East Claydon Battery Energy Storage System (BESS)

Environmental Statement

Volume 9, Chapter 1: Climate Change

October 2023

Contents

1 INTRODUCTION

1.1.1 This chapter of the Environmental Statement (ES) presents the findings of the EIA concerning the potential environmental effects of the East Claydon Battery Energy Storage System (BESS) (referred to in this report as the ‘Proposed Development’) on climate change.

1.1.2 Climate change in the context of EIA can be considered terms of:

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

1.1.3 This chapter is supported by the following appendices:

- Appendix 9.1.1: Climate Change Policy Review;
- Appendix 9.1.2: Climate Risk Assessment; and
- Appendix 9.1.3: GHG Calculations.

1.2 Design Parameters

1.2.1 This assessment is based on the site description detailed within Volume 1, Chapter 2: The Project. This includes a description of the key components and construction phase of the Proposed Development, and indicative layout shown on the project masterplan (planning drawing reference SL261_L_X_GA_P_1).

2 LEGISLATIVE AND POLICY FRAMEWORK

2.1 Planning Policy Context

2.1.1 A summary of relevant policy is given in this section. Full references are provided in Appendix 9.1.1: Climate Change Policy Review.

2.1.2 The National Planning Policy Framework (NPPF) (UK Government, published 2012 and revised in 2021 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.

2.1.3 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"*.

2.1.4 With regard to local policy, the Vale of Aylesbury Local Plan 2013-2033 (adopted by the Buckinghamshire Council in September 2021) seeks to address climate change through adaptation and mitigation measures, by *"making appropriate provision for the generation and use of renewable or low-carbon energy, and locally distributed energy"*. The Local Plan outlines the Council's vision of embracing renewable energy and energy-efficient systems in development planning. Policy C3 'Renewable Energy' highlights this, promoting development projects that secure energy from renewable or low-carbon sources, minimising energy use, and encouraging greater efficiency in the use of natural resources.

2.1.5 Additionally, the Buckinghamshire Local Energy Strategy 2018-2030 sets out a comprehensive set of policies and actions that aim to accelerate the pace of "clean growth" in Buckinghamshire. The Strategy promotes the development of ''*innovative, local, integrated, clean energy systems*'', seeking to overcome the constraints on grid capacity by working with developers.

2.2 Relevant Guidance

Legislation

2.2.1 The Climate Change Act 2008, as amended (2019), creates 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.

2.2.2 At present, the Third, Fourth, Fifth and Sixth Carbon Budgets, set through The Carbon Budget Orders 2009, 2011, 2016, and 2021 are 2.54 giga tonnes carbon dioxide equivalent ($GtCO_2e$) for 2018-2022, 1.95 $GtCO_2e$ for 2023-2027, 1.73 $GtCO_2e$ for 2028-2032 and 0.97 $GtCO_2e$ for 2033-2037 respectively. The Sixth Carbon Budget is the first Carbon Budget that is consistent with the UK's net zero target, requiring a 78% reduction in GHG emissions by 2035 from 1990 levels.

2.2.3 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.

[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).

Guidance and Recommendations

2.2.4 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, gives advice on climate change risks and adaptation.

2.2.5 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.

2.2.6 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 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.

2.2.7 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 in addition to an increase in energy storage capacity.

2.2.8 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).

2.2.9 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).

2.2.10 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), 2022); and
- UK Government GHG Conversion Factors for Company Reporting (Department for Energy Security and Net Zero (DESNZ), and Department for Environment, Food and Rural Affairs (Defra), 2023).

---

[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.

3 ASSESSMENT METHODOLOGY

3.1 GHG Emissions Calculations – Overview and Assessment Boundary

3.1.1 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.

3.1.2 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).

3.1.3 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.

3.1.4 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.

3.1.5 Due to the nature of the Proposed Development – importing and exporting electricity from the grid for storage purposes – its gross GHG emissions total is dominated by avoided Scope 2 emissions. 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 are those that would have occurred as a result of alternative technology, in this case typical peaking plant operation.

3.1.6 Scope 3 emissions resulting from the manufacturing and construction of the battery packs, associated balance of system (BoS)[4] components and site infrastructure (including container crates, concrete foundations and gravel/stone access tracks) have also been calculated via published benchmark carbon intensities and published lifecycle analysis (LCA) literature regarding battery technology.

3.1.7 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

---

[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).

[4] Balance of system components, in this context, refer predominately to the Project's transformers, inverters, switchgear and cooling plant.

or future baseline, and hence (c) the net impact on climate change due to these changes in GHG emissions overall.

3.2 Climate Risks – Overview

3.2.1 Potential climatic conditions in the 2040-2069 and 2070-2099 time periods at the site of the Proposed Development have been considered based on the Met Office Hadley Centre 'UKCP18' probabilistic projections (MOHC, 2023). 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.

3.2.2 Further detail of the approach and data input is given in Appendix 9.1.2: Climate Risk Assessment.

3.2.3 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 project design can have on the risk.

3.2.4 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.

3.2.5 The assessment of flood risk, including increases in rainfall rates due to climate change, is provided in Volume 4: Hydrology and Flood Risk.

3.3 In-Combination Climate Impact Assessment – Overview

3.3.1 IEMA guidance (2020) defines an in-combination climate impact as '*when a projected future climate impact (e.g., increase in temperatures) interacts with an effect identified by another topic and exacerbates its impact'*.

3.3.2 The in-combination climate impact assessment has been informed by the potential climatic conditions during the 2040 to 2069 and 2070 to 2099 time periods based on the MOHC UKCP18 probabilistic projections (MOHC, 2023), consistent with paragraph 3.2.1. Projections for the global emissions 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.

3.3.3 An initial screening exercise for each environmental topic has been undertaken which identifies impacts reported within each technical chapter of this ES and considers whether projected climate conditions will alter the sensitivity of receptors or magnitude of impact resulting in a change in significance. The significance of any effect has been re-assessed using the standard methodologies for each relevant environment topic.

3.3.4 Consideration has also been given to whether any new effects will arise as a result of the Proposed Development under future projected climate conditions.

3.3.5 The assessment of in-combination climate impacts has considered the mitigation measures adopted as part of the Proposed Development in determining whether projected climate change affects effects on sensitive receptors. Should an effect remain significant following the above-described assessment of in-combination climate impacts, further mitigation has been presented where relevant.

3.4 Study Area

3.4.1 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.

3.4.2 The climate change risk study area is the climate projections 25 km grid cell in which the site of the Proposed Development is located.

3.5 Baseline Methodology

3.5.1 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:

- BEIS (2022) 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. Report Number: OXF10872
- VPI Immingham (2019) VPI Immingham OCGT. Environmental Statement: Volume I. Chapter 15: Sustainability and Climate Change. Document ref. 6.2.15.
- MOHC (2023) UK Climate Projections User Interface v2.8.0

3.6 Consultation

3.6.1 An EIA Scoping Opinion Request (Statera, 2023) was submitted to Buckinghamshire Council in July 2023 (23/02205/SO). Comments relevant to the assessment of climate change are included within **Table 3.1**, below.

Table 3.1: Consultation Responses

Comment	How and where considered within this ES
Natural England	
The ES should identify how the development affects the ability of the natural environment (including habitats, species, and natural processes) to adapt to climate change, including its ability to provide adaptation for people (i.e. what's already there and affected) as well as impacts on how the environment can accommodate change for both nature and people, for example whether the development affects species ability to move and adapt. Nature-based solutions, such as providing green infrastructure on-site, and in the surrounding area (e.g. to adapt to	This chapter assesses the in-combination climate impacts on the Proposed Development, which could modify its other environmental impacts. This assessment includes consideration of the effects identified within Volume 3: Ecology and Biodiversity, identifying where projected climate changes may influence the effects identified. Where relevant, consideration has been given to additional mitigation measures to

flooding, drought and heatwave events), habitat creation and peatland restoration, should be considered. The ES should set out the measures that will be adopted to address impacts.	ensure the Proposed Development is adaptable to climate change.
The ES should also identify how the development impacts the natural environment's ability to store and sequester greenhouse gases, in relation to climate change mitigation and the natural environment's contribution to achieving net zero by 2050.	This chapter considers the ability of the natural environment to store and sequester carbon within the site boundary in the assessment of effects on climate change (Section 5.2).

3.7 Assessment Criteria and Assignment of Significance

Receptor Sensitivity

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

Magnitude of Impact

3.7.2 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.

Significance of Effects

3.7.3 Assessment guidance for GHG emissions (IEMA, 2022) describes five levels of significance or emissions resulting from a development, each based on how the Proposed Development 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 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.

3.7.4 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);
- 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)).

3.7.5 Effects from GHG emissions are described in this chapter as adverse, negligible or beneficial based on the following definitions, as stated within IEMA guidance (IEMA, 2022).

- **Major Adverse**: the Proposed Development's 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 Development may not provide further emission 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. 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 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 exceed, 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-project baseline. As such its net GHG impacts would be below zero. The Proposed Development would substantially exceed net zero requirements.

3.7.6 Major to moderate adverse effects are both significant, 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 and negligible effects are not considered to be significant.

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

3.7.8 In accordance with IEMA's 2020 guidance for climate 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 project design can have on the risk. The approach to this risk assessment is detailed in Appendix 9.1.2: Climate Risk Assessment. 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.

3.7.9 The in-combination climate impact assessment applies the significance criteria developed by the relevant environmental topics and detailed within each technical chapter of the PEIR.

3.8 Limitations of the Assessment

3.8.1 There is uncertainty about future climate and energy policy and market responses, which affect the likely future carbon intensity of energy supplies, and thereby the future carbon intensity of the electricity generation being displaced by the Proposed Development. As detailed at paragraph 3.1.5, 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 section 3.5). 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 Appendix 9.3: GHG Calculations for further detail).

3.8.2 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 our assessment. 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 operational and whole life effects reported at sections 6.2 and 7 provide a conservative view of emissions that could be avoided as a result of the Proposed Development for the purpose of this EIA.

3.8.3 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 with the context of how this Proposed Development contributes towards net zero policy and obligations.

3.8.4 Owing to its charge capability, energy density, round-trip efficiency and falling costs, lithium-ion batteries (LIB) are the most commonly employed battery technology for stationary applications. At this stage, this is the technology type being considered in this assessment. More specifically, as circa 60% of grid-scale batteries are currently nickel-manganese-cobalt (NMC) cathode material blends (IEA, 2020a), it is the carbon intensity of these materials – and the carbon intensity of the associated manufacturing processes – that have been considered in this assessment. Moreover, the most energy intensive process of lithium ion battery manufacturing has been identified as the energy demand of the dry room (Dai *et.al,* 2019), which would be a consistent factor across many different lithium ion battery technology manufacturing processes.

3.8.5 The carbon intensity of lithium ion battery manufacturing can vary depending on the carbon intensity of the electricity grid at the point of production. In order to account for such uncertainty a range of construction-stage GHG impacts has been stated.

3.8.6 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 9.1.2: Climate Risk.

3.8.7 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.

4 BASELINE CONDITIONS

4.1.1 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 9.1.2.

4.1.2 With regard to GHG emissions, the current baseline is agricultural land, predominantly in use for arable farming. The Proposed Development site contains loamy and clayey soils (SOYL, 2022), 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.

4.1.3 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 (VPI Immingham, 2019) and Thurrock Flexible Generation Plant (RPS, 2020)). This baseline for the carbon intensity of peak demand electricity generation is 0.304 tCO_2e/MWh in the Proposed Development's first year of operation (2026).

4.2 Future Baseline Conditions

4.2.1 Under the UK's climate targets it will be necessary for peaking plants to decarbonise[5] (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.

4.2.2 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 long run marginal grid projection by 2035 onwards. A simple linear reduction in the carbon intensity of peaking plants from present-day values to converge with the BEIS long run marginal projected factors by 2035 has been calculated. Further detail regarding the carbon intensity of peaking plants can be found in Appendix 9.1.3.

[5] 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.

5 ASSESSMENT OF CONSTRUCTION EFFECTS

5.1 Assessment of Effects as a Result of Climate Change

5.1.1 Due to the relatively short construction programme (circa 18 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 9.1.2 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 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 chance of summer heatwave conditions may require adaptations, such as shading work areas or increased attention to construction dust control measures.

5.1.2 Direct short term negligible effects and **no significant** construction-stage effects are predicted in the construction phase as a result of climate change.

5.2 Assessment of Effects on Climate Change

Magnitude of Impact

5.2.1 The manufacturing and installation of the energy storage facility would result in both direct and indirect GHG emissions at the point of construction.

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

5.2.3 The construction stage emissions cover carbon LCA stages A1-A3, i.e. the emissions associated with the extraction, processing and manufacturing of materials. The sections below break the Proposed Development down into categories, each of which detail the construction stage emissions associated with that category. Further details regarding the adopted methodology used to calculate these emissions can be found within Appendix 9.1.3.

Battery Packs

5.2.4 Given their charge capability, energy density, round-trip efficiency and falling costs, lithium-ion batteries (LIB) are the most commonly employed battery for stationary applications. As such, this is the technology type being considered within this assessment.

5.2.5 The carbon intensity of the production of LIBs used for the purposes of this assessment has been informed by a study undertaken by the Swedish Environmental Research Institute (Emilsson and Dahllöf, 2019). Battery manufacture is an energy-intensive process, where energy can be sourced from a renewables-rich mix or fossil fuel-rich mix. Given that it is not known what energy-mix may be used, a range of carbon intensities was applied to account for this uncertainty.

5.2.6 It is anticipated that the batteries would have an expected lifetime of 5,000 discharge cycles (IEA, 2020b). Therefore, over the forecasted 40 year assessment period, and assuming one full cycle per day, the battery packs would have to be replaced circa three times. This has been accounted for in the embodied carbon values in **Table 5.1**. To be conservative, present-day values have been used for the carbon intensity of battery pack production even for future replacements.

5.2.7 **Table 5.1** displays the benchmark carbon intensities that have been used in assessing the magnitude of impact of the GHG emissions from the production of the battery packs being used in the Proposed Development.

Table 5.1: Construction-stage GHG Intensity and Impact of the Battery Pack Element of the Proposed Development

	Lower estimate	Mid-point	Upper estimate
Output capacity (MW)	500	500	500
Discharge Time (hrs)	7	7	7
Number of battery pack replacements for Proposed Development's assumed lifetime	2.92	2.92	2.92
Carbon intensity of battery pack manufacturing (kgCO_2e/kWh)	61	83.5	106
Battery packs embodied carbon (tCO_2e)	**623,420**	**853,370**	**1,083,320**

Substation (including busbars, BoS components and additional transformers)

5.2.8 There is limited design data and few published LCAs from which to calculate the embodied emissions associated with the substation, busbars and BoS components. Data from an environmental product declaration (EPD) for a 16 kVA – 1000 MVA transformer (ABB, 2003) has therefore been used to provide an approximation of the potential order of magnitude of emissions, as transformers are among the major substation plant components and have a relatively high materials and carbon intensity, including the copper or aluminium winding. This totals **1,314 tCO_2e** for lifecycle stages A1-A3.

5.2.9 In comparison to the emissions associated with the battery packs, this value is negligible, but has high uncertainty and does not account for all substation equipment, or additional transformers not located within the substation compound. To consider whether the full balance of plant in the substation components and additional transformers is likely to make a material contribution to the total construction-stage carbon, a materiality threshold[6] of 5% of the total known construction-stage GHG emissions has been considered[7]. This totals **31,916 tCO_2e**, more than 24 times greater than the estimated embodied carbon for the transformer equipment located within the substation compound.

5.2.10 On this basis, it is considered unlikely that the embodied emissions associated with the substation equipment, including additional transformers (not located within the substation compound), busbars and other BoS, will exceed the 5% materiality threshold of the battery packs' embodied carbon. As such this emission source will not materially contribute to the total emissions inventory and has not been assessed in further detail.

[6] a term often used in greenhouse gas accounting for very minor emission sources, either not appreciably affecting the total or likely to be within its uncertainty range

[7] using the lower estimate for the embodied emissions of the battery packs, to be conservative, and including calculated emissions resultant from the supporting infrastructure

Supporting Infrastructure

5.2.11 Additional supporting infrastructure proposed to be included as part of the Proposed Development includes the following:

- inverter buildings;
- switch and control units;
- shipping containers (to house BESS, spare parts storage, and welfare facilities);
- crushed stone access tracks;
- loose permeable gravel upon which structures will be installed; and
- concrete foundations.

5.2.12 Published benchmarks (RICS, 2012) have been used to estimate possible emissions associated with the inverter buildings and switch and control units, as material estimates have some uncertainty in terms of their quantities. The carbon intensity was scaled by the maximum area of proposed buildings to give the embodied carbon value.

5.2.13 The embodied carbon associated with the remaining listed items has been calculated by scaling their estimated weights with an associated embodied carbon factor listed within the Inventory of Carbon and Energy (ICE) (Jones and Hammond, 2019).

5.2.14 The embodied carbon emissions of the supporting infrastructure contained within the Proposed Development totals **8,781 tCO_2e** and includes lifecycle stages A1-A3.

Transportation

5.2.15 As the construction stage carbon values for the above-described technologies include only lifecycle stages A1-A3, emissions associated with their transport to site is not included within these values. While it has been shown that the transportation of batteries to the end typically contributes less than 1% of total GHG emissions (Accardo et al, 2021), this has been explored further for the Proposed Development.

5.2.16 Based on the construction traffic estimates outlined within the Construction Traffic Management Plan, prepared in support of the application, and assuming a maximum construction duration of 18 months, the emissions associated with the delivery of materials to site has been calculated.

5.2.17 An estimated distance of road travel to the site for HGVs (national-scale journeys) and cars/vans (local journeys) (as informed by RICS, 2017 guidance) was assigned to each type of vehicle and scaled by the anticipated number of vehicles and GHG conversion factors (DESNZ and Defra, 2023). The total construction traffic emissions were estimated to be **6,116 tCO_2e**, just under 1% of the lower estimate of the total embodied carbon calculated for the battery packs. This finding is consistent with the above-mentioned literature, and as such the transport of materials to site has not been considered in further detail. As the potential supply chain for the batteries and any other materials likely to be sourced outside the UK is not confirmed at this stage in design, international shipping transport has not been estimated.

Carbon Storage and Sequestration

5.2.18 The Proposed Development includes areas of new woodland planting, which will deliver on-site carbon sequestration and storage over the lifetime of the Proposed Development. As trees grow, they absorb (or sequester) CO_2 from the atmosphere and store it both in the woody biomass parts of the tree and in the topsoil, thereby reducing the concentration of atmospheric CO_2.

5.2.19 Estimates of the carbon sequestered within the proposed woodland planting was informed by Natural England's guidance on carbon storage and sequestration (Natural England, 2021). The total carbon sequestration potential was calculated to be **2,147 tCO_2e**.

Total

5.2.20 **Table 5.2** displays the total magnitude of GHG emissions impact for the construction stage of the Proposed Development.

Table 5.2: Total Construction-stage Magnitude of GHG Impact of the Proposed Development

	Magnitude of Impact (tCO_2e)		
	Lower estimate	**Mid-point**	**Upper estimate**
Battery packs	623,420	853,370	1,083,320
Substation components	1,314	1,314	1,314
Supporting infrastructure	8,781	8,781	8,781
Transportation	6,116	6,116	6,116
Carbon sequestration by on-site woodland	-2,147	-2,147	-2,147
Total	**637,484**	**867,434**	**1,097,384**

Sensitivity of the Receptor

5.2.21 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 consequences of global climate change and the cumulative contributions of all GHG emissions sources).

Significance of Effect

5.2.22 As stated in paragraph 3.7.7, the majority of the construction-stage emissions are likely to occur from the battery 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.

5.2.23 Considering the potential magnitude of GHG emissions set out in **Table 5.2** and the policy goals for carbon reduction, based on the definitions in paragraphs 3.7.5 and 3.7.6 the magnitude of impact on the **high sensitivity** receptor would result in a **significant moderate adverse** construction-stage effect, in the absence of mitigation.

Mitigation

5.2.24 The majority of emissions occur at LCA stages A1-3. The following embedded mitigation measures concerning the limitation of GHG emissions at the production and manufacturing stage of the Proposed Development are as follows:

- no-build methods, i.e. only designing areas of hardstanding where they are necessary to reduce the quantity of materials required; and

- inclusion of recycled aggregate within hardstanding.

5.2.25 Further, materials used in the construction of the Proposed Development will be sourced locally where possible, thereby reducing emissions associated with transportation.

5.2.26 Good working practices during the construction of the Proposed Development are being defined through a Code of Construction Practice (CoCP). The CoCP 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.

Residual Effect

5.2.27 Accounting for the implementation of the above-listed mitigation measures, the Proposed Development’s construction-stage climate change impacts have the potential to be reduced compared to a typical business-as-usual approach. Despite this reduction, it is unlikely that significant residual emissions can be fully avoided.

5.2.28 As such, the residual effect of GHG emissions from the construction phase of the Project on the **high sensitivity** receptor would result in a **moderate adverse** effect which is **significant**.

5.2.29 However, given the Proposed Development is a facilitator of low carbon energy generation, 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 Operational Effects section (Section 6) and also in the assessment of Whole-Life Effects (Section 7).

Further Mitigation

5.2.30 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 minimal GHG impacts (e.g. via the use of renewable energy and efficient resource consumption). Greater transparency into the GHG impacts of products being specified for the Proposed Development can be achieved by requesting environmental product declarations (EPD) from manufacturers. This mitigation should be focused on the BESS elements of the Proposed Development where possible, given they contribute the majority of construction-stage emissions. As such, any reductions in their embodied carbon would provide the greatest impact in reducing total construction-stage emissions.

5.2.31 Given the limited extent to which the supporting infrastructure contributes to total construction-stage GHG emissions, further mitigation to reduce associated construction-stage emissions would have minimal impact on the overall construction-stage emissions associated with the Proposed Development. Nevertheless, it is good practice to mitigate GHG emissions where possible, and the following further mitigation measures should be considered where feasible:

- use of recycled shipping containers; and
- using carbon neutral concrete products or products with higher substitution of ordinary portland cement with low carbon cementitious material alternatives (e.g. fly ash or ground-granulated blast furnace slag).

5.2.32 Should the above further mitigation measures be implemented, they could reduce the residual effect assessed to not significant.

Future Monitoring

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

Accidents and/or Disasters

5.2.34 It is not considered 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.

6 ASSESSMENT OF OPERATIONAL EFFECTS

6.1 Assessment of Effects as a Result of Climate Change

Sensitivity of the Receptor

6.1.1 As detailed within Appendix 9.1.2 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 9.1.2.

Magnitude of Impact

6.1.2 The magnitude is the degree of a change from the relevant baseline conditions which derives from the construction of the Proposed Development. The magnitude has been expressed in Appendix 9.1.2 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

6.1.3 Appendix 9.1.2 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 to the Proposed Development is likely to arise from flooding. This is assessed in detail in Volume 4: Hydrology and Flood Risk and appropriate flood management and resilience measures have been provided, including an allowance for climate change effects.

6.1.4 The risk assessment in Appendix 9.1.2 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.

6.1.5 With the exception of flood risks, the greatest risks to the Proposed Development due to climate change have been identified as those arising from high temperatures affecting operation and storms affecting power transmission, container or building damage.

6.1.6 Overall, the risk assessment identified three out of the seven assessed effects as potentially significant (as defined in paragraph 3.7.8) prior to resilience or adaptation measures to mitigate the risks.

6.1.7 As the three potentially significant effects 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.

- Battery cooling plant load being designed for a range of ambient temperature conditions.

6.2 Assessment of Effects on Climate Change

Magnitude of Impact

6.2.1 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.

6.2.2 As the UK electricity grid decarbonises, and the penetration of non-dispatchable 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 1555.7 GWh of curtailed wind energy, as monitored by the UK Wind Curtailment Monitor (Dudfield and de Berker, n.d.). 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.

6.2.3 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.

6.2.4 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.

6.2.5 During periods of low renewable energy supply, the BESS are likely to be charged directly from grid electricity (assuming the average generation mix 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 electricity required to charge the BESS, the quantity of peaking plant generation it displaces, and the associated GHG impacts of both.

6.2.6 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 Appendix 9.1.2). The associated GHG emissions are determined by the GHG intensity of the enabled and displaced sources of generation.

6.2.7 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

6.2.8 Given wind energy sources contribute the greatest proportion of non-dispatchable renewable energy generation in the UK (BEIS, 2021), and 140 GW of offshore wind is recommended to be deployed by 2050 (CCC, 2020), it is expected that the source of renewable energy that is most likely to be enabled by the Proposed Development is offshore wind.

6.2.9 A GHG intensity of 0.99 gCO_2e/kWh for offshore wind (Dolan and Heath, 2012), and peaking plant intensity of 0.304 tCO_2e/MWh (in the first year of operation) (see paragraph 4.1.3) were used to determine the magnitude of GHG emissions avoided by the Proposed Development.

Scenario B: BESS charged directly from grid electricity

6.2.10 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.

6.2.11 A GHG intensity of 0.177 $kgCO_2e/kWh$ for grid electricity (in the first year of operation) (BEIS, 2022), and peaking plant intensity of 0.304 tCO_2e/MWh (in the first year of operation) (see paragraph 4.1.3) were used to determine the magnitude of GHG emissions avoided by the Proposed Development.

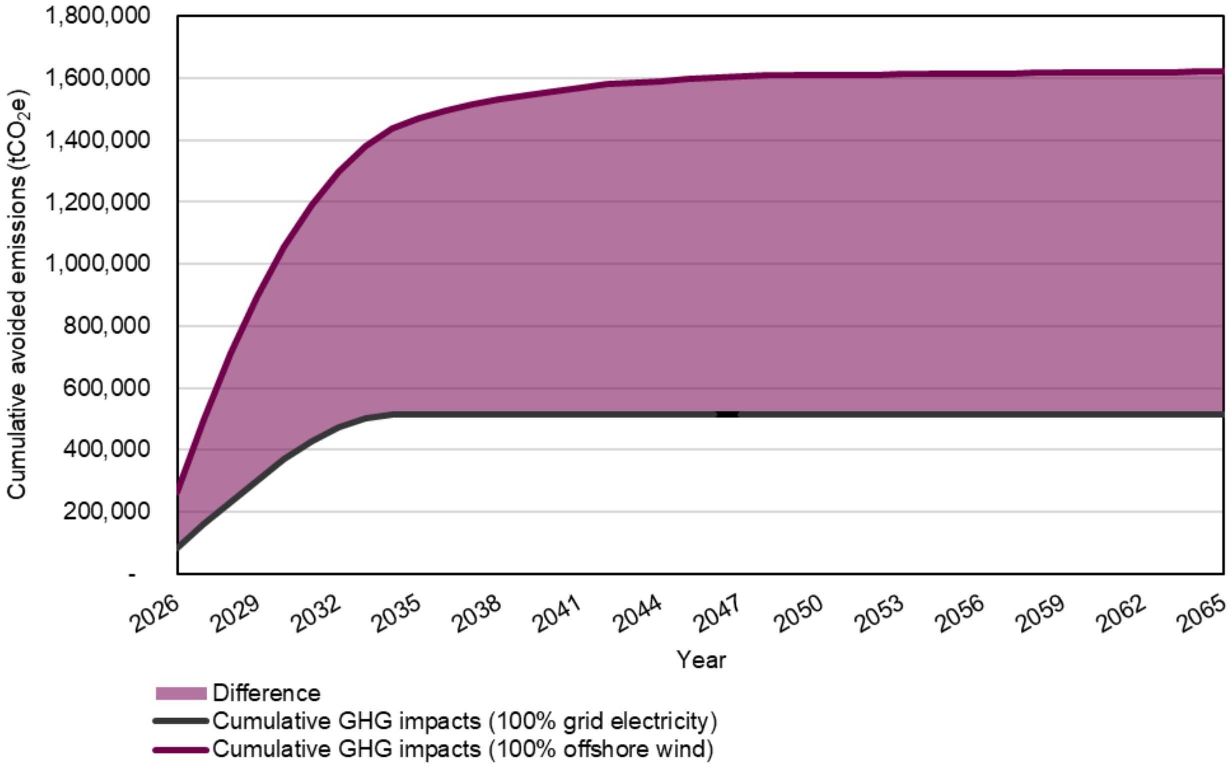
Results

6.2.12 During the first year of operation, the magnitude of impact for the operational phase of the Proposed Development has been calculated to be between **82,763 tCO_2e** and **262,645 tCO_2e** of avoided emissions.

6.2.13 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 **513,766 tCO_2e** and **1,514,631 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. Cumulative avoided emissions over the Proposed Development's 40-year operational lifetime total between **513,766 tCO_2e** and **1,621,819 tCO_2e**.

6.2.14 Graph 6.1 below displays the cumulative impact of both scenarios, with shading to highlight the difference, representing the potential range of avoided emissions that the Proposed Development's operational phase will enable.

Graph 6.1: Grid electricity and offshore wind scenarios – avoided emissions difference



Sensitivity of Receptor

6.2.15 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

6.2.16 The nature and significance of effect has been characterised as set out in paragraphs 3.7.5 and 3.7.6, 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 regards to its compliance with the UK's net zero trajectory, local and national climate-related policy, legislation and guidance.

National Carbon Budget

6.2.17 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 6.1 represent carbon budget expenditures that would have occurred in the absence of the Proposed Development and have therefore been avoided. Table 6.1 displays the UK national carbon budgets and how the Proposed Development's operational GHG impacts relate to them.

Table 6.1: GHG impacts in the context of the UK's carbon budgets

Time period	2023-2027	2028-2032	2033-2037	Total[8]
UK carbon budget (tCO_2e)	1,950,000,000	1,730,000,000	960,000,000	4,640,000,000
Proposed Development impacts (tCO_2e)	- 160,242 to - 499,566	- 311,203 to - 798,748	- 42,321 to – 216,317	- 513,766 to – 1,514,631
Development avoided emissions as percentage of UK carbon budget	- 0.008% to - 0.026%	- 0.018% to - 0.046%	- 0.004% to - 0.023%	- 0.011% to - 0.033%

6.2.18 Additionally, the Tyndall Centre for Climate Change Research (2022) has created district-specific carbon budgets up to 2100. The Proposed Development's operational GHG impacts were considered in terms of Aylesbury Vale's Tyndall Centre-derived carbon budget.

6.2.19 The Tyndall Centre carbon budgets are more stringent than the UK national budgets (as advised by the CCC); the carbon budget for Aylesbury Vale would result in achieving zero or near zero carbon by 2041[9]. The Tyndall Centre carbon budgets expressed below are for energy-related CO_2 emissions only.

6.2.20 Table 6.2 displays the Aylesbury Vale-specific carbon budgets and how the Proposed Development operational GHG impacts relate to them.

Table 6.2: GHG impacts in the context of the Aylesbury Vale carbon budgets

Time period	2023-2027	2028-2032	2033-2037	Total[10]
Aylesbury Vale carbon budget (tCO_2e)	1,800,000	900,000	400,000	3,100,000
Proposed Development impacts (tCO_2e)	- 160,242 to - 499,566	- 311,203 to - 798,748	- 42,321 to – 216,317	- 513,766 to – 1,514,631
Development avoided emissions as percentage of Aylesbury Vale carbon budget	- 8.90% to - 27.75%	- 34.58% to - 88.75%	- 10.58% to – 54.08%	- 16.57% to – 48.86%

[8] This is the total during the budget periods, not the total for the Proposed Development's assumed lifetime.

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

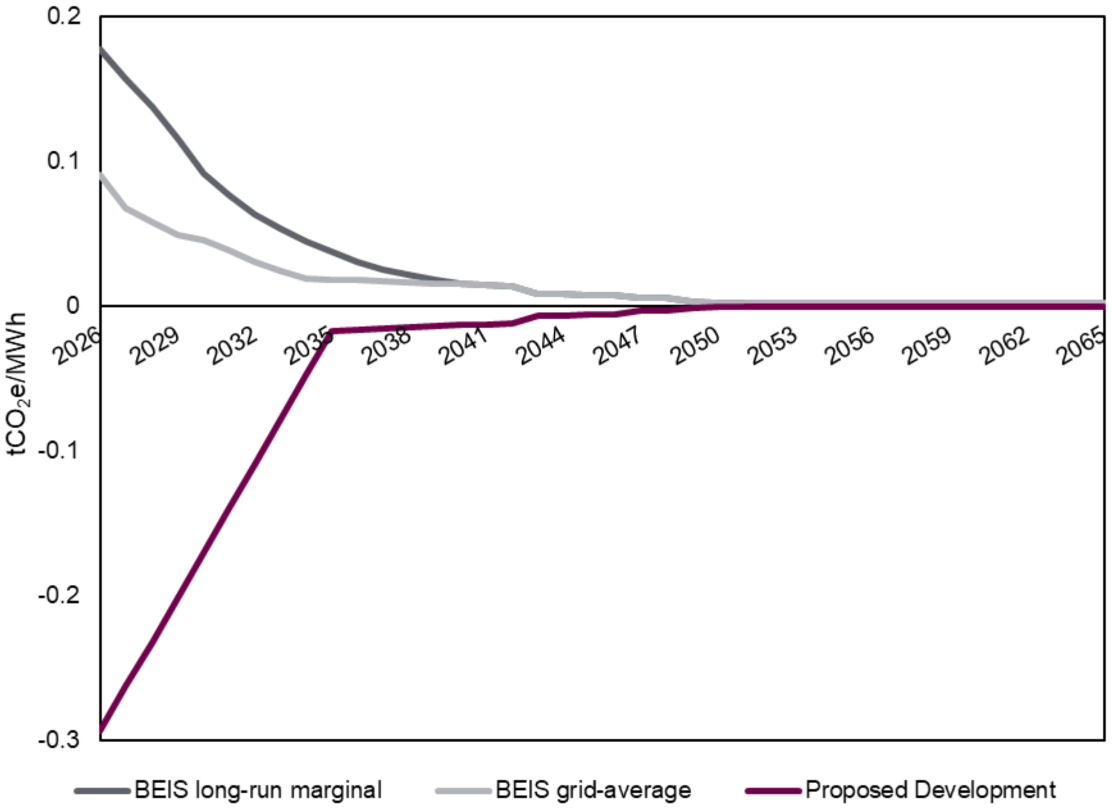
[10] This is the total during the budget periods, not the total for the Proposed Development's assumed lifetime.

6.2.21 As can be seen from Table 6.2, the Proposed Development would make a measurable contribution to avoiding potential carbon budget expenditure in Aylesbury Vale.

Carbon Intensity

6.2.22 Graph 6.2 displays how the operation of the Proposed Development has a beneficial effect in reducing the carbon intensity of the UK power grid. It also displays how the carbon intensity of the Proposed Development eventually tends towards the grid average, as power sector carbon reduction goals are met.

Graph 6.2: Comparison of BEIS and Proposed Development future carbon intensity projections



Climate Policy, Legislation and Guidance

6.2.23 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 Appendix 9.1.1) which promote the decarbonisation of grid electricity, aided by the implementation of energy storage technologies.

6.2.24 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. Through this, the operation of the Proposed Development facilitates the demand for renewable energy by consumers.

6.2.25 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 carbon and energy-related policy stated in the Buckingham Local Energy Strategy, Vale of Aylesbury Local Plan and the Buckinghamshire Council Climate Change and Air Quality Strategy.

Effect

6.2.26 Using the definitions in paragraphs 3.7.5 and 3.7.6, 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.

6.2.27 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). It has been assumed that the development will 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.

Mitigation

6.2.28 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.

Residual Effect

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

Further Mitigation

6.2.30 No further operational-stage mitigation has been proposed.

Future Monitoring

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

Accidents/Disasters

6.2.32 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 GHG emissions.

7 ASSESSMENT OF WHOLE-LIFE EFFECTS

7.1 Significance of Effect

7.1.1 There is some uncertainty in defining the significance of the whole-life GHG emissions effects of the Proposed Development. Consistent with the assessment of operational effects, this assessment accounts for scenarios where the BESS are charged by surplus renewable energy, or by grid electricity (i.e. the electricity generation mix at the time of import) at times when there may be no surplus renewable energy supply. Further, the assessment assumes the Proposed Development will displace high-emission energy associated with gas-fired peaking plants.

7.1.2 The whole-life GHG emissions (total construction and operational-stage emissions) resultant from the Proposed Development are displayed within Table 7.1. This is shown alongside the anticipated carbon payback period for the Proposed Development.

Table 7.1: Proposed Development net GHG impact

	Value	Unit
Construction-stage emissions (upper estimate)	1,097,384	tCO_2e
Operational-stage emissions	- 513,766 to - 1,621,819	tCO_2e
Net emissions (lifetime)	583,617 to -524,435	tCO_2e
Carbon payback period[11]	6	Years

7.1.3 Over the lifetime of the Proposed Development, it will result in between a total of 583,617 and -524,435 tCO_2e. Within the context of the UK and Aylesbury Vale carbon budgets, totalled from 2023-2037 (as detailed within Table 6.1 and Table 6.2), the net avoided emissions result in 0.013% to -0.011% and 18.8% to -16.9% avoided potential carbon expenditures, respectively.

7.1.4 Despite the high GHG emissions resulting from the construction-stage of the development, the magnitude of avoided emissions resulting from the operational-stage of the development (under scenario A, where the BESS are charged from renewable wind energy) allows the Proposed Development to enable avoided emissions from its sixth year of operation at the earliest (carbon payback period).

7.1.5 Under scenario B, where the BESS are charged directly from the grid (assuming the average electricity generation mix at the time of import), a payback period cannot be achieved. This is largely due to the projected decarbonisation of peaking plant generating sources, reducing the intensity of energy generation that the Proposed Development will

[11] Earliest possible carbon payback period.

displace over its operational lifetime to such a point where the operational avoided emissions do not exceed those resultant from the construction phase.

7.1.6 As detailed at paragraph 3.8.2, the methodology adopted within this assessment provides an optimistic view of peaking plant decarbonisation, which as such results in a conservative range of estimates for operational avoided emissions. In reality, it is likely that such avoided emissions are much greater than those reported, thereby reducing the net effects of the Proposed Development.

7.1.7 Further, it is important to consider the role of the Proposed Development in enabling grid decarbonisation in line with national policy. It is anticipated that energy storage facilities will become part of 'business as usual' in order to provide necessary low carbon alternatives to peaking plants, enabling greater flexibility in the energy network and facilitating the increased penetration of renewable energy into grid electricity, avoiding its curtailment. 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 carbon and energy-related policy stated in the Buckingham Local Energy Strategy, Vale of Aylesbury Local Plan and the Buckinghamshire Council Climate Change and Air Quality Strategy.

7.1.8 Using the definitions in paragraphs 3.7.5 and 3.7.6, the impact of whole-life GHG emissions from the Proposed Development on the **high sensitivity** receptor would result in a **significant beneficial** effect. However, it is considered that it is most informative to consider the effects of the construction and operational-phases in isolation, as outlined within the sections above.

8 ASSESSMENT OF CUMULATIVE EFFECTS

8.1.1 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 GHG emissions from other energy sources.

9 INTER-RELATIONSHIPS

9.1.1 The assessment of inter-related effects with climate change – in-combination climate impacts – is detailed below. The main areas where there is potential for inter-related effects, subject to assessment are considered to be:

- Volume 3: Ecology and Biodiversity
- Volume 4: Hydrology and Flood Risk
- Volume 5: Landscape and Visual

9.1.2 During the initial screening exercise, a number of environmental topics were identified for further assessment as effects identified within relevant chapters may be altered when also considering the impact of future climate change. Relevant topics and impacts are detailed within Table 9.1Error! Reference source not found., alongside the likely interaction with climate change.

Table 9.1: In-combination climate impacts

Impact Identified	Residual Effect	Impact of Climate Change on Effect	Updated Effect	Mitigation
Volume 3 Ecology and Nature Conservation		Impact of temporary and permanent habitat loss and disturbance during construction, operation and decommissioning of the Proposed Development.	Projected future climate change may exacerbate habitat loss, in addition to the success of the ecological mitigation strategy, as selected species may not be suitable for future climate conditions.	[TBD]
Hydrology and Flood Risk				
Increased flood risk.	**Construction:** minor adverse **Operation:** minor adverse	Predicted increases in peak rainfall intensity (20% by 2050, 25% by 2070) will be accounted for within the surface water drainage scheme, with attenuation designed to accommodate flows from the critical 1 in 100-year storm plus 25% uplift to account for the impacts of climate change.	**Construction:** minor adverse **Operation:** negligible beneficial	No further mitigation is required.

Impact Identified	Residual Effect	Impact of Climate Change on Effect	Updated Effect	Mitigation
Impacts to water quality within surrounding water courses.	**Construction:** minor adverse **Operation:** minor adverse	Predicted increase in high intensity rainfall events will increase rates and volume of surface water runoff. This may mobilise potential contaminants more freely than observed at present and therefore potentially more likely to increase pollutants/contaminants entering watercourses. Embedded mitigation includes: • The implementation of SuDS to offer water treatment prior to its discharge from the site. • Operational practices to incorporate measures to prevent pollution and increased flood risk, including emergency spill response procedures, and clean up and remediation of contaminated water runoff.	**Construction:** minor adverse **Operation:** minor adverse	No further mitigation is required.
Landscape Character				
Landscape character of the Site	**Year 1**: Moderate adverse	Predicted increased temperatures combined with	Minor beneficial	No further mitigation is required.

		decreased precipitation during dry seasons will result in beneficial impacts on certain species. Deep rooted fast growing lowland trees, such as willow and alder, on moisture retentive soils will benefit from wetter winters and warmer summers, and higher atmospheric CO_2 concentrations. This will increase the rate of establishment of species characteristic of the valley, and reduce the visual influence of the electrical infrastructure on landscape character.		
Adjacent landscape character areas	**Year 1**: Moderate adverse	Predicted increased temperatures combined with decreased precipitation during dry seasons will result in beneficial impacts on certain species. Deep rooted fast growing lowland trees, such as willow and alder, on moisture retentive soils will benefit from wetter winters and warmer summers, and higher atmospheric CO_2 concentrations. This will increase the rate of establishment of species characteristic of the valley, and reduce the visual influence of	Minor beneficial	No further mitigation is required.

		the electrical infrastructure on landscape character.		
Visual Amenity				
VIEW 1: from rural footpath GRA 10/1 on the western edge of Granborough	**Year 1:** Major adverse winter. Moderate Major adverse summer.	Deep rooted fast growing lowland trees such as willow and alder on moisture retentive soils will benefit from wetter winters and warmer summers and higher CO_2 levels. This will increase the rate screening will be effective.	Minor beneficial	No further mitigation is required.
VIEW 22: From a field gateway on Botyl Road within Botolph Claydon	**Year 1**: Moderate – Major adverse in winter and summer	Deep rooted fast growing lowland trees such as willow and alder on moisture retentive soils will benefit from wetter winters and warmer summers and higher CO_2 levels. This will increase the rate screening will be effective.	Minor beneficial	No further mitigation is required.

10 SUMMARY OF EFFECTS

10.1.1 The potential impact of GHG emissions due to the Proposed Development, resulting in an effect on the global atmospheric GHG concentration that contributes to climate change, has been assessed and reported in this chapter. The impacts of climate change on the Proposed Development have also been assessed and reported.

10.1.2 The construction-stage emissions from the manufacturing of battery packs would result in supply chain emissions of up to **1,083,320 tCO_2e**. The construction stage emissions associated with the manufacture of other infrastructure on site, and the transportation of materials to the site (within the UK) totals **14,064 tCO_2e**. Total construction stage emissions have therefore been estimated to contribute up to **1,097,384 tCO_2e**. This would be a **significant moderate adverse** effect of the construction phase but must also be evaluated in terms of total lifetime emissions from the Proposed Development.

10.1.3 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 **513,766 and 1,514,631 tCO_2e** savings by 2037, the end of the Sixth Carbon Budget period, and **513,766 and 1,621,819 tCO_2e** over the Proposed Development's operational lifetime. This would result in 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.

10.1.4 Over the lifetime of the Proposed Development, it will result in a total of between **-524,435 and 583,617 tCO_2e** of avoided emissions. The assessment is considered to adopt a conservative methodology, assuming the decarbonisation of electricity generated by peaking plants aligns with the targeted decarbonisation of grid electricity. Should this decarbonisation occur more gradually in reality, avoided emissions during the operational phase would be expected to be significantly greater than those reported, likely resulting in net avoided emissions over the lifetime of the Proposed Development. Further, the operation of the Proposed Development would provide necessary low carbon alternatives to peaking plants, enabling greater flexibility in the energy network and facilitating the increased penetration of renewable energy into the grid.

10.1.5 Despite the significant impact of the construction-phase, and given the above-listed reasons for the effects of the operational-stage, this would result in a **significant beneficial** effect.

10.1.6 Of the seven potential risks to the Proposed Development as a result of climate change, three were considered to have a potentially significant effect in the initial screening risk assessment. Owing to the good practice design measures that will be incorporated into the Proposed Development, these effects were determined to be negligible and not significant.

11 REFERENCES

ABB (2003) Environmental Product Declaration: Power transformer TrafoStar 500 MVA. [Online] https://library.e.abb.com/public/566748ad75116903c1256d630042f1af/ProductdeclarationStarTrafo500.pdf. [Accessed August 2023]

Accardo, A., Dotelli, G., Musa, M. and Spessa, E. (2021) Life Cycle Assessment of an NMC Battery for Application to Electric Light-Duty Commercial Vehicles and Comparison with a Sodium-Nickel-Chloride Battery. Applied Sciences, 11(3), p.1160.

BEIS (2021) UK Energy in Brief 2021. [Online] UK Energy in Brief 2021 (publishing.service.gov.uk). [Accessed August 2023]

BEIS (2022) Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book.

Buckinghamshire Council (2021). Vale of Aylesbury Local Plan 2013-2033. [Online] https://buckinghamshire-gov-uk.s3.amazonaws.com/documents/Aylesbury_local_plan_L46JWaT.pdf [Accessed August 2023]

Buckinghamshire Local Enterprise Partnership (n.d.). Buckinghamshire Local Energy Strategy 2018-2030. [Online] Buckinghamshire-Local-Energy-Strategy-2018-2030.pdf (buckslep.co.uk) [Accessed August 2023]

Climate Change Act 2008 (c. 27).

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-path-to-Net-Zero.pdf. [Accessed August 2023]

Dai, Q., Kelly, J., Gaines, L. and Wang, M. (2019) Life Cycle Analysis of Lithium-Ion Batteries for Automotive Applications. Batteries, 5(2), p.48.

Dawson, R.J., Thompson, D., Johns, D., Gosling, S., Chapman, L., Darch, G., Watson, G., Powrie, W., Bell, S., Paulson, K., Hughes, P., and Wood, R. (2016) UK Climate Change Risk Assessment Evidence Report: Chapter 4, Infrastructure. Report prepared for the Adaptation Sub-Committee of the Committee on Climate Change, London.

DESNZ and Defra (2023) UK Government GHG Conversion Factors for Company Reporting. [Online] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023 [Accessed August 2023]

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

Dudfield, P. and de Berker, A. (n.d.) How much wind are we wasting? [online] https://wind-curtailment-app-ahq7fucdyq-lz.a.run.app/ [Accessed August 2023]

Emilsson, E. and Dahllöf, L. (2019) Lithium-Ion Vehicle Battery Production: Status 2019 on Energy Use, CO2 Emissions, Use of Metals, Products Environmental Footprint, and Recycling. IVL Swedish Environmental Research Institute Ltd. Report number C 444

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.

HM Government (2013) The Building Regulations 2010, Approved Document A: Structure.

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 [Accessed August 2023].

HM Government (2021) National Planning Policy Framework.

HM Government (2021) Net Zero Strategy: Build Back Greener. [Online] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf [Accessed August 2023]

IEA (2020a) Energy Storage. [Online] available at: https://www.iea.org/reports/energy-storage. [Accessed August 2023]

IEA (2020b) Environmental LCA of Residential PV and Battery Storage Systems. [Online] available at: https://iea-pvps.org/key-topics/environmental-life-cycle-assessment-of-residential-pv-and-battery-storage-systems/ . [Accessed August 2023]

IEMA (2020) Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation [online] available at: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020 [Accessed August 2023]

IEMA (2022) Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance. 2nd Edition. [Online] Available at: https://www.iema.net/resources/blog/2022/02/28/launch-of-the-updated-eia-guidance-on-assessing-ghg-emissions [Accessed August 2023]

Jones, C and Hammond, G (2019). Inventory of Carbon and Energy. [Online] Embodied Carbon Footprint Database – Circular Ecology [Accessed September 2023]

MOHC (2023) UK Climate Projections User Interface v2.8.0 [Online] https://ukclimateprojections-ui.metoffice.gov.uk/ui/home [Accessed August 2023]

Natural England (2021). Carbon storage and sequestration by habitat: a review of the evidence (second edition). [Online] https://publications.naturalengland.org.uk/publication/5419124441481216 [Accessed August 2023]

RICS (2012) RICS Professional Information, UK Methodology to calculate embodied carbon of materials. Available:https://www.igbc.ie/wp-content/uploads/2015/02/RICS-Methodology_embodied_carbon_materials_final-1st-edition.pdf. [Accessed August 2023]

RICS (2017). Whole life carbon assessment for the built environment. [Online] https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/building-surveying-standards/whole-life-carbon-assessment-for-the-built-environment. [Accessed August 2023]

RPS (2020) Thurrock Flexible Generation Plant. Environmental Statement Volume 6. Appendix 14.1: GHG Calculations. Prepared for Thurrock Power. Report Number: OXF10872.

SOYL (2022) Report on Agricultural Land Classification (ALC) for Statera Energy Ltd.

Statera Energy Ltd (2023). East Claydon Battery Energy Storage System (BESS) Environmental Impact Assessment Scoping Opinion Request. [Online] https://publicaccess.aylesburyvaledc.gov.uk/online-applications/files/SO-EAST_CLAYDON_SCOPING_REQUEST-2526910.pdf [Accessed August 2023]

Tyndall Centre (2022) Setting Climate Commitments for Aylesbury Vale: Quantifying the implications of the United Nations Paris Agreement for Aylesbury Vale. [Online] https://carbonbudget.manchester.ac.uk/reports/E07000004/. [Accessed September 2023]

VPI Immingham (2019) VPI Immingham OCGT. Environmental Statement: Volume I. Chapter 15: Sustainability and Climate Change. Document ref. 6.2.15

WRI and WBCSD (2004) The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. Revised edition, Washington and Geneva: WRI and WBCSD.