. Therefore, the effects reported in this ES chapter provide a conservative view of emissions that could be avoided as a result of the Proposed Development for the purpose of this EIA.

5.58 Further uncertainty arises from the use of BEIS' long-run marginal projections to inform projected peaking plant intensity over the Proposed Development's lifetime. The long run marginal projections account for the installation and connection of future infrastructure, such as BESS and hydrogen, in line with current policy. Therefore, the assessment conservatively considers the Proposed Development's impact against a decarbonisation scenario which effectively relies upon its own, or similar project's development occurring. Without projects such as the Proposed Development, progress towards decarbonisation would be reduced compared to current projections. In the absence of greater certainty around grid and peaking plant decarbonisation this assessment approach is considered conservative and should be considered within the context of how this Proposed Development contributes towards net zero policy and obligations.

5.59 This assessment has projected GHG emissions up to the end of the Sixth Carbon Budget period (2037), consistent with the assessment of significance which was undertaken within the context of the UK carbon budgets. Although, it is noted that given the predicted 40-year operational lifespan of the Proposed Development, avoided GHG emissions as a result of the Proposed Development will likely be experienced beyond this period.

5.60 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 robust estimate of the effects of the Proposed Development.

Baseline Conditions

5.61 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 **ES Volume 3, Appendix: Climate Change – Annex 1**.

5.62 With regard to GHG emissions, the current baseline comprises non-developed, agricultural land. As set out in **ES Volume 1, Chapter 4: Land Take and Soils**, the soils on-site are described as comprising a mixture of loamy sand, sandy loam and sandy clay loam with a range of gravel content in the subsoil, with no indication of peat soils being present. Only land with high carbon stock such as woodland and peatland is of relevance to the assessment of GHG emissions, as both may have a material impact on emissions arising from or sequestered on site. Given both such environments are not identified on site, it is unlikely that any disruption to the current land use, resulting from the Proposed Development, will result in anything more than a negligible and immaterial change in carbon stores and sequestration capacity.

5.63 With regard to the electricity export of the Proposed Development, the current baseline is the carbon intensity of the grid during periods of low renewable energy supply and high demand. Without energy storage, the electricity demand during these periods will be met via peaking plants. The unabated carbon intensity of peaking plants has been calculated by taking an average of the calculated carbon intensity for two UK facilities employing different gas-fired peaking generation technologies (Immingham Open Cycle Gas-Turbine[34] and Thurrock Flexible Generation Plant[35]). This follows the same approach undertaken for the assessment of Grendon Lakes BESS[36]. This baseline for the carbon intensity of peak demand electricity generation is 0.274 tCO_2e/MWh in the Proposed Development's first year of operation (2027), as set out in **ES Volume 3, Appendix: Climate Change – Annex 3**.

Future Baseline

5.64 Under the UK's climate targets it will be necessary for peaking plants to decarbonise[37] (if not displaced by alternatives such as battery storage). Projections specific to the carbon intensity of peaking power generation (rather than grid average) are not available.

5.65 To be conservative in not overstating the benefits of displacing peaking generation with the Proposed Development's battery storage capacity, it has therefore been assumed that the carbon intensity of peaking plants will be equal to the grid-average projection by 2035 onwards. A simple linear reduction in the carbon intensity of peaking plants from present-day values to converge with the BEIS projected factors by 2035 has been calculated (see **ES Volume 3, Appendix: Climate Change – Annex 3**).

Potential Effects

Assessment of Effects on Climate Change

Magnitude of Impact

5.66 Under expected future conditions where the electricity supply is characterised by an increasing penetration of intermittent and non-dispatchable renewable energy resources, the Proposed Development would provide a mechanism for enabling greater harmonisation between electricity supply and demand profiles.

5.67 As the UK electricity grid decarbonises and the provision of renewable energy resources (predominately wind and solar) increases, surpluses in demand will be increasingly met via carbon-intensive peaking plants in the absence of sufficient energy storage. In contrast, surpluses in supply are often met with the curtailment of zero carbon renewable energy: the first seven months (January 1 – July 31) of 2023 saw 1,555.7 GWh of curtailed wind energy, as monitored by the UK Wind Curtailment Monitor[38]. Furthermore, as the production of wind power increases over the years, it will likely be matched with higher curtailment of energy. The National Grid's own projections (National Grid, 2022) predict between 7.6 TWh and 21.3 TWh of curtailment by 2030 in all Net Zero aligned scenarios.

5.68 It is assumed that as the penetration of non-dispatchable renewable energy generation sources in the UK grid increases, energy market price mechanisms will be in place to ensure that, insofar as is possible, stationary grid-scale batteries only charge using surplus renewable energy. The magnitude of GHG emission impact of the Proposed Development is therefore determined by the quantity of renewable energy use it enables by avoiding curtailment, the quantity of peaking plant generation it displaces, and the associated GHG impacts of both. However, as it is not certain that this would be the case in all market conditions. An analysis of the GHG impacts of the Proposed Development based on the carbon intensity of an alternative source has also been undertaken. During periods of low renewable energy supply, the BESS will be charged directly from grid electricity (assuming the average generation mix on the grid at the time of import), releasing such energy back to the grid during times of peak demand. As such, a second scenario has been assessed, whereby the magnitude of GHG emission impact of the Proposed Development is determined by the quantity of grid

[34] *VPI Immingham (2019) VPI Immingham OCGT. Environmental Statement: Volume I. Chapter 15: Sustainability and Climate Change. Document ref. 6.2.15*
[35] *RPS (2020) Thurrock Flexible Generation Plant. Environmental Statement Volume 6. Appendix 14.1: GHG Calculations. Prepared for Thurrock Power*
[36] *RPS (2022) Grendon Lakes Battery Storage Facility. Environmental Statement Chapter 8: Climate Change. Prepared for Statera Energy Limited.*
[37] *It is expected that decarbonisation of gas fired peaking plants will be achieved via the implementation of carbon capture and storage (CCS) and by switching to alternative fuels such as hydrogen and biogas.*
[38] *Dudfield, P. and de Berker, A. (n.d.) How much wind are we wasting? [online] https://wind-curtailment-appahq7fucdyq-lz.a.run.app/*

electricity required to charge the BESS, the quantity of peaking plant generation it displaces, and the associated GHG impacts of both.

5.69 The quantity of renewable energy enabled/grid electricity stored, and peaking plant energy displaced is determined by the total annual energy input and output values for the Proposed Development (see **ES Volume 3, Appendix: Climate Change – Annex 3**). The associated GHG emissions are determined by the GHG intensity of the enabled and displaced sources of generation. It is assumed that operational emissions resultant from the Proposed Development will lie between those calculated for each scenario.

Scenario A; BESS charged from renewable energy sources

5.70 Given wind energy sources contribute the greatest proportion of non-dispatchable renewable energy generation in the UK[39], and 140 GW of offshore wind is recommended to be deployed by 2050[40], it is expected that the source of renewable energy that is most likely to be enabled by the Proposed Development is offshore wind.

5.71 A GHG intensity of 0.99 gCO_2e/kWh for offshore wind[41], and peaking plant intensity of 0.274 tCO_2e/MWh (in the first year of operation – see paragraph 5.64) was used to determine the magnitude of GHG emissions avoided by the Proposed Development.

Scenario B; BESS charged directly from grid electricity

5.72 Under this scenario the indirect GHG emissions associated with charging the BESS are assumed to be equal to those associated with grid electricity. Such emissions have been sourced from BEIS long-run marginal grid intensity figures (BEIS, 2022) which account for year-on-year decarbonisation of grid electricity in line with national decarbonisation targets.

5.73 The GHG intensity for grid electricity (in the first year of operation), sourced from BEIS long run marginal grid intensity figures[42], and peaking plant intensity of 0.274 tCO_2e/MWh (in the first year of operation – see paragraph 5.63) was used to determine the magnitude of GHG emissions avoided by the Proposed Development.

Results

5.74 During the first year of operation, the magnitude of impact for the operational phase of the Proposed Development has been calculated to be between 77,479 tCO_2e and 236,921 tCO_2e of avoided emissions.

5.75 Given the significance of the Proposed Development has been assessed in the context of the UK national carbon budgets (see below), cumulative avoided emissions have been projected to the end of the Sixth Carbon Budget and total between 431,003 tCO_2e and 1,251,986 tCO_2e. Beyond this point it is assumed that emissions associated with grid electricity generation from a variety of both baseload and peaking sources will have decreased as a result of decarbonisation strategies (as shown within BEIS projections of the carbon intensity of grid electricity). As such, the magnitude of annual avoided emissions over the remainder of the Proposed Development's operational lifetime is reduced in comparison to those avoided emissions achieved up to the end of the Sixth Carbon Budget.

Sensitivity of Receptor

5.76 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

5.77 The nature and significance of effect has been characterised 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 future 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

5.78 The Proposed Development's operational-stage emissions have been contextualised in the context of the UK's fourth, fifth and sixth carbon budgets. The Proposed Development GHG impacts given within Table 5.2 and Table 5.3 represent carbon budget expenditures that would have occurred in the absence of the Proposed Development and have therefore been avoided. Table 5.2 displays UK national carbon budgets and how the Proposed Development's operational GHG impacts relate to them.

Table 5.2 GHG Impacts in the Context of the UK's Carbon Budgets

Time Period	2023-2027	2028-2032	2033-2037	Total[43]
UK carbon budget (tCO_2e)	1,950,000,000	1,730,000,000	960,000,000	4,640,000,000
Proposed Development GHG impacts (tCO_2e)	-77,479 to -236,921	-311,203 to -798,748	-42,321 to -216,317	-431,003 to -1,251,986
Development avoided emissions as percentage of UK carbon budget	-0.004% to -0.012%	-0.018% to -0.046%	-0.004% to -0.023%	-0.009% to -0.027%

5.79 Additionally, the Tyndall Centre for Climate Change Research (2022)[44] has created district and area-specific carbon budgets up to 2100. The Proposed Development's operational GHG impacts were considered in terms of Oxford's Tyndall Centre-derived carbon budget.

5.80 The Tyndall Centre carbon budgets are more stringent than the UK national budgets (as advised by the CCC); the carbon budget for Oxford would result in achieving zero or near zero carbon by 2043[45]. The Tyndall Centre carbon budgets expressed below are for energy-related CO_2 emissions only.

5.81 Table 5.3 displays the Oxford-specific carbon budgets and how the Proposed Development operational GHG impacts relate to them.

Table 5.3 GHG Impacts in the Context of the Oxford Carbon Budgets

Time Period	2023-2027	2028-2032	2033-2037	Total
Oxford carbon budget (tCO_2e)	1,500,000	800,000	400,000	2,700,000
Proposed Development GHG impacts (tCO2e)	-77,479 to -236,921	-311,203 to -798,748	-42,321 to -216,317	-431,003 to -1,251,986
Development avoided emissions as percentage of Oxford carbon budget	-5.17% to -15.79%	-38.90% to **-99.84%**	-10.58% to -54.08%	-15.96% to -46.37%

5.82 As can be seen from Table 5.3, the Proposed Development would make a measurable contribution to avoiding potential carbon budget expenditure in Oxford.

Effect

5.83 The impact of GHG emissions from the operational phase of the Proposed Development on the high sensitivity receptor would result, conservatively, in a Negligible to **Significant Beneficial** effect.

Mitigation, Monitoring and Residual Effects

5.84 No further operational-stage mitigation has been proposed. No future monitoring of operational phase GHG emissions is considered to be required.

5.85 As set out above, the residual effect GHG emissions from the operational phase of the Proposed Development on the high sensitivity receptor would result, conservatively, in a Negligible to Significant Beneficial effect.

[39] *BEIS (2021) UK Energy in Brief 2021. [Online] UK Energy in Brief 2021 (publishing.service.gov.uk).*
[40] *Climate Change Committee (2020) The Sixth Carbon Budget: The UK's path to Net Zero. [Online] https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-pathto-Net-Zero.pdf*
[41] *Dolan, S.L & Heath, G.A (2012) Life Cycle Greenhouse Gas Emissions of Utility-Scale Wind Power. Journal of Industrial Ecology. Volume 16 Number S1.*
42 BEIS (2022) Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book.
[43] *This is the total during the budget periods, not the total for the Proposed Development's assumed lifetime.*
[44] *https://carbonbudget.manchester.ac.uk/reports/E07000178/*
[45] *The Tyndall Centre defines zero or near zero carbon as achieving CO2 levels >96% lower than in the Paris Agreement reference year (2015)*

5.86 This is on the basis that, during its operational period, the Proposed Development would not result in any GHG emissions (aside from negligible energy use during maintenance activities). It has been assumed that the Proposed Development would store renewable energy (likely generated by offshore wind, with the possibility of alternative sources), thereby enabling the displacement of gas-fired peaking plants. As such, the Proposed Development indirectly removes GHG emissions, that would otherwise have been emitted, from the atmosphere. Further, the development of energy storage facilities meets energy sector policies requiring an increased flexibility and adaptability of renewable energy supply to enable continued grid electricity decarbonisation.

Assessment of Future Environment

Evolution of the Baseline Scenario

5.87 The existing site comprises agricultural fields, which would continue to remain should Proposed Development not be implemented.

Cumulative Effects Assessment

5.88 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 individually 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 Beneficial effect of the assessment of the Proposed Development takes account of cumulative changes in greenhouse gas emissions from other energy generation sources.

PART B LIKELY SIGNIFICANT EFFECTS

5.89 The operational phase of the Proposed Development would enable the storage and use of excess renewable electricity (avoiding generation curtailment) and the displacement of fossil fuel-powered peaking power generators. This would result in a positive GHG impact in the order between 431,003 tCO_2e and 1,251,986 tCO_2e savings by 2037, the end of the Sixth Carbon Budget period. This would result in up to a significant beneficial effect on the basis that:

- it contributes to reducing carbon budget expenditure at a national and local level;
- it has an emissions intensity significantly lower than the grid average and that of the current baseline for flexible energy generation; and
- it is in keeping with local and UK energy and climate policy.

5.90 The Proposed Development is in line with the NPPF'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. Further, the Proposed Development is supported by national energy and climate change policy (including the National Infrastructure Strategy, Sixth Carbon Budget, and Net Zero Strategy, detailed within **ES Volume 3, Appendix: Climate Change – Annex 2**) which promote the decarbonisation of grid electricity, aided by the implementation of energy storage technologies.

5.91 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 becoming net zero by 2050.

5.92 As a facilitator of the expansion of renewable energy generation, the Proposed Development is in line with UK-wide planning policy and legislation as well as renewable energy-related policy stated in the South Oxfordshire Local Plan.