Blackhillock BESS

Carbon Assessment

Doc Ref: R001/rev5

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1. Introduction

This document has been prepared in response to Moray Council's Carbon Guidance for Planning Applications, and S36 and S37 consents. It demonstrates how the proposed development meets the requirements of this planning policy.

This document has been commissioned by TNEI and prepared by ALtass Consulting on behalf of Blackhillock Flexpower Ltd.

1.1 The Need for a Carbon Statement - Policy Review

The National Policy Framework 4 (NPF4) is a key strategic document guiding Scotland's planning policies, integrating the country's broader objectives for sustainable development, climate change mitigation, and achieving net-zero emissions by 2045.

NPF4 strategically positions **Battery Energy Storage Systems** (BESS) as an integral component of Scotland's pathway to net-zero energy. Through policies that support renewable energy expansion, infrastructure development, and energy efficiency, NPF4 highlights the importance of BESS in stabilising the grid, managing renewable energy intermittency, and contributing to a sustainable, low-carbon energy system. The extracts from the policy document underscore the framework's commitment to integrating BESS within Scotland's energy infrastructure to achieve the country's ambitious climate targets.

Sustainable Development and Climate Change (Policy 1):

- NPF4 commits to placing climate change at the forefront of all planning decisions, ensuring that new developments contribute to Scotland's net-zero targets. This includes the promotion of renewable energy projects and the integration of low-carbon technologies.

Zero Emissions from New Buildings (Policy 3):

- While this policy focuses on reducing emissions from new buildings, it also indirectly supports technologies like BESS by encouraging developments that integrate low-carbon and energy storage solutions. BESS can be crucial in balancing supply and demand in energy-efficient buildings that rely on renewable energy sources.

Infrastructure First (Policy 8):

- Policy 8 promotes the alignment of infrastructure development with Scotland's net-zero goals. This policy supports the early provision of infrastructure such as energy storage systems, which are crucial for facilitating the transition to a low-carbon energy system.

Renewable Energy (Policy 11):

- Policy 11 emphasises the need for significant growth in renewable energy generation to meet climate targets. It explicitly supports the development of onshore and offshore renewable energy projects, which are vital for decarbonising the energy sector. BESS is implied as a supporting technology to manage the variability of renewable sources like wind and solar.

- Clause 11(e) specifically recognises the need for energy storage solutions, including BESS, to support the integration of renewable energy into the grid. It acknowledges that energy storage systems are essential for addressing the intermittency of renewables and ensuring a stable energy supply.
- Clause 11(d) also mentions the support for technologies that enhance grid resilience and flexibility, which directly relates to the deployment of BESS.

Local Living and 20-Minute Neighbourhoods (Policy 7):

- Policy 7 encourages the development of self-sufficient communities, which can be supported by localised energy generation and storage. BESS is particularly relevant in these contexts as it enables local energy resilience and the efficient use of locally generated renewable energy.

Moray Council's Green Energy and Infrastructure Framework is a strategic document aimed at guiding the development and integration of green energy technologies and supporting infrastructure within the areas of Blackhillock and Keith. Its relevance to **Battery Energy Storage Systems (BESS)** can be outlined as follows:

1. Strategic Alignment with Renewable Energy Goals

- The Framework emphasises the importance of transitioning to renewable energy sources, reducing carbon emissions, and supporting broader climate change targets. BESS is crucial in this transition as it enhances the efficiency and reliability of renewable energy by storing excess energy and balancing supply and demand.

2. Support for Infrastructure Development

- The Framework details priorities for developing energy infrastructure in Moray (Blackhillock & Keith NE), which includes the deployment of BESS. This is essential for grid stability and ensuring that renewable energy generated in the region can be effectively utilised, even when production does not align with demand.

3. Facilitating the Integration of Renewables

- The Framework focuses on the integration of renewable energy sources, such as wind and solar power, which are intermittent by nature. BESS is vital for better integration of energy generation, making it a critical technology for achieving the goals set out in the framework.

4. Resilience and Energy Security

- The Framework emphasises the importance of energy security and resilience within Moray. By providing backup power and stabilising the grid, BESS can help mitigate the effects of power outages and ensure a steady supply of electricity, particularly in remote or rural areas.

5. Economic and Environmental Benefits

- The Framework states the economic benefits, such as job creation in the green energy sector and reduced energy costs. Environmentally, BESS supports the reduction of greenhouse gas emissions by making renewable energy more viable and reducing the reliance on fossil fuel-based peaking power plants.

6. Community Engagement and Benefits

- The Framework outlines the importance of maximising the benefits to local communities in the planning and implementation of green energy projects, including BESS. This ensures that projects are socially acceptable and that the local population benefits from the green energy transition.

Moray Council Carbon Guidance for Planning Applications and S36 and S37 consents stipulates that a Carbon Assessment is required "To support the development management process to determine planning applications against Policy 2 of National Planning Framework 4, which requires that "development proposals will be sited and designed to minimise lifecycle greenhouse gas emissions as far as possible" and "development proposals will be sited and designed to adapt to current and future risks from climate change"." This requirement applies to:

- residential developments of 10 or more units
- commercial, industrial, retail, leisure, infrastructure developments where floor space is 1,000 square metres of more
- Energy related developments of 5MW or more (including battery storage, grid infrastructure and energy production).

All planning applications within the stated threshold will be required to submit a Carbon Assessment responding to the following information.

2. Carbon Assessment

Blackhilllock BESS site meets the definition of a development site that requires a carbon assessment. Therefore, this document and the planning submission addresses the “**Moray Council Carbon Guidance for Planning Applications and S36 and S37 consents” document** as appropriate.
This carbon assessment report is structured in accordance with the questions set out in this document under each topic area as described below.

2.1 Description of the development, and key carbon and climate considerations.
2.2 How the development meets the needs of the current climate and future climate scenarios.
2.3 Whole life carbon assessment.
2.4 When the development would achieve net zero.
2.5 Carbon management and reporting plan
2.6 Carbon sequestration statement
2.7 Renewable energy and heat decarbonisation statement
2.8 Barriers to net zero statement (this will be used to inform strategic planning and development)

2.1 Description of the development, and key carbon and climate considerations

This section provides a brief overview of the development and the main considerations being given to whole life carbon reduction.

The proposed development is to provide a 349MW BESS and associated infrastructure on a Site 21.5 acres in size, in a rural area, south of the town of Keith (the Site). The development consists of 208 x20ft battery containers and 54 inverter/transformer skids.

The intended purpose of the development is to support the flexible operation of the National Grid and the decarbonisation of the electricity supply by balancing the supply and demand of electricity. There is no electricity generation on site.

Figure 1- Site layout of the Blackhillock BESS Site

The operational principle of BESS is based on the charging and discharging of electricity on a daily basis. Batteries receive electricity from the grid (charge) when the demand is low (where excess electricity is available), store for a period of time and then release it (discharge) back to the grid when the demand is high. Charging typically coincides with low carbon grid (high renewable energy deployed at the grid and discharging when fossil fuel, typically gas turbine deployment, is high (high carbon grid). The system therefore stores low and zero carbon electricity and releases it back to the grid, replacing high carbon electricity. This operational model therefore results in significant carbon emission savings. BESS increases green electricity deployment and underpins increased uptake of renewables, supporting resilience, and decarbonisation of the UK's electricity grid.

The Site is considered to be appropriate for BESS due to its proximity to both the Blackhillock Substation and the A96 road for access and transportation. Furthermore, this location is identified as having a low to moderate sensitivity to BESS development.

2.2 The main considerations being given to whole life carbon reduction

Whole Life Carbon (WLC) emissions are the sum of all related Green House Gas (GHG) emissions and removals, both operational and embodied over the life cycle of an asset including its disposal. WLC consideration of the Blackhillock BESS comprises of all components making up the development including the supporting infrastructure over its life cycle from extracting raw materials and manufacturing, through operation and disposal, and any potential emissions beyond the end of life.

Site construction activities, and operation and maintenance of the Site, including any replacements, are also considered in scope over a 20-year lifetime period (Most case studies for BESS have a lifetime of 20 years and therefore this lifespan is selected for the study). More specifically, this includes manufacturing and sourcing of the BESS, the Balance of Power (BOP) Systems, and transportation to the Site. Construction activities include enabling works, infrastructure construction, and BESS installation. The operation of the system is based on daily charge and discharge assuming two hourly cycles each day. Additional power use includes controls and monitoring, cooling and ventilation, security lights, and powering the batteries. The operation also includes the replacement of the batteries after 10 years. End of life emissions include decommissioning and the disposal or recycling of BESS.

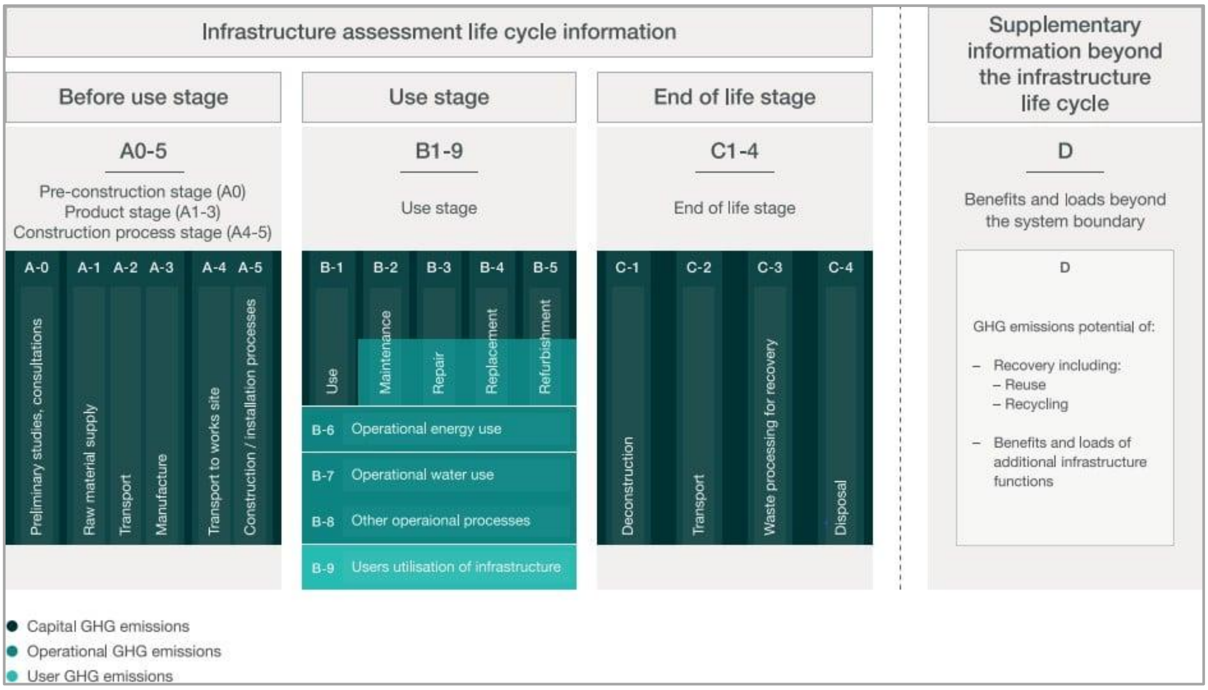

Figure 2 - Life cycle stages of a typical infrastructure project according to the PAS 2080 standard

Category	Description	What does it entail
BESS	Battery Energy Storage System	Lithium-ion batteries
BOP	Balance of Plant	Switchgear, transformers and inverters
Construction Activities	Site construction including enabling works	Fencing, cabling and other electrical infrastructure, BESS installation, groundworks, access and roads within the boundary
Battery Replacement	Repowering	Battery replacement after 10 years

EOL	End of Life	Disposal and recycling of BESS and BOP, reinstating the site
Site operation	Activities carried out during operation	Operational electricity consumption
Charging	Electricity flow to the BESS	On two hourly /day basis
Discharging	Electricity dispatch back to grid	On two hourly /day basis

Figure 3 - GHG Emissions from the Blackhillock BESS development based on whole life carbon emissions

2.3 How does the development meet the needs of the current climate and future climate scenarios?

This section addresses how the development has been designed with future climate risks in mind, including the adaptation strategies for changes in climate in the future.

Future climate scenarios relevant to the location of the site are examined. According to a comprehensive study undertaken by the James Hutton Institute (1), the Northeast of Scotland is likely to see increased rainfall by up to 50% in winter but dryer conditions in the summer months. The temperatures are expected to rise up to 4°C in summer months between 2020 – 2049), but also with substantial warming in the winter months (variable by projection, approximately 2-3°C). The implications of the future forecast and the mitigation measures proposed for the site are described below.

Increase in rainfall intensity due to the climate change and anticipated projections in flood risk: A site wide Drainage Impact Assessment (2) was carried out taking account of climate change projections in rainfall and therefore the risk of flooding, in accordance with SEPA guidelines.

According to the Drainage Impact Assessment, the Site is not in a flood risk area and the drainage design has taken into account a 1 in 200-year rainfall event plus the climate change allowance. The discharge strategy incorporates attenuation ponds and sustainable drainage measures, according to best practice criteria.

Temperature increases in summer and winter months: To ensure optimal operation of the overall system, the heating and cooling requirements of the battery system and also the BOS will take account of the projections in temperature increases both summer and winter.

Accordingly, the Site has been designed to be resilient in the face of current and predicted future climate scenarios, both in terms of precipitation, but also in terms of rising temperatures in the Northeast of Scotland.

2.4 Whole life carbon assessment

6.1 Whole Life Carbon Assessment Methodology - PAS 2080 and applicability to the development

This Carbon Assessment proposes to adopt PAS 2080 (Publicly Available Specification 2080) as a framework and guideline in principle. PAS 2080 is a standard developed by the British Standards Institution (BSI) that focuses on carbon management in infrastructure. While PAS 2080 itself is not specifically tailored for BESS, its principles and framework for managing carbon can be effectively applied to BESS projects. The framework looks at the whole value chain, aiming to reduce carbon and reduce cost through more intelligent design, construction, and use. This standard is considered to be highly suitable for the Blackhillock development for the following reasons:

I. **Carbon Management and Reduction**: PAS 2080 focuses on managing and reducing carbon emissions, which aligns well with the objectives of the Blackhillock BESS project aimed at supporting grid resilience, renewable energy deployment and reducing reliance on fossil fuels.
II. **Whole Lifecycle Approach**: The framework encourages considering carbon impacts throughout the entire lifecycle of a project. For BESS, this includes not only the construction and installation but also the operation, maintenance, and eventual decommissioning of the storage systems.
III. **Sustainable Design**: By following PAS 2080, the development incorporates sustainable design principles, ensuring that the site design, and the use of materials and technology are optimised for low carbon emissions.
IV. **Supply Chain Management**: PAS 2080 emphasises the importance of engaging with the supply chain to reduce carbon footprints. This is relevant for BESS projects, which rely on components and materials that may have significant carbon footprints (e.g., lithium-ion batteries).
V. **Stakeholder Engagement**: The framework promotes collaboration and communication with stakeholders, which is crucial for BESS projects that often involve multiple stakeholders, including energy providers, regulators, local government, and local communities.
VI. **Continuous Improvement**: PAS 2080 encourages continuous improvement in carbon management practices. BESS projects, being at the forefront of technological innovation, can benefit from an iterative approach to enhancing efficiency and reducing emissions.

6.2 Embodied carbon emissions for the Blackhillock BESS Development and measures to minimise emissions

A desktop analysis is carried out to examine embodied and operational carbon emissions attributed to different components and life cycle stages of the development. This is to identify and inform embodied carbon emission hot spots (where significant emissions occur) so that mitigation measures can be introduced accordingly.

Reference material relevant to BESS development has been reviewed (3,4,5,6,10,11). This includes a number of publicly available studies, peer reviewed scientific articles as well as a specific and representative LCA study undertaken for a different BESS site in the UK. According to the studies, the following activities contribute to CO2 emissions.

Embodied carbon emissions are those related to the BESS, Balance of Power, Construction Activities, Transport, and Repowering (replacing the batteries after 10 years). In order to be on the conservative side of the analysis, End of Life emissions are considered to be zero (no carbon benefits are allocated due to recycling of batteries). Of those, the embodied carbon of BESS, replacement and BOS is considered to be significant.

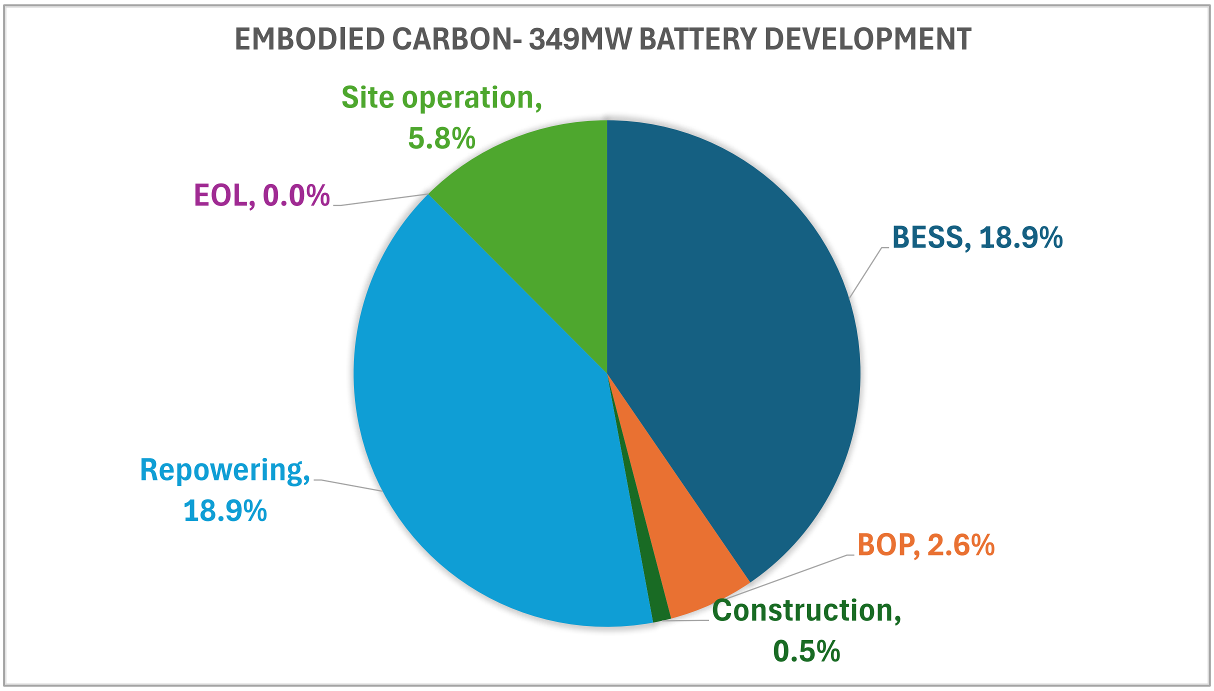

Figure 4 - Embodied Carbon distribution of the Blackhillock BESS Site

According to the literature review, embodied carbon hotspots of BESS (lithium-ion batteries) are primarily associated with the production of the cathode, particularly due to the resource-intensive production of lithium hexafluorophosphate (LiPF6), which is used as an electrolyte in these batteries. The cathode production contributes significantly to the overall GHG emissions due to the high energy consumption and emissions involved in producing materials like phosphorous, especially in its white, liquid form (4).

It is important to state that, this desktop study and extrapolation is subject to a number of assumptions and simplifications provided in appendices. There is significant variability in GHG emissions of BESS according to the literature and therefore conservative estimates are made in assumptions (i.e. one of the highest emission figures for Lithium-Ion battery is selected).

Embodied Carbon Reduction Strategies for BESS

According to the studies, embodied carbon emissions of BESS per kWh delivery is several times higher than the traditional renewable energy systems such as wind, hydro and solar panels and a number of reduction strategies are presented below.

1. **Reducing Fossil Fuel Use**: One approach is to reduce the emissions from fossil resource use in the material production processes, particularly through phosphorous recycling. This would decrease the environmental impact associated with cathode production. Currently, the manufacturing takes place in places with high carbon intensity energy generation. This increases the embodied carbon aspect of BESS significantly as it is a highly energy intensive process for manufacturing BESS.

2. **Increasing Energy Density**: Improving the energy density of the batteries allows for more energy to be stored per unit of material, thereby reducing the overall GHG emissions per unit of energy stored.
3. **Extending Battery Lifespan**: By increasing the lifespan of batteries, either through better design or through effective services that prolong battery life, the environmental impact per unit of energy over the battery's lifetime can be reduced.
4. **Enhancing Recyclability**: Improving the recyclability of batteries and increasing the number of recycling cycles can significantly lower the GHG emissions.

Other considerations for Blackhillock BESS Project are:

- **Transportation and Installation**: Minimising emissions associated with the transportation and installation of BESS units.
- **Site Works and Construction**: Adhering to best practice and signing up to a Construction Environmental Management Plan.
- **Operational Efficiency**: Optimising the efficiency of BESS operations to reduce carbon emissions during use.
- **End-of-Life Management**: Planning for the recycling and disposal of BESS components to minimize carbon impact at the end of the system's life.

It is important to consider the future emission scenarios (FES). According to the FES (7) by the National Grid, there are a number of scenarios to decarbonise the grid entirely. It is expected that the role of natural gas and other fossil fuels will diminish over the next twenty years. This will have an impact on the WLC emissions of BESS since the savings from discharge will reduce over time (Although this is not expected in the next five years in which time the BESS will payback the embodied carbon emissions via discharge savings). However, BESS plays a significant role in the whole energy system, enabling zero-carbon electricity, increasing resilience and flexibility in all FES scenarios. Therefore, BESS is intrinsic to the future energy system in achieving net zero and the required renewable energy deployment in the future (7).

2.5 Operational carbon emissions for the Blackhillock BESS Development and measures to minimise

Operational emissions amount to less than 6% of the total embodied carbon emissions. The cause of the operational carbon emissions are due to the heating, cooling and ventilation requirements to ensure that the batteries operate safely and efficiently. Further to this, electricity use for the controls, CCTV and lighting contribute to emissions. The power usage for the transformers, inverters and battery cores also forms part of the operational emissions. Note that, system round trip efficiency (approximately 88%) is not included in the operation and maintenance. It is included in the charging and discharging emissions.

The desktop study identifies significant emission savings in operation over a lifetime of 20 years. GHG emission savings due to discharge is significantly higher compared to all other stages of the development.

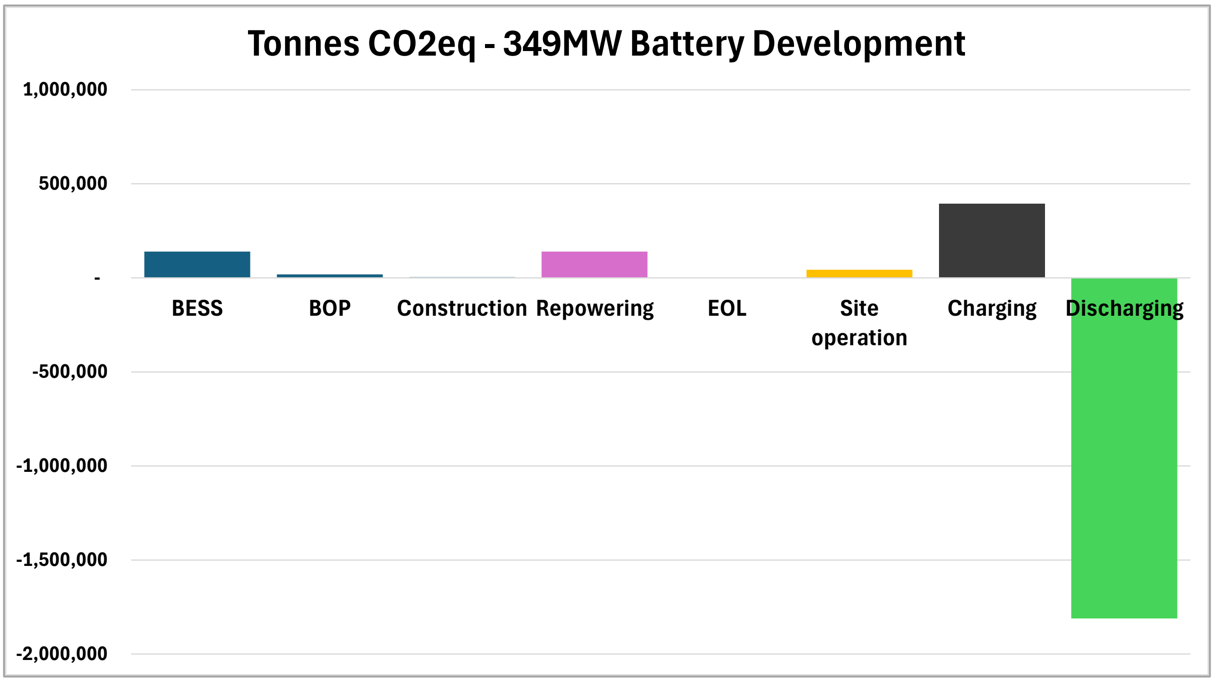

Figure 5 - Breakdown of whole life carbon according to the 349 MW BESS Site to the literature review

2.6 Net Zero Emissions in the Context of the Proposed Development

Strategic Context

The proposed BESS system plays a crucial role in achieving a net-zero electricity grid by providing flexibility, reliability, and resilience to the power system. As the grid transitions towards a greater reliance on renewable energy sources such as wind and solar, which are intermittent by nature, it enables further renewable energy system integration into the National Grid. It is therefore a critical piece of infrastructure toward meeting the local and national net zero carbon emission reduction targets and essential to the transition to a net-zero electricity grid. Further details on how the proposed BESS contribute to a net-zero grid is described below:

I. Balancing Supply and Demand:

Energy Shifting: BESS can store excess electricity generated during periods of high renewable output (e.g., midday solar power) and discharge it when generation is low (e.g., nighttime or cloudy days) and demand is high. This ensures a continuous balance between supply and demand.

Peak Shaving: By discharging stored energy during peak demand times, BESS reduce the need for peaking power plants, which are typically fossil fuel-based and more carbon-intensive.

II. Grid Stability and Reliability:

Frequency Regulation: BESS can respond rapidly to fluctuations in grid frequency, helping to maintain grid stability. This is particularly important as conventional generation sources are replaced by renewables, which can create fluctuations in the grid.

Voltage Support: BESS can provide reactive power to help maintain voltage levels on the grid, preventing blackouts and ensuring consistent power quality.

III. Enabling Higher Penetration of Renewables:

Curtailment Reduction: By storing excess renewable energy that would otherwise be curtailed (wasted), BESS allow for higher integration of renewable energy into the grid.

Grid Congestion Relief: In areas with high renewable generation, transmission lines can become congested. The Blackhillock Site is strategically placed to store renewable energy that is abundant and release it when congestion is lower, optimising the use of the existing grid infrastructure.

Replacing Fossil Fuel-based Ancillary Services: Traditionally, services like spinning reserves and load following were provided by fossil fuel generators. BESS can provide these services without emissions, supporting a cleaner grid.

Net Zero Emissions in Operation

According to the desktop review undertaken for BESS whole life carbon emissions, carbon emission savings due to discharge is significant. Taking account of all emissions of the development including the embodied carbon emissions, carbon payback period is estimated to be approximately two and a half years. The site is therefore can be considered net zero carbon in operation in year three.

The total WLC emissions over the life of the development is approximately minus 1.07 million tonnes of CO_2 (1.07 million tonnes of emission savings) assuming peak time electricity carbon intensity remains the same over the 20-year period. Whilst this assumption is unlikely to be accurate, it is very unlikely the grid will decarbonise until the year 2030 (as per FES evidence). Therefore, the site still achieves net zero carbon status in a short period of time.

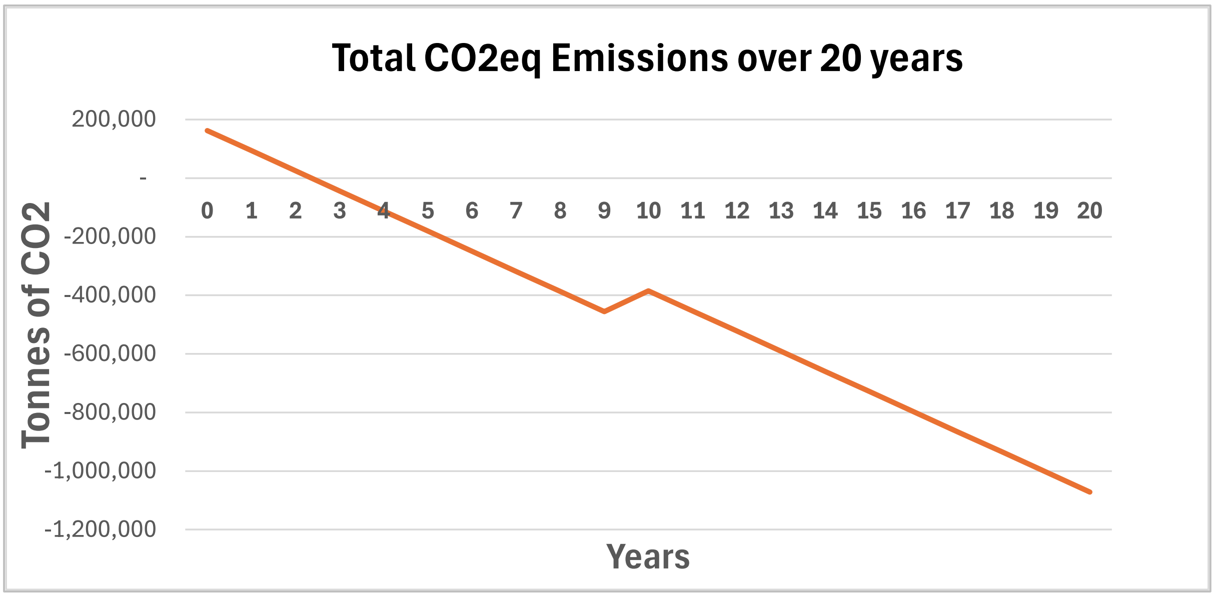

Figure 6 - Cumulative emissions of the Blackhillock Site over 20 year operation period. It is assumed that batteries are replaced after 10 years

2.7 Carbon management and reporting plan

A carbon management and reporting plan will be developed for Blackhilllock BESS Site. This Carbon Management Plan will be reviewed, updated and reported annually.

This Plan will comply with **PAS 2080:2023** enabling a structured approach that aligns with the principles and requirements of the standard. This standard will be adhered to for the proposed development's carbon reporting. PAS 2080 focuses on whole-life carbon management, aiming to reduce carbon emissions across the lifecycle of infrastructure projects.

PAS 2080:2023 emphasises the assessment and management of carbon emissions across the entire lifecycle of a project. It is well aligned with Industry Best Practices. It promotes consistency in carbon reporting, making it easier to compare performance across different projects or sectors. It is target-driven and encourages the setting of specific carbon reduction targets, which are essential for tracking progress and demonstrating commitment to carbon reduction targets. It has strong alignment with national and international goals and support for regulatory compliance. PAS 2080 provides a robust framework for transparent carbon reporting. PAS 2080 encourages the involvement of all stakeholders in the carbon management process, including designers, suppliers, contractors, and the community. The standard promotes a culture of continuous improvement, which is essential for adapting to new technologies, methodologies, and regulatory changes over the lifespan of a BESS project.

2.8 Carbon sequestration statement

Carbon sequestration measures are those existing and enhanced vegetation on the site.
The existing vegetation on the site, as described in the *Landscape Strategy Plan (14)*, primarily consists of native tree belts and woodland blocks. These existing vegetative features are marked on the plan as shown below and will likely serve as a foundation for enhancing ecological diversity on the site.

Figure 7 – Blackhillock Site Landscape Strategy Plan

The plan focuses on integrating enhancements, such as hedgerows, wildflower meadows, and scrub planting, around this existing vegetation to enrich the site's overall ecological value and carbon sequestration on the site. The ecological enhancement measures implemented on this site, as outlined in the *Plan* include the following:

1. **Mixed Species Hedgerow and Trees**: The site features hedgerows and tree belts composed of a diverse mix of native species, including *Crataegus monogyna* (hawthorn), *Prunus spinosa* (blackthorn), *Acer campestre* (field maple), *Corylus avellana* (hazel), and *Rosa canina* (dog rose) in the hedge mix, along with a variety of tree species such as *Alnus glutinosa* (alder), *Betula pendula* (silver birch), and *Quercus robur* (oak).
2. **Species-Rich Wildflower Meadow Grassland**: Within the overhead line (OHL) exclusion zone, a species-rich wildflower meadow will be created using the SCM9 Highland Grassland Mix from Scotia Seeds or a similar approved mix. This aims to enhance biodiversity and support pollinators.
3. **Attenuation Basin with Wet Meadow Mix**: An attenuation basin is planned, which will be planted with the SCM2 Wet Meadow Mix from Scotia Seeds or an equivalent. This basin will manage water flow while promoting the growth of native wetland species.
4. **Low-Level Scrub Planting**: Native scrub planting will provide additional habitats for wildlife and contribute to the ecological diversity of the site

The proposed native tree belts and woodland blocks and enhancement measures will provide carbon sequestration for the life of the development. This has not been quantified due to the lack of robust scientific methods to evaluate the carbon capture accurately in this context.

2.9 Renewable energy and heat decarbonisation statement

Blackhillock BESS Site does not include renewable energy and heat decarbonisation technologies. It is a BESS site, supporting the increased uptake of renewable energy penetration into the grid and supplying critical support and stability services to the National Grid.

The electrical capacity of the site is 349 MW, capable of storing and discharging a maximum of 748MWh of renewable energy every day (over a one charge and one discharge cycle). The current layout contains 234 Battery containers - each battery container comprising of lithium-Ion batteries. There will be 52 Inverter and Transformer Skids which step down the voltage from grid to batteries and invert power from AC to DC and vice versa. The project is expected to utilise around 21 acres and will be connected via an underground cable to the Blackhillock Substation at 400KV.

2.10 Main challenges in achieving net zero on the proposed development

It is considered that the proposed BESS development is an intrinsic element of achieving net-zero in a highly renewable powered electricity grid. The barriers identified below apply to all BESS infrastructure and not specific to the Blackhillock Site.

The barriers and challenges are multifaceted challenges the UK faces in scaling up BESS deployment to support UK Net Zero goals and achieve a fully decarbonized power system by 2035:

1. **Insufficient Domestic Manufacturing Capacity**: The UK lacks sufficient domestic manufacturing for batteries, which hampers large-scale BESS development. This is compounded by a heavy reliance on imported critical minerals such as lithium (8)
2. **High Upfront Capital Costs and Uncertain Revenue Streams**: BESS projects require substantial initial investment, and the revenue models for these systems can be uncertain, making it difficult to attract investors (8).
3. **Delays in Grid Connections**: Lengthy and unpredictable timelines for obtaining grid connections pose a significant challenge. This uncertainty can delay projects and increase costs (9)
4. **Planning and Regulatory Challenges**: The planning and permitting process for BESS installations can be complex and time-consuming. The need for multiple permits and the lengthy approval process can disadvantage UK projects compared to those in other countries with arguably more streamlined systems (9) (10).
5. **High Energy and Operational Costs**: The high costs associated with operating in the UK, including energy costs, make it less competitive compared to other countries. This deters investment and development (9)
6. **Skills Shortage**: There is a notable shortage of skills across the entire battery supply chain, from design and engineering to construction and maintenance (9). While the Blackhillock

Site has a skilled workforce in place for the development and operation of the Site, on a nationwide scale, skill shortages and supply chain can hinder the development of BESS.

7. **Safety Concerns**: Although safety incidents with BESS are rare, the potential and perceived fire risk associated with lithium-ion batteries remains an area of careful consideration. Ensuring the safety of these systems through robust regulatory frameworks and measures are essential but adds another layer of complexity and cost (8). It is important to note that BESS sites are very unlikely to catch fire. In order to minimise any risk, the developer uses proven suppliers in the market who comply with UL 9540 requirements. The batteries are spaced at minimum of three metres which is a proven safety distance to prevent propagation. Additionally, the units are located in blocks of approximately 10 batteries which are spaced at greater distances to prevent further propagation. The site will contain a dry riser system for fire suppression and each container is fit with own suppression system.

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Blackhillock Site Whole Life Carbon Emissions - Methodology Explained:

Whole Life Carbon Emissions Analysis is based on literature review. This means an assessment with exact bill of quantities and the specific features of the site has not been undertaken. The study instead relies on extrapolation from similar LCA studies that are considered to be relevant to the Site.

However, certain assumptions have been changed to provide further relevance and also remain conservative in terms of emission savings, considering the high level nature of the study.

The key determinants are the size of the BESS in terms of power and storage capacity and the UK Grid emission factors.

It is considered that:

BESS Carbon Emissions: 1 kwh of storage capacity is 200 kg CO_2 eq per kWh and 1kW power capacity is 400 kg CO_2 eq per kW installation (11) This is the highest GWP among literature.

Discharge Emissions: An average carbon emission factor of a combined gas turbine is assumed for the discharge replacement emissions (the average carbon emissions intensity of

OCGT – 0.46kgCO_2/kWh. This is not the highest emission value of OCGT but an average figure) (12).

Charge Emissions: A low carbon emission factor of a typical year (2023) is assumed for the charge (0.1 kgCO_2/kWh. This is not the lowest emission value as renewable electricity generation in 2023 went as low as 0.036kgCO_2/kWh). These assumptions are conservative and therefore in reality the emission savings at present time can be higher than these estimates (13).