# OUTLINE BATTERY SAFETY MANAGEMENT PLAN

Teindland Wind Farm

Volume 3

Technical Appendix 15.1: Outline Battery Safety Management Plan

Document prepared by Envams Ltd for: Teindland Wind Farm Ltd

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# Contents

# 1 EXECUTIVE SUMMARY

This Outline Battery Safety Management Plan (BSMP) has been prepared by Envams Ltd on behalf of Teindland Wind Farm Ltd ('the Applicant'). It provides an overview of the key measures to be adopted in order to ensure fire safety during the construction, operation and decommissioning of the Battery Energy Storage System (BESS) within the proposed Teindland Wind Farm (the 'Development') on land 'hereafter referred to as 'The Site'. The Site is situated approximately 2.7 kilometres (km) north, at its closest point, from the centre of the village of Rothes, and 9.7 km southeast from the centre of Elgin. The BESS compound will be constructed at approximately NGR 329141, 854248, as shown on Figure 4.1 of the Environmental Impact Assessment Report (EIA Report).

This Outline BSMP provides the planning related battery safety information required to enable Scottish Ministers to determine an application for consent under Section 36 of the Electricity Act for the Development.

The National Fire Chiefs Council (NFCC) Grid Scale Battery Storage System Planning Guidance for FRS[1] has been used as guidance in the design of the BESS.

The Outline BSMP includes a summary of the proposed approach to battery safety in the context of the guidance and best practice procedures known at the time of writing. This Outline BSMP will be used as the basis for a detailed BSMP in advance of construction of the BESS, and SFRS will be consulted on the detailed BSMP. It is expected that a consent condition will be imposed, requiring that this document be submitted to Moray Council for approval in consultation with SFRS before construction of the BESS commences.

The key principles applied to the design and management plan include:

- The BESS has been designed in accordance with published standards, international guidance and good practice;
- The BESS has been designed to minimise the risk of thermal runaway through fire detection and automated suppression systems;
- Separation distances between the BESS units comply with best practice guidance (NFPA 855[2]):
  - "Outdoor Installations: A minimum separation of 5 feet (1.5 meters) between BESS units, or reduced spacing if allowed by risk mitigation measures like fire-resistant barriers or other protections";
- Alternative access route provision to ensure access from two different directions is available to the BESS compound in the unlikely event of an incident occurring in accordance with NFCC guidance (2022);
- All equipment will be monitored, maintained and operated in accordance with the manufacturer's instructions; and
- An Emergency Response Plan will be developed and shared with the Scottish Fire and Rescue Service (SFRS) prior to construction of the BESS.

# 2 INTRODUCTION

## 2.1 SCOPE OF THE BSMP

This Outline BSMP document provides planning-related battery safety information relating to the proposed BESS.

This Outline BSMP contains the following sections:

- Introduction, background, risk identification, design objectives and guidance; and

[1] National Fire Chiefs Council (2022) *Grid Scale Battery Energy Storage System planning – Guidance for FRS*. [Online] - Available at: https://nfcc.org.uk/wp-content/uploads/2023/10/Grid-Scale-Battery-Energy-Storage-System-planning-Guidance-for-FRS.pdf (Accessed: 20/11/2024).

[2] NFPA (2022) *NFPA 855 - Standard for the Installation of Stationary Energy Storage Systems*. [Online] - Available at: https://www.nfpa.org/codes-and-standards/nfpa-855-standard-development/855 (Accessed: 20/11/2024)

- Planning application BESS design approach, including siting and location, BESS safety systems, provision for dealing with an emergency and the design response to relevant guidance.

## 2.2 RISK IDENTIFICATION

All forms of energy generation and electrical installation carry a level of risk of equipment failure. In respect of a BESS, thermal runaway poses the most significant potential hazard and associated risk of damage to health and property. If left uncontrolled, thermal runaway can result in a fire. The main objective of this BSMP is to set out the measures that have been and will be incorporated in the design of the BESS to mitigate the fire risk and to address an emergency incident in the unlikely event of its occurrence.

Other commonly deployed electrical systems forming part of the BESS, such as transformers, inverters, and switchgear, may also carry their own specific fire risks which are addressed by extant industry guidance and codes. This document therefore specifically focusses on the battery component of the BESS.

## 2.3 DESIGN OBJECTIVES

The BESS design addresses the following objectives:

- Minimise the likelihood of a fire occurring;
- Facilitate early detection and intervention;
- Minimise the consequences of a fire event should one occur;
- Ensure the safety of any personnel on Site and in surrounding areas; and
- Ensure that firefighters can operate and fight fire in reasonable safety.

## 2.4 THE SITE

The Site is situated approximately 9.6 kilometres (km) southeast of Elgin, and approximately 2.7 km north of Rothes.

The Site area is approximately 1,054 ha, with 1.0 ha of the Site proposed to contain the BESS and associated infrastructure.

Access to the Site will be taken from the north of the Site from the B9103 at National Grid Reference (NGR) 330207, 856430, as shown in Figure 4.1 of the EIA Report.

The Site location in shown in Figure 1:1 of the EIA Report.

## 2.5 THE DEVELOPMENT

The Development comprises a wind powered electricity generating station known as Teindland Wind Farm with a generation capacity exceeding 50 Megawatts (MW). The Development will include 12 turbines, eight with a maximum tip height of up to 230 m, and four with a maximum tip height of 200 m, with associated infrastructure. The BESS compound would contain typically 19 battery containers with a total of approximately 85 MW maximum export power and 170 MWh energy storage capacity.

Construction of the Development is expected to be completed within approximately 12 months, and any effects arising from this would be short term and temporary. The Development has an operational lifespan of up to 40 years. The Development is temporary and reversible; at the end of the operational period, the Development would be decommissioned in accordance with best practice at that time.

An indicative layout of the BESS is provided as Figure 4.7 of the EIA Report. The layout shown here is preliminary, and both the layout and the designs depend on the final choice of technology and supplier of the BESS equipment. Many of the potential safety aspects of the BESS, such as fault/heat detection and fire suppression also depend on the technology and supplier, and as a result the required spacing of BESS units may require to be changed at that time.

Areas of new hardstanding around the BESS units will be limited to the foundations underneath containers, transformers and other electrical installations.

Further information is provided in Chapter 4, Development Description, of the EIA Report.

# 3 RELEVANT GUIDANCE

At the time of writing, there is limited specific UK guidance documents and standards for BESS development, and guidance is expected to develop further before construction of the BESS. The Applicant has therefore sought to take into account the following guidance and to develop the BESS design accordingly.

- Planning Practice Guidance (August 2023) Paragraph 034 Ref ID: 5-034-20230814[3];
- National Fire Protection Agency (NFPA) 855 Standard for the Installation of Stationary Energy Storage Systems 2023[4];
- United Kingdom Power Networks (UKPN) Engineering Design Standard 07-0116: Fire Energy Storage Systems, 2016[5];
- UK Government - Health and Safety Guidance for Grid Scale Electrical Energy Storage Systems, 2024[6];
- National Fire Chiefs Council (NFCC) Grid Scale Battery Storage System Planning – Guidance for FRS (November 2022)[7], including the following documents referenced in that guidance:
  - State of Victoria (County Fire Authority) (2022), Design Guidelines and Model Requirements: Renewable Energy Facilities[8];
  - NFPA (2023) Standard for the Installation of Stationary Energy Storage Systems[9]; and
  - FM Global 2017 Property Loss Prevention Data Sheets: Electrical Energy Storage Systems Data Sheet 5-33 (see also interim revision July 2023)[10].
- The Energy Institute: Battery Storage Guidance Note 1 - Battery Storage Planning August 2019[11]; and
- DNV GL-Recommended Practice-0043: Safety, Operation and Performance of Grid Connected Energy Storage Systems 2017[12].

# 4 BESS DESIGN APPROACH

## 4.1 INTRODUCTION

This section details the design approach undertaken in accordance with the guidance outlined above, particularly the NFCC guidance.

The design has evolved to reflect the guidance in Section 3, in response to environmental studies.

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[3] UK Government (2023) Planning practice guidance: renewable and low carbon energy. [Online] - Available at: https://www.gov.uk/guidance/renewable-and-low-carbon-energy (Accessed: 20/11/2024).
[4] National Fire Protection Agency (2023) NFPA 855: Standard for the Installation of Stationary Energy Storage Systems. Available at: https://www.nfpa.org/product/nfpa-855-standard/p0855code [Accessed 20/11/2024].
[5] United Kingdom Power Networks (2016) Engineering Design Standard 07-0116. [Online] Available at: https://g81.ukpowernetworks.co.uk/library/design-and-planning/substations/eds-07-0116-fire-protection-standard-for-uk-power-networks-property-and-operational-sites (Accessed 20/11/2024).
[6] UK Government (2024) Health and Safety Guidance for Grid Scale Electrical Energy Storage Systems, 2024. [Online] – Available at: https://www.gov.uk/government/publications/grid-scale-electrical-energy-storage-systems-health-and-safety (Accessed 20/11/2024)
[7] National Fire Chiefs Council (2023) Grid Scale Battery Energy Storage System planning – Guidance for FRS. [Online] - Available at: https://nfcc.org.uk/wp-content/uploads/2023/10/Grid-Scale-Battery-Energy-Storage-System-planning-Guidance-for-FRS.pdf (Accessed: 20/11/2024).
[8] State of Victoria County Fire Authority (2022) Design Guidelines and Model Requirements: Renewable Energy Facilities. [Online] Available at: https://www.cfa.vic.gov.au/plan-prepare/building-planning-regulations/renewable-energy-fire-safety (Accessed 20/11/2024)
[9] NFPA (2022) Standard for the Installation of Stationary Energy Storage Systems. [Online] - Available at: https://www.nfpa.org/codes-and-standards/nfpa-855-standard-development/855 (Accessed: 20/11/2024)
[10] FM Global (2017) Property Loss Prevention Data Sheets: Electrical Energy Storage Systems [Online] Available at: https://liiontamer.com/wp-content/uploads/Property-loss-prevention-data-sheet-5-33-ESS.pdf
[11] Energy Institute (2019) Battery storage guidance note 1 - battery storage planning. Energy Institute.
[12] DNV GL, 2017. DNV GL-Recommended Practice-0043: Safety, Operation and Performance of Grid Connected Energy Storage Systems. DNV GL.

The design approach meets or exceeds the NFCC guidance, except in relation to spacing. The 2022 guidance cites that a 6 m spacing should be used between BESS units[13], unless an alternative separation can be justified. The spacing between the battery units is approximately 4 m in the proposed layout. The manufacturer of the battery units to be installed has not yet been decided and would not be, until planning permission is secured. Post-consent, when a preferred supplier is identified, technical documentation and statements will be provided by the supplier to be used as a justification for this matter, and the SFRS will be consulted on an updated and detailed version of this BSMP document at that time.

## 4.2 THE SITING AND LOCATION OF THE BESS

The siting and location of the BESS compound and individual units has been considered from the outset.

The following approach has been undertaken, responding to requirements of the NFCC (2022) guidance:

- The batteries units are located at least 10 m away from vegetation (trees in this area have recently been removed, and any re-growth would be kept clear of an area within 10 m of BESS units);
- An alternative direction of access to the BESS compound has been integrated into the design to allow continued access to the Site for emergency vehicles, should an incident occur, and the main access track be inaccessible. Access to the Site will be taken from the north of the Site from the B9103 at National Grid Reference (NGR) 330207, 856430, as shown in Figure 4.1 of the EIA Report. As can be seen on this Figure, the track approached the BESS compound from the west, and forks c. 50 m before it reaches the BESS compound. This provides two different approaches to the BESS compound, so that, in the event of a fire, emergency vehicles could take whichever route did not have smoke blowing across it (if any). Experience and modelling on other sites (for example, Cleve Hill Solar Park) has shown that concentrations of toxins in the smoke would disperse to the extent that they would be below tolerable thresholds at distances of c. 30 m. The track alternatives being at 50 m means that the emergency services would be able to approach safely via at least one of the options;
- The nearest residential property is approximately 500 m to the north-east of the BESS, which substantially exceeds the minimum distance (note that Station House, located at approximate grid reference 331202 852974, c. 400 m to the east of the BESS, is derelict);
- The prevailing winds at the Site are south-westerly. The access routes have been designed accordingly with the main access being from the west of the BESS (main access), and an alternative access being from the north-west (alternative access for emergency vehicles); and
- There will be a water tank onsite with the capacity of 228 $m^3$. The proposed water tank is situated to the northwest of the BESS units. If required, two hydrants may be installed at either end of the BESS units to ensure at least one will be accessible regardless of what the wind direction is during an incident.

## 4.3 PREVENTION OF THE IMPACT OF THERMAL RUNAWAY

Batteries can present a fire risk due to the combustibility of the materials and the possibility for heat generation due to short circuit potential and chemical reactions. If such energy is released uncontrollably, it could provide the conditions necessary for ignition and fire. In addition to the batteries, energy storage systems present a fire risk similar to other electrical utility equipment. The fire risk can be grouped into 3 categories:

1. Electrolyte fire risk (class B): li-ion cells are made of a cathode, anode, separator layer, terminals, electrolyte, and cell packing material. The electrolyte is often an organic ethylene like substance that is flammable. As a flammable substance the

[13] It is worth noting that there is currently ongoing consultation on a draft revision to the NFCC guidance, which removed any specific recommendation of separation distance: National Fire Chiefs Council (2024) Draft NFCC Grid Scale Energy Storage System Planning – Guidance for Fire and Rescue Services. [Online] - Available at: https://nfcc.org.uk/consultation/draft-grid-scale-energy-storage-system-planning-guidance/ (Accessed 20/11/24)

electrolyte is considered a fire risk in the event of a spill. Note that a spill is only possible in the event of mechanical damage to the cell (drop, puncture, crush, etc.) or failure. Careful handling of the batteries, visual inspection post installation, and continuous monitoring are the best mitigation measures.

2. Electrical fire risk (class C): energy storage systems contain energized electrical equipment. As such, there is an inherent fire risk. Use of proper design guidelines (NEC, IEC, etc.), proper equipment selection (appropriately rated OCPDs and conductors), and the use of insulation/touch safe covers where possible are the best mitigation measures.
3. Thermal runaway (class D): in li-ion cells, thermal runaway can be described as a process whereby the cell, after reaching a threshold temperature, enters a "positive" feedback loop where the internal oxidation reaction rate in the cell accelerates thus increasing the rate of the exothermic reactions and ultimately resulting in combustion and the total oxidation of the materials. This positive feedback loop in most li-ion batteries is the result of the reaction between the electrolyte (organic and flammable) and oxygen contained in the cathode. After reaching a certain temperature the oxygen atoms in the cathode break away and start interacting with the electrolyte fuelling this positive feedback loop.

Control measures and management systems for the BESS units themselves will be specific to a given battery manufacturer. Once a preferred manufacturer has been selected, post-consent, specific control measures will be identified and used to replace the example measures that are set out below, in a revised BSMP. The SFRS will be consulted on the revised BSMP prior to its approval.

A typical Battery Management System (BMS) monitors and protects the battery from:

1. Overcharging/overvoltage: the separators used in li-ion cells do not have very high dielectric capabilities. If a cell is overcharged/overvoltage it could lead to the damage of the separator layer and a short circuited cell. The BMS monitors and controls charging such that voltage limits are never exceeded. Charging is also done more conservatively as the battery reaches full charge in order to avoid stressing the separator.
2. Over discharging: discharging at very low state of charge (SOC) values could result in overcurrent and/or dendrite formation in the separator which overtime could lead to a short circuited cell. The BMS monitors and controls discharging such that overcurrent limits are not exceeded.
3. Overtemperature: the compounds in the cathode of the cell start to react with the electrolyte at around 90C. this reaction is exothermic in nature and once triggered it could lead to cell failure. The BMS monitors the temperature at the cell surface level and in different spots to ensure proper awareness. The BMS stops battery operation once the temperature reaches ~55C during operation.
4. Under temperature: charging a battery cell during low temperatures could result in separator damage due to platting. The BMS regulates the rate of charge over certain low temperature bands in order to mitigate this potential failure mode.
5. Imbalance: it is very important for all the cells inside a module and string to be balanced from a State of Health (SOH) and State of Charge (SOC) perspective to ensure electrical stresses during operation are imposed symmetrically and without hot spots/stress spots. The BMS constantly measures these parameters and ensures proper cell balancing during resting periods in order to harmonize SOC and SOH.

## 4.4 OTHER NFCC GUIDANCE REQUIREMENTS

### 4.4.1 Information Requirements

Prior to the commencement of construction of the BESS, site specific risk information (SSRI) and an emergency response plan (ERP) will be developed in consultation with the SFRS, and incorporated into a revised, detailed BSMP at that time.

### 4.4.2 System Design

The system design characteristics relevant to this BSMP are set out in Table 1.

***Table 1 – Relevant NFCC information requirements relating to system design, construction, testing and decommissioning***

| NFCC Information Requirements | Planning Application Details |
|---|---|
| 1. The battery chemistries being proposed (e.g. Lithium-ion Phosphate (LFP), Lithium Nickel Manganese Cobalt Oxide (NMC)). | To be decided (TBD) post-consent |
| 2. The battery form factor (e.g. cylindrical, pouch, prismatic) | TBD post-consent |
| 3. Type of BESS e.g. container or cabinet | Container (TBD post-consent) |
| 4. Number of BESS containers/cabinets | 19 (TBD post-consent) |
| 5. Size/capacity of each BESS unit (typically in MW/h) | 6.0 m by 2.5 m, 4.5 MW, 9 MWh.<br>The sum of the BESS in the compound will have capacity to store up to 171 MegaWatt-hours (MWh) of energy and an instantaneous power output of approximately 85 MW (indicative – to be confirmed post-consent) |
| 6. How the BESS units will be laid out relative to one another. | The indicative layout of the BESS compound is shown in Figure 4.7 of the EIA Report, and typical elevations of the components of the BESS are shown in Figure 4.8. |
| 7. A diagram / plan of the Site. | The indicative layout of the BESS compound is shown in Figure 4.7 of the EIA Report. |
| 8. Evidence that Site geography has been taken into account (e.g. prevailing wind conditions). | The prevailing winds are south-westerly, the Site has been designed with two access approaches to the BESS area.<br>There is the main access route from the west to be used during construction and operation, as well as an additional access route from the north-west. It is therefore unlikely that both access points would be blocked in the event of an incident. |
| 9. Access to, and within, the Site for SFRS assets[14] | The Site will contain 5 m wide access tracks throughout, with the BESS units being directly adjacent to this track.<br>Provisions have been made to ensure the Site has adequate turning areas.<br>In addition, the access roads will be designed to accommodate a "standard axle" (i.e. have the same load carrying capability as a public road) for equipment installation during construction and emergency replacement during site operation. |
| 10. Details of any fire-resisting design features | The BESS enclosures will be designed to reduce the risk of fire propagation. Further details will be provided once a preferred supplier has been identified, post-consent.<br>It is worth noting that there are existing solutions called “back2back” that require a minimum distance of only 1 m. The final separation distance will be determined post-consent and will follow the most up to date fire safety requirements and standards at that time. |

[14] The FM Global document referenced in the NFCC guidance section on “access between BESS units and unit spacing” was updated in July 2023 and therefore the standard minimum spacing referred to in that section should be considered with reference to the updated version of the FM Global data sheet.

| NFCC Information Requirements | Planning Application Details |
|---|---|
| 11. Details of any:<br>a. Fire suppression systems<br>b. On Site water supplies (e.g. hydrants, EWS etc)<br>c. Smoke or fire detection systems (including how these are communicated)<br>d. Gas and/or specific electrolyte vapour detection systems<br>e. Temperature management systems<br>f. Ventilation systems<br>g. Exhaust systems<br>h. Deflagration venting systems | b. There will be a water tank onsite with the capacity of 228 $m^3$ – in alignment with the NFCC guidance. The proposed water tank is situated to the northwest of the BESS units, and two hydrants may be installed at either end of the BESS units to ensure at least one will be accessible regardless of what the wind direction is during an incident.<br>Other details vary from manufacturer to manufacturer, and this section of the BSMP would be updated post-consent, when a preferred supplier is identified, and the SFRS would be reconsulted at that time. |
| 12. Identification of any surrounding communities, sites, and infrastructure that may be impacted as a result of an incident. | The nearest residential dwelling is over 500 m from the BESS. The battery units are located at least 10 m from vegetation and overhead lines as per the NFCC guidelines, minimising potential impacts.<br>An ERP will cover all potential impacts to receptors as well as appropriate mitigation measures. |
| 13. Testing | Information on testing would be provided post-consent, when a preferred supplier is identified. |
| 14. Design | Information on the design detail of the battery units would be provided post-consent, when a preferred supplier is identified. |
| 15. Detection and monitoring | Information on detection and monitoring detail of the battery units would be provided post-consent, when a preferred supplier is identified. |
| 16. Suppression systems | Information on suppression system detail of the battery units would be provided post-consent, when a preferred supplier is identified. |
| 17. Deflagration prevention and venting | Information on deflagration prevention and venting detail of the battery units would be provided post-consent, when a preferred supplier is identified. |
| 18. Access | As per NFCC guidance, the Site includes:<br>Two separate access route approaches to the site taking into account different wind conditions/directions.<br>5 m-wide access roads/hard standing capable of accommodating fire service vehicles in all weather conditions. No extremes of grades.<br>Unobstructed access to all areas of the facility. |
| 19. Access between BESS units and unit spacing | The indicative layout shown in Figure 4.7 of the EIA Report shows that there is space for access between the BESS units. Post-consent, when a preferred supplier is identified, a revised design specific to the selected technology will be developed, which will ensure there is space for access between the BESS units. |
| 20. Distance from BESS units to occupied buildings and site boundaries | The nearest residential property is over 500 m from the BESS. |
| 21. Site conditions (Sites should be maintained in order that, in the event of fire, the risk of propagation between units is reduced.) | The BESS area will be maintained to be free of debris and other obstructions. The BESS area will be gravelled, and any vegetation will be kept to low levels to avoid obstruction and/or fire risk. |

| NFCC Information Requirements | Planning Application Details |
|---|---|
| 22. Water supplies | There will be a water tank onsite with the capacity of 228 $m^3$ – in alignment with the NFCC guidance. The proposed water tank is situated to the northwest of the BESS units, and two hydrants may be installed at either end of the BESS units to ensure at least one will be accessible regardless of what the wind direction is during an incident. |
| 23. Signage | Site signs will be installed to direct emergency services towards the BESS area, from both access approaches. |
| 24. Emergency Plans | An ERP will be prepared and included in the detailed BSMP post-consent, when a contractor has been appointed and a preferred battery supplier has been identified. SFRS will be re-consulted on the detailed BSMP at that time, prior to its approval. |
| 25. Environmental Impacts | See section 4.4.3. |
| 26. Recovery | Following any event, there would be a detailed investigation (and report) conducted with input/feedback from the operator and outlining a Root Cause Analysis of the incident and Lessons Learned.<br>A full description of this process, including disposal of damaged equipment, will be prepared prior to construction of the BESS. |

### 4.4.3 Environmental Impacts

The potential environmental impacts of the BESS are assessed in the EIA Report, including potential effects of both the BESS and the rest of the Development. The Emergency Response Plan will also factor in environmental considerations for the construction and operational phases.

The principal potential impact from the BESS is associated with fire water, which could be contaminated, in the event of a fire. This is considered in EIA Report chapter 12: Hydrology, noting provision of the ability to capture and hold run-off, in the event of a fire, such that it can be tested and, if necessary, taken off site by licenced contractor in tankers, rather than being released into the environment.

# 5 CONCLUSION

This Outline BSMP sets out the BESS design approach taken, and the information which is required to be provided (following the consenting process) in advance of construction of the BESS to demonstrate that the BESS will be constructed and operated safely. Compliance with the NFCC guidance, insofar as is practical ahead of selecting a specific BESS technology, is designed to minimise impacts on nearby sensitive receptors. An ERP will be drafted prior to operation which takes into account any environmental impacts likely to occur during the lifetime of the BESS. This Outline BSMP will be used as the basis for a detailed BSMP which will be prepared in advance of construction of the BESS, and SFRS will be consulted on the detailed BSMP. It is expected that a consent condition will be imposed, requiring that this document be submitted to Moray Council for approval in consultation with SFRS before construction of the BESS commences.

# 6 FIGURES

Figures are provided elsewhere in the EIA Report:

- Figure 1.1: Site Location;
- Figure 4.1: Site Layout;
- Figure 4.7: Indicative BESS Layout; and
- Figure 4.8: BESS Substation Elevations.