APPENDIX 4-4

FIRE RISK MANAGEMENT EMERGENCY RESPONSE PLAN

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FIRE RISK MANAGEMENT & EMERGENCY RESPONSE PLAN

CLIENT: **Carrow Renewable Energy C/O MKO.**

PROJECT TITLE: **Carrow Renewable Energy Ltd.**

LOCAL AUTHORITIES: **Tipperary Co. Co. & Tipperary Fire Service.**

DATE OF REPORT: **2026-March-11**

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1 INTRODUCTION

It is proposed that a planning application will be submitted to An Coimisiún Pleanála under Section 37E of the Planning and Development Act (PDA) seeking permission for 14 No. wind turbines and associated infrastructure in the townlands of Carrow, Carrowkeale, Moheragh, Glenpaudeen and Scarrough, County Tipperary (Figure 1) and an on-site substation and associated works, including underground cabling to connect to the National Grid with a potential generating capacity of greater than 50 megawatts (MW). The wind farm is being proposed in line with Government targets to establish Ireland as a carbon neutral country by 2050.

2 DESCRIPTION OF THE PROJECT

The proposed development will include the following:

- 14 No. wind turbines with a ground to blade tip height of 185m and a blade length of 81.5m.
- 1 no. meteorological mast with a height of 103.5m.
- 3 no. Temporary Construction Compounds
- Upgrade of existing tracks/roads and provision of new site access roads and hardstands areas.
- All associated site development works and apparatus
- A Battery Energy Storage System (BESS).

The BESS aspect of the proposed project and the associated fire hazard is the primary focus of this report. The BESS will be installed in a separate compound. The battery storage compound will have a footprint of 4,140 m^2. The compound will include 10 no. battery storage modules (units or containers) and 10 no. transformers. Each battery storage container will measure 12.2 m x 2.4 m with a height of 2.58 m (Figure 2). The storage containers are packed with successive battery packs wired together to create modules that are connected within racks to create an energy storage array.

Connection to the grid will be made via,

- 1 no. onsite 110kV electrical substation, control buildings & battery storage including associated infrastructure and access.
- Proposed 110kV grid connection is to the existing 110kV substation at Killonan in the townland of Milltown, Co. Limerick.
- c.37km of 110kV underground electricity cabling to Killonan within the public road corridor and third-party lands to facilitate the connection to the national grid.

The BESS facility will connect to the proposed AIS substation using electric plant (including step-up transformer) and HV cables. The proposed 10 no. battery enclosures (12.2 m long x 2.4 m wide) and 10 no. medium voltage power station (MVPS) enclosures (3.5m long x 3.5m wide) will be positioned on concrete plinth foundations. Once positioned the top of the battery enclosures will be a height of 4.42

m above the finished ground level (FGL) of the BESS compound and the top of the MVPS enclosures will be a height of 3.29m above the compound FGL. The enclosures will be connected by underground ducts and cables. Associated externally located equipment includes an air-cooling unit for the generator, electrical plant (such as transformers), a fire water storage tank and a below ground foul wastewater holding tank.

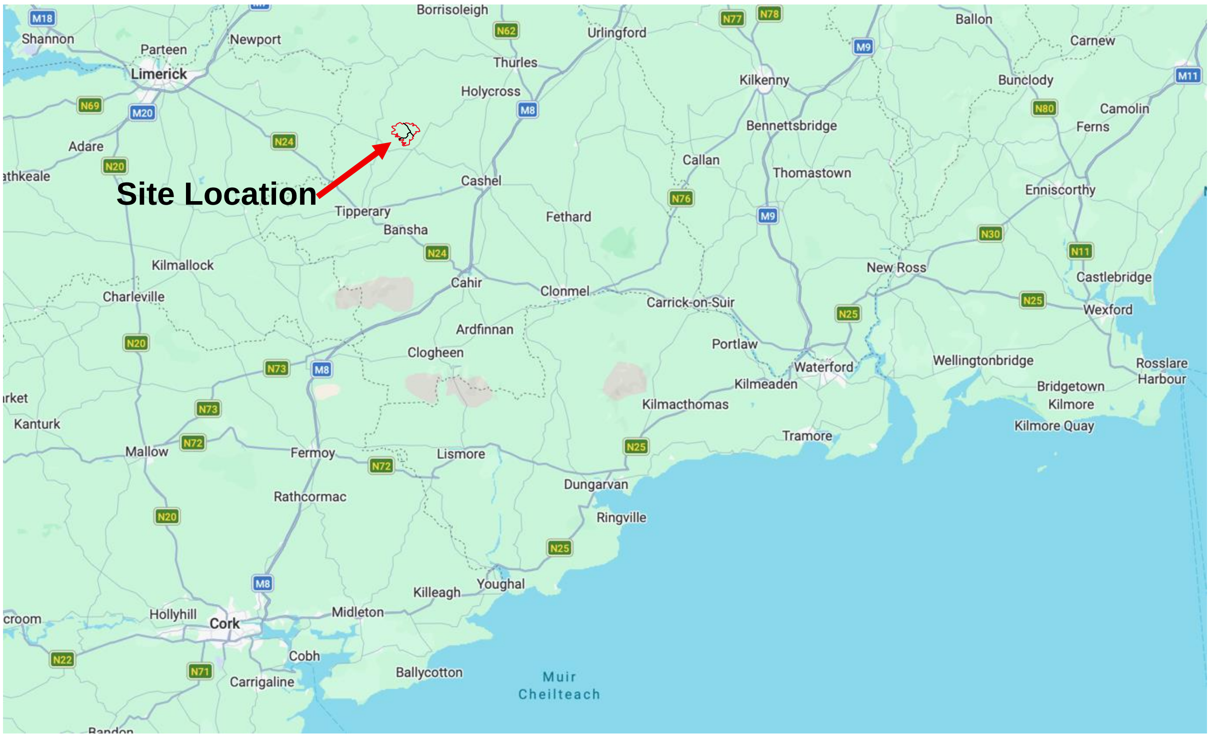


Figure 1 – Site Location

External lighting is proposed to serve the compound which will be protected and secured with 2.5m high palisade fencing (Figure 2). Prior to installing the steel containers, clearance of the site area, levelling off the ground surface and creation of a hard stand is proposed to be undertaken.

The containers and the adjacent infrastructure house the batteries, inverters, transformers, fire safety equipment and associated electrical components. The containers are to be spaced to allow airflow around the containers, feeding their climate control systems and provide fire spread separation. The battery storage compound will operate continuously, linked to the IPP Building within the substation adjacent to the BESS compound. It will be monitored in tandem with the overall development and there will be sporadic maintenance visits as required.

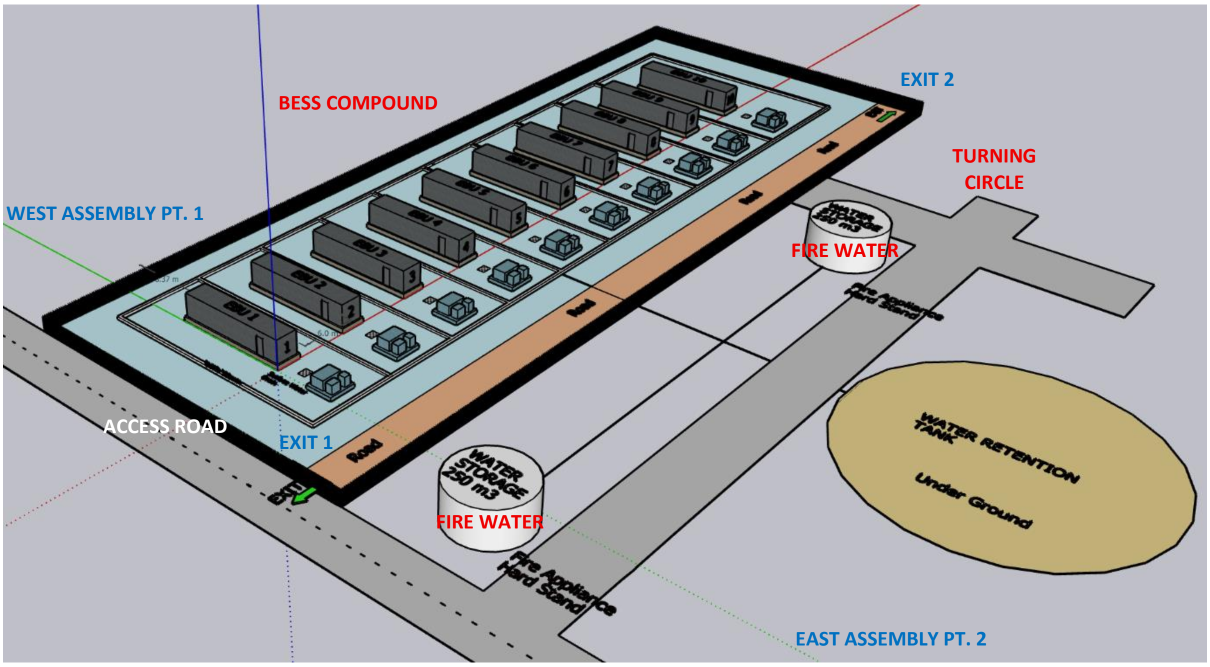


Figure 2 – BESS Compound

3 A BATTERY ENERGY SYSTEM (BESS)

A battery energy storage system (BESS) comprises severai integral components, each crucial for maintaining efficiency and safety. The image below (Figure 3) demonstrates how these parts are connected in the BESS.

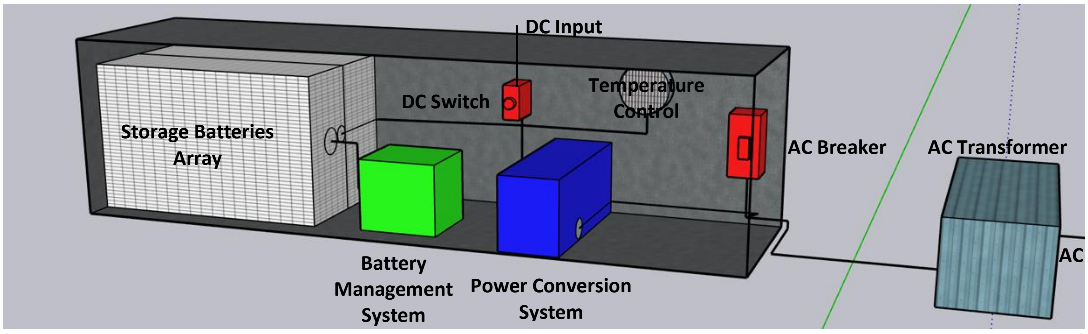


Figure 3 - Battery Storage Container

The Battery Management System (BMS) is a real-time monitoring system containing an electronic circuit apparatus which monitors the state of the battery ensuring battery safety, reliability, and stability. This includes a cell supervision circuit, a sub-battery management unit and master battery management.

The Power Conversion System (PCS) is an electrical or electro-mechanical device that converts electrical energy between DC and AC, essential for managing various loads. Most loads use AC but batteries, wind turbines and solar panels have a DC output. The PCS is bi-directional inverter/charger, compared with a Photo Voltaic inverter.

Environment Sensor & Temperature Control System detects any abnormal surrounding conditions of the BESS and alerts the environment control module. This includes door sensors, flooding sensors, smoke sensors and more. The environment control module contains an air conditioner and an automatic control system providing an ideal temperature and humidity environment for batteries during charging and discharging. The fire suppression system is managed and control by this system to ensures the safety of the energy storage system designed to prevent electrical fires.

The BESS contains a DC switch between PCS and storage device and an AC breaker between PCS and AC transformer for safety. The wind turbine energy DC input or DC output load can be connected to the system after the DC switch. The transformer is a major external component that ensures the output of the BESS requirements on AC voltage.

4 STANDARDS and GUIDANCE

The fire safety measures identified for this installation will be developed using considerations from Irish guidance, international best practices and applicable international standards. The European Regulations (Regulation (EU) 2023/1542) for Battery Energy Storage Systems (BESS) with lithium-ion batteries involves several key standards. These standards address safety, performance, and lifecycle management of lithium-ion batteries used in BESS, ensuring they are safe for normal operation and under expected fault conditions.

The Batteries Regulation (Regulation (EU) 2023/1542) requires that stationary BESS be safe during normal operation and use. It mandates demonstration of compliance with state-of-the-art testing methods developed by organisations such as the European Committee for Electrotechnical Standardisation (CENELEC) and the International Electrotechnical Commission (IEC) and other organisations with global recognition.

The BESS installation plan will be designed and installed to the recommendations from the following standards and best practice guides in Ireland and internationally:

- EN-IEC 62619 - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications.
- EN IEC 63056 - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems.
- IEC 62933-5-1 - Electrical energy storage (EES) systems - Part 5-1: Safety considerations for grid-integrated EES systems - General specification.
- IEC 62933-5-2 - Electrical energy storage (EES) systems - Part 5-2: Safety requirements for grid-integrated EES systems - Electrochemical-based systems.

- IEC 62485-5 – Safety requirements for secondary batteries and battery installations – Lithium-ion batteries for stationary applications.
- NFPA 855 – Standard for the Installation of Stationary Energy Storage Systems.
- NFPA 68 – Standard on Explosion Protection by Deflagration Venting.
- NFPA 69 – Standard on Explosion Prevention Systems.
- NFPA 2010 – Standard for Fixed Aerosol Fire-Extinguishing Systems.
- FM Global Property Loss Prevention Data Sheets 5-33.
- UL 9540 Standard for Energy/Storage and Equipment.
- UL 9540A Test Method for Battery Energy Storage Systems (BESS).
- CSA TS-800:24 Large-Scale Fire Test (LSFT) Procedure.

In response to the requirements of the standards and guidance documents, this plan outlines safety measures specifically for this proposed outdoor utility-scale lithium-ion Battery Energy Storage Systems. It is envisaged that the batteries used on site will be testing at cell-level to UL 9540A to provide detailed information of the breakdown of the composition of vented gas from cells in thermal runaway, including flammable gases and vapours. It is also recommended that large scale fire testing be carried out to CSA TS-800:24 Large-Scale Fire Test (LSFT) Procedure. This technical specification provides a standardised method for evaluating fire hazards associated with energy storage systems. TS-800 provides an extensive testing procedure that verifies fire events from a fully involved ESS unit do not propagate to adjacent units or external exposures.

5 FIRE RISK MANAGEMENT PLAN

5.1 Introduction

Battery energy storage systems (BESS) are devices or groups of devices that enable energy from intermittent renewable energy sources (such as wind power) to be stored and then released when customers need power most. They are constructed of successive battery packs wired together to create modules that are connected within racks to create an energy storage array. The battery chemistries for this BESS installation have not been decided at this point. The choice will be made between Lithium Iron Phosphate (LFP) battery technology or the alternative technology, Nickel Manganese Cobalt Oxide (NMC).

The fire safety measures outlined in this report for this BESS installation have been developed using considerations from Irish guidance, international best practices and applicable international standards. The European Regulations (Regulation (EU) 2023/1542) for Battery Energy Storage Systems (BESS) with lithium-ion batteries involves several key standards. These standards address safety, performance, and lifecycle management of lithium-ion batteries used in BESS, ensuring they are safe for normal operation and under expected fault conditions.

It is assumed that the BESS compound and the site in general will operate mostly unstaffed autonomous through an Alarm Receiving Centre (ARC) monitoring the onsite control systems with Supervisory

Control and Data Acquisition (SCADA) systems and 24/7 monitoring by a human operator or team, enabling comprehensive oversight and control without a constant on-site presence. Integrations with Closed Circuit TV (CCTV) will allow for live video feeds in which the monitoring centre will be able to verify alarms and detect false alarms, ensuring appropriate responses. Automated alerts can also be sent via text, email or App, keeping stakeholders informed of incidents in real-time.

This plan has been developed accordingly with the safety of the staff, public and emergency services in mind. It is based on trying to help reduce the risk as far as reasonably practicable, whilst recognising that ultimate responsibility for the safe design and running of these facilities rests with the operator. This fire risk management plan is based upon a range of supporting materials including academic research, national and international standards, case studies, and industry guidance. The content of this plan is the result of analysis of that supporting material with subsequent professional judgement applied. Every Battery Energy Storage System installation is different and for this proposal bespoke solutions will be necessary.

5.2 BESS Fires

If a battery cell creates more heat than it can effectively dissipate it can result in a rapid uncontrolled release of heat energy, known as 'thermal runaway,' that can result in a fire or explosion. This can occur as a result of an internal short circuit due to manufacturing defects, 'lithium plating' (formation of metallic lithium on an anode surface within a battery cell), or mechanical damage. Other possible causes of thermal runaway are exposure to heat from an external source, overcharging, over-discharging, and failure or malfunction of the BMS.

BESS installations often use large numbers of flat 'prismatic battery cells' (rather than 'cylindrical battery cells') that are sandwiched together. These typically pose a greater risk of thermal runaway occurring than with cylindrical cells, however the protection strategies are the same.

Thermal runaway can lead to the ejection of a range of gases from battery casings, such as hydrogen (extremely flammable), carbon monoxide (toxic, asphyxiant, and flammable), and hydrogen fluoride gas (acutely toxic and corrosive).

When a battery cell vents or ruptures due to thermal runaway, immediate ignition of the emitted gases can occur (especially for batteries with a high level of charge). Alternatively, the gases may spread-out unignited, with the potential for a deflagration (very rapid combustion) or explosion if an external ignition source is encountered.

5.3 Proposed Risk Management Approach

A Hazard Mitigation Analysis (HMA) approach will be employed for this proposed development. The installation be systematicly assessed to identify potential risks, evaluate their consequences, and develop strategies to reduce or eliminate long-term threats to people, property, and the environment. The scope of the HMA will be to establish the fire and explosion protection design criteria for the facility. The development of the HMA will be an iterative process. The HMA will be revised as the design progresses and technical design aspects are selected and finalised and based on dialogue among the stakeholders. The HMA will outline the protection/prevention design basis for achieving the fire hazard control objectives agreed upon by the stakeholders.

The systematic HMA approach, that will be employed, to minimise the risks at the Carrow BESS site will follow the Hierarchy of Controls Methodology (Figure 4). The Hierarchy of Controls is a methodology that ranks safeguards for managing workplace hazards from most to least effective, prioritising methods that eliminate or reduce the hazard at its source. The five levels, in order of effectiveness, are Elimination (remove the hazard), Substitution (replace it with something less hazardous), Engineering Controls (physical isolate people from the hazard), Administrative Controls (change work policies and procedures) and Personal Protective Equipment (PPE) (provide protective gear as a last resort). This methodology will endeavour to ensure there are robust control measures are put in place to:

- reduce the likelihood of fire event.
- mitigate the consequences of a fire event should a fire occur.

These controls measures are imperative to protecting maintenance and emergency response personnel and the environment.

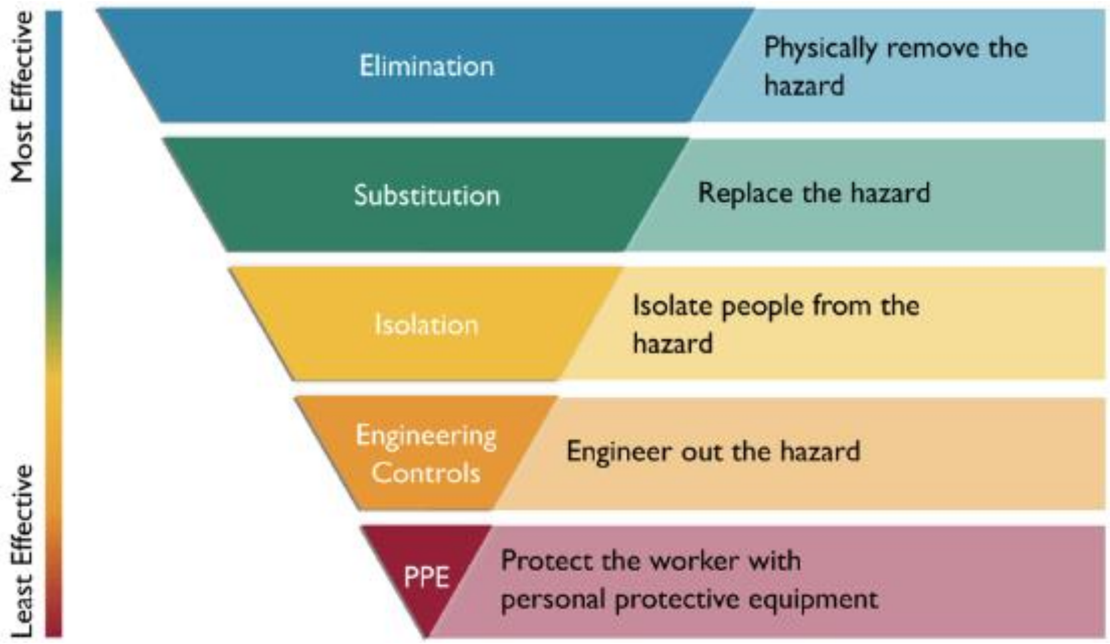


Figure 4 – Hierarchy of Controls

5.4 Elimination

The suppliers of the Battery Energy Storage Systems will be selected such that all levels including cell, module and BMS and the barriers designed within their equipment package are tested and certificated to reduce the fire risks.

Testing of battery equipment to UL9540A standard or equivalent (cell, module and unit) will be required by the equipment supplier. This will provide a critical input in understanding the volume of off-gases which are likely to be produced in a fire event and adequate steps to mitigate the impacts. It is envisaged that large scale testing of the BESS enclosure will have been carried out to CSA TS-800:24 Large-Scale Fire Test (LSFT) Procedure. This involves intentionally initiating a fire in a BESS enclosure to evaluate how fire might spread to nearby systems. Unlike UL 9540A testing, which may only lead to the release of flammable gases without ignition, large-scale fire testing forces a fire condition in one BESS enclosure to assess if thermal runaway and fire propagation will occur in adjacent enclosures.

5.5 Substitution

Transformers are an integral component of BESS sites, with coil and core insulation facilitated by oil. To reduce the fire risk in the event of a spill, a non-mineral oil which is less flammable will be specified to be used as the insulating fluid.

As stated earlier, the choice will be made between Lithium Iron Phosphate (LFP) battery technology or the alternative technology, Nickel Manganese Cobalt (NMC). Lithium Iron Phosphate batteries have a thermal ignition temperature of 270^{o}C whereas Nickel Manganese Cobalt batteries have a thermal ignition temperature of 210^{o}C thereby being less thermally stable. Therefore, LFP batteries provide better resistance to a thermal runaway initiation.

5.6 Isolation

The design of the BESS enclosures itself will provide a passive barrier of protection to personnel. In addition, the exposure risks to personnel are further reduced/eliminated as the BESS site will operate largely unstaffed with monitoring done autonomously through the onsite control systems and 24/7 monitoring by a remotely.

5.7 Engineering Controls (Engineer Out the Hazard)

5.7.1 Introduction

All equipment/systems (BESS enclosures, power systems and inverter and transformers) are to be installed per the manufacturer’s equipment specifications including spacing requirements for maintenance and safety clearances.

The BESS enclosures are proposed to include various engineering controls ranging from passive barriers to active monitoring and detection systems. These measures will be employed to further reduce the likelihood and consequences of a fire at this BESS facility. These controls include:

5.7.2 Battery Management System (BMS)

A BMS will be installed to provide early detection of potential cell failure which could result in a thermal runaway event. The critical cell is identified, automatically disconnected and isolated before further degradation and ultimately a thermal runaway event can be initiated. The BMS will also provide cell and module over and under voltage protection, alert, and correction.

Computer controlled battery management systems (BMS) are a key element of BESS systems which manage the flow of energy to and from the BESS system and ensure that battery cells remain within their safe operating range for voltage, current, and temperature. Flammable electrolytes combined with high energy, contained in lithium-ion battery cells can lead to a fire or explosion from a single-point failure.

Cell level protection will be provided at each cell level which will be controlled by the BMS:

- Battery cells are to be fitted with current interrupting devices (CIDs) which allow for automatic isolation of individual cells during an external short.
- Overcharge safety devices (OSD) – are to be fitted which activate current interruption during over-charge.

Cells are to be outfitted with a safety function layer through ceramic coating which is designed to suppress thermal runaway within the cell.

5.7.3 Enclosure Panels

The BESS enclosure panels are proposed to provide 60 minutes fire resistance and therefore 120 minutes fire resistance between one BESS enclosure to another. (back-to-back containers).

5.7.4 Gas Detectors

Installation of gas detectors is proposed in each container for the early detection of off-gases/ electrolyte-vapour such as H_2 and CO. The detectors will be monitored by the BMS with automatic shutdown capabilities.

5.7.5 Fire Detection & Alarm

It is proposed to provide a fire detection and alarms system to each BESS enclosure to include smoke detection, heat detection, sounders and strobe alert and one fire alarm panel (Control Indicating Equipment) per enclosure/row connected to a central BMS.

5.7.6 Aerosol Suppression

An aerosol extinguishing agent flooding system will be installed in each container to extinguish an energised electrical fire in electrical components. This agent is intended for use on this classification of fire only and is not designed to prevent or combat thermal runaway. The choice of the type of suppression system will be informed by liaison with a competent system designer who can relate the system choice to the risk identified and the duration of its required activation. Such a choice must be evidence based.

5.7.7 Deflagration Panels

The BESS containers will be fitted with deflagration venting and explosion protection appropriate to the hazard. Designs will be developed by competent persons, with design suitability able to be evidenced. The deflagration panel(s) will be included which are designed to structurally fail at a lower pressure than the enclosure structure in the event of an overpressure situation. Any blast overpressure of gases will be directed upwards and away from personnel in the event of exhaust ventilation system failure. Deflagration ventilation will be installed in accordance with NFPA 69 and NFPA 68. The sizing the vent area (Av) involves several complex variables such as the enclosure strength (P_{red}), the venting characteristics C, which is a function of the fundamental burning velocity, density and other thermo-physical properties of the off-gases from UL 9540A tests.

The vent area is calculated using the formula,

$$Av = C \cdot As / \sqrt{P_{red}}, \text{ where;}$$

As is the internal surface area of the enclosure and the maximum pressure, P_{red}, that an ISO container can withstand is typically 0.2 bar-g before structural failure.

5.7.8 Ventilation

A ventilation system will be included to vent an ESS container after a combustible concentration reduction system (CCR system), based on an NFPA 69 deflagration study, is activated and signals the BMS of the presence of flammable gases. The continuous gas detection system will comply with the following:

1. The gas detection system will be designed to activate the CCR system on detection of flammable gases at no more than 10% of the LFL of the gas mixture or of the Individual components.
2. The CCR system will remain on to ensure the flammable gas does not accumulate and exceed 25% on average of the LFL of the total enclosure volume of the gas mixture. For hydrogen produced the maximum concentration must be limited to 1% of the total volume of the container. An exhaust ventilation rate based on the area of not less than 5.1 l/sec/m^2.
3. The CCR system and its components will be considered a critical safety system and will be provided with a minimum of 24 hours of standby power.
4. The gas detection system and CCR system will annunciate at a supervising station.

The CCR system should take priority over a suppression system. The activation of a suppression system must not hinder the CCR system operation or delay its performance. To ensure this, a “no impact” analysis with supporting performance data should be performed.

5.7.9 Space Separation

Separation of BESS container units is the most effective means of preventing a fire event from escalating through radiated fire spread to adjacent BESS containers of building and equipment. Separation distances are proposed which exceed or match standards and best practice (See Appendix A for site diagram).

- 30 m separation distance (minimum) from the BESS site boundary and occupied building per NFPA 855.
- 10 m separation from combustible vegetation.
- 6.0 m BESS container distance separation in excess of the 3.0 m guidance from NFPA 855.
- BESS systems will be at least 15 metres from building HVAC air inlets.
- 6.5 m fire break between groups of equipment where possible
- 10 m separation between the water tank and BESS nearest enclosure.

It may be acceptable to reduce some of the above risk control measures where large-scale testing, such as testing to UL9540A or equivalent for this same type of battery technology and it has been demonstrated that adjusted mitigation measures are adequate and acceptable. The fire characteristics of the composition of the gases generated at cell level, module level and unit level for an installation undergoing thermal runaway can be evaluated.

5.7.10 Ingress protection (IP)

The IP rating of the BESS containers will be specified to at least a rating of IP54. This provides protection to the internal equipment from water jet sprays in any direction. A higher IP rating to IP55 or IP65 will provide a greater level of protection against solid objects and water ingress and prevents the entry of dust, water, and other elements that can damage internal components and circuitry. Cooling BESS container/Units with water spray will be a fundamental tactic used by the fire and rescue services to mitigate against thermal runaway and fire spread to opposing containers/unit through thermal radiation.

5.8 Administrative Controls

Internal procedures and training, stakeholder engagement and emergency response planning will be utilised to manage the residual risks which remain after the designed engineering controls. This will include the following:

- Early engagement with the Fire and Rescue Service forms a critical input during the development and early design phase of BESS sites. The process begins with consultation with local authority fire brigade during the initial site design which can provide further guidance to the development engineering works for the BESS site. The finalised designs and site layout cater to the equipment of the local authority fire service with provisions for site access, adequate turning circles and fire water capacity.
- An Emergency Response Plan (ERP) will be developed for the BESS site in alignment with current Irish civil response procedures using the national incident command and control structure. The ERP will be informed by site-specific risks and detail the level of response required following activities such as the consultation with the Fire and Rescue Service and other emergency services, the recommendations of the plume analysis and any other risk or impact assessments conducted. All personnel deployed to the site will be adequately trained and act as tactical liaisons. Site-specific risk information will be available at the site entrance(s) to aid in response efforts.
- A series of risk assessments with the BESS equipment suppliers will be completed. These risk assessments contain many of the engineering controls detailed in this document and a will be presented using the 'Bowtie' Methodology. This process gives a graphical method for analysing and managing hazards across the site and to ensure a level of standardisation among different equipment suppliers. This will be a crucial part of the Safety Statement process.

5.9 Firewater Supply

Static water storage tanks, with a combined capacity of at least 500,000l shall be provided in the compound to assist fire fighters in a fire event. The provision of firewater stored on site shall be subject to consultation with Tipperary Fire Service. Refer to section 5.7 and Appendix A of this report for water storage design details.

5.10 Personal Protective Equipment (PPE)

All personnel on site whether during construction, commissioning or during operation will have the minimum Personal Protection Equipment requirement necessary to be on site. In addition, there will be adequate signage detailing the required PPE for each site area and equipment. The operation or maintenance of specific equipment may have different safety requirements. There are different levels of PPE that will be checked and maintained. All personnel who wear levels of protection above and beyond their normal everyday attire will be trained in that PPE. All training of PPE will be conducted by a competent person and documented. Some PPE will have a requirement to be maintained and the wearer will be familiar with the limitations of such equipment. Wearers of PPE will be aware of individual equipment operational requirements and hazards as well as out of service dates.

All personnel on site will have and don the following minimum PPE:

- Safety glasses with side shields (no dark glasses are permitted except those approved for welding or cutting)
- Face shields for cutting & grinding
- Approved safety toe shoes
- Approved hearing protection (as specified)
- Approved hardhat & gloves
- Long sleeve shirt & long pants

All PPE will be required to be worn at all times. Any PPE that is compromised or no longer considered viable for protection will be discarded and replaced. Any PPE that comes in contact with hazardous material will be properly decontaminated and inspected for functionality before being returned to service.

6 EMERGENCY RESPONSE PLAN

6.1 Introduction

Emergency Management is about managing risks to infrastructure, communities and the environment. The emergency management cycle consists of four phases, Prevention/Mitigation, Preparedness, Response and Recovery. These phases form a continuous, integrated framework to reduce vulnerability to hazards, prevent emergencies, prepare for them, respond to them when they occur, and recover to normal operations.

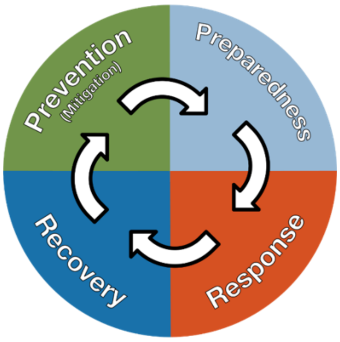


Figure 5 – Emergency Management Cycle

The breakdown of each phase is shown in figure 5 and is as follows:

- Prevention/Mitigation

  This phase involves efforts to alter operations to reduce the risk of an emergency occurring or lessen its potential impact. Examples detection systems or investing in early warning systems.

- Preparedness:

  Before an emergency happens, plans and procedures are created and refined through training and simulations. This includes educating staff and ensuring necessary equipment is available.

- Response:

  During an emergency, the pre-established plans are put into action to protect lives and property. Effective, quick action is critical during this phase.

- Recovery:

  This phase focuses on restoring infrastructure, systems, and normal operations to their pre-emergency state. It involves repairing damage and resuming operations.

This continuous cycle helps organisations build resilience and cope with emergency situation, in an efficient, effective and more informed way. The prevention/mitigation phase is addressed through the systematic fire risk management hierarchy of controls methodology approach that was outlined earlier to minimise the fire risk at the site.

The other three phases will be managed through a comprehensive Emergency Response Plan (ERP). The ERP for this site can be summarised as a document detailing immediate and ongoing actions to manage an emergency incident, ensuring safety, minimising damage, and maintaining operations. It outlines specific steps for various scenarios like fires, defines roles and responsibilities for personnel, specifies emergency contacts, and establishes procedures for actions to be taken immediately, evacuation, communication, and post-incident review. Regular training and updates are crucial to the effectiveness of an ERP.

This plan specifically outlines an Emergency Response Plan detailing the procedures to be followed and actions to be taken by the Operator of this site in the event of a fire involving an outdoor stationary

Battery Energy Storage System (BESS). It establishes key responsibilities of the system operator and provides guidance for coordination with emergency services. This report will apply to all site personnel, contractors, and fire service personnel at the BESS facility. It specifically addresses fire events involving lithium-ion or other electrochemical energy storage systems located in outdoor enclosures.

This site contemplates the use of lithium-ion (Li-ion) batteries for the BESS installation. The key Hazards from a Lithium-ion BESS fire are:

- **Toxic gases:** Hydrogen fluoride (HF), carbon monoxide (CO), hydrocarbons, and fine particulates.
- **Flammable vapour clouds:** Potential for deflagration/explosion if vapours accumulate.
- **Corrosive aerosols:** Acidic condensates may damage eyes, skin, and airways.
- **Stored Energy:** Stored energy within the batteries can be a chemical hazard. When a fire is extinguished, there is still stranded energy within the unaffected cells that can lead to electrical shock.

These hazards vary based on the battery technology used and the operating conditions.

Emergency services pre-incident planning is a key component of a successful emergency response plan. The operator of this site will endeavour to develop, with the emergency services, pre-incident plans for responding to fires, explosions, and other incidents associated with the BESS installations and provide key information to include:

- Awareness and understanding of procedures involved with the BESS facility operations and ERP.
- Knowledge of technology (battery type) and the related hazards and methods for responding to this type of BESS.
- Identifying the locations of all electrical disconnects.
- Understanding that there may be stored or stranded electrical energy in the BESS that cannot be discharged or isolated.
- Understanding procedures related to dealing with damaged BESS equipment.

Fires in electrochemical energy storage systems are often a result of thermal runaway, whereby the batteries create heat that cannot be dissipated, resulting in dynamic temperature increase.

6.2 Health and Safety Legislation

Workplaces in Ireland, are legally mandated to provide a Safety Statement, which is informed by thorough Risk Assessments and includes a detailed Risk Assessment Method Statement (RAMS) for specific high-risk activities. This operation will have a site-specific Safety Statement tailored to the organisation, outlining how health and safety will be managed, risks identified and how controls are implemented. A RAMS will further detail the precise procedures for carrying out hazardous tasks, ensuring compliance with the Safety, Health and Welfare at Work Act 2005. The key Documents and Requirements will include:

Safety Statement: This is a legal requirement for all employers in Ireland under the Safety, Health and Welfare at Work Act 2005. It will be a written, up-to-date, and site-specific document that reflects the actual management of health and safety within the organisation. It will act as a record of the operator's commitment to safeguarding the health and safety of employees and others affected by the work activities.

Risk Assessment: A comprehensive risk assessment will be a crucial part of the Safety Statement process, as it forms the basis of its content. The site operator is legally required to carry out a risk assessment for the workplace to identify hazards and assess associated risks. This assessment will identify potential dangers and the procedures necessary to control them, with the goal of reducing the risk of injury and illness and damage.

Risk Assessment Method Statement (RAMS) - For the high-risk activities, a RAMS will be provided. This document will outline how specific tasks with potential hazards will be performed safely. It will include identifying hazards and risks, implementing control measures, and regularly reviewing these measures.

These documents will work together such that the findings from the risk assessment will directly contribute to the content of the site's Safety Statement, explaining how risks are controlled.

Both the Risk Assessment and RAMS will be treated as live working documents that are reviewed and updated as conditions change or when new information becomes available.

As part of the site's safety statement there will be a requirement to clearly outline the roles and responsibilities for persons responsible for emergency management, noting the primary and secondary contact persons for liaison with the emergency services. Well-defined emergency fire management and procedures are crucial for an effective response during a fire incident. All roles pertaining to emergency management will be clearly understood by all and posted onsite in an area visible to workers, with contact details provided. The success or failure of all emergency plans depends upon effective training, continual review of this response plan, and execution of the response.

A review of this emergency response plan will be conducted and documented at minimum on an annual basis. The plan shall also be reviewed and amended whenever there is a change in facility design, construction, operation, or maintenance that affects emergency response planning. When outside resources are changed or modified the plan shall be reviewed and updated to reflect the changes that may affect this plan.

6.3 Roles and Responsibilities

Overall responsibility for the Emergency Response Plan (ERP) lies with the Wind Farm's appointed Emergency Response Coordinator. The Emergency Response Coordinator or their designee will be responsible for program implementation, including designating evacuation routes and employee assembly points, coordinating severe weather activities, communicating emergency response procedures to site personnel, contracting with emergency response organisations, and contractor coordination.

Specific management personnel will assume leadership roles for emergency responses. The Emergency Response Coordinator/Site Manager will assist in the implementation of this plan by knowing and communicating evacuation routes to workers during emergency evacuation and reporting the status of the evacuation to Tipperary Fire and Rescue Service. The Emergency Response Coordinator is responsible for seeing that this plan is implemented and will appoint the necessary resources to enforce the plan, assure everyone is familiar with this plan and act as a liaison with the fire and rescue service.

All facility personnel/contractors will have the responsibility to immediately report emergency situations to the Emergency Response Coordinator or designee on duty. There will be no delay to report emergency events that require attendance by the fire and rescue services. The Emergency Response Coordinator or designee will notify the control centre / system owner / grid operator as per the Site Emergency Plan. The following principles will be addressed in the Emergency Response Plan:

1. Effective identification and management of hazards and risks specific to the siting, infrastructure, layout, and operations at the facility.
2. Impact on surrounding communities, buildings, and infrastructure.
3. Siting of renewable energy infrastructure so as to eliminate or reduce hazards to emergency responders.
4. Safe access for emergency services in and around the facility, including to energy storage infrastructure and firefighting infrastructure.
5. Provision of adequate water supply and firefighting infrastructure to allow safe and effective emergency response.
6. Vegetation sited and managed so as to avoid increased wild fire and grass fire risk.
7. Prevention of fire ignition on-site.
8. Prevention of fire spread between site infrastructure (battery containers/enclosures).
9. Prevention of external fire impacting and igniting site infrastructure.
10. Provision of accurate and current information for the emergency services during emergencies.
11. Effective emergency planning and management, specific to the site, infrastructure and operations demonstrating a full understanding of hazards, risks, and consequences.

6.4 Preparation and Planning for Emergencies

Pre-planning for emergencies is a crucial element of this Emergency Response plan. The following steps will be taken in planning for emergency situations at the site:

1. The Fire and Rescue Service and other emergency services will receive a copy of this plan and will have participated in on-site familiarisation meetings.
2. All emergency access points to the site shall be identified.

3. An emergency response information notice board shall be maintained at the Operation's Building and readily visible and accessible to all personnel, identifying key contacts for emergencies, a list of personnel certified in First Aid/CPR, and other notices as outlined in this document or as deemed appropriate by the Emergency Response Coordinator.
4. Provision shall be made for non-English speaking workers on site.
5. All road exits are established and posted on the emergency information notice board.
6. Evacuation route diagrams have been documented and posted on the emergency information notice board.
7. Logs of on-site personnel for tracking headcounts during emergencies will be maintained.
8. All buildings and property surrounded by fencing will be marked by signage that identifies specific hazards (Danger, Caution, Warning signal words).
9. Site personnel receive instruction to keep exit routes from the site clear and to maintain ready access to portable fire equipment.
10. Battery Safety Data Sheets (MSDS) shall be provided by manufacturers.

6.5 Emergency Access

The Site is located within a rural setting in southwest Co. Tipperary, approximately 17km north-east of Tipperary Town via the R-661 and L-1154 roads, approximately 21km north-west of Cashel via the R-505, L-5221 and L-5206 roads and approximately 22 km to the south-west of Thurles via the R-661 and R-660 roads. To prevent unauthorized access, the BESS containers will be secured within a dedicated BESS compound with a 2 m perimeter fence and monitored remotely by CCTV.

In the event of an emergency call out, the predetermined attendance (PDA) for The Fire and Rescue Services is for 2 pumps for industrial incidents. This requires the attendance from Tipperary and Cashel fire brigades with 1 Pump (class B appliance) from both stations. If the incident escalates and additional resources are required, Thurles fire station is next on the PDA for attendance at this site. The time for attendance for Tipperary and Cashel appliances is approximately 20 minutes which includes a response time of 5 minutes for fire fighters to mobilise to their respective stations.
Emergency assess to the site will be available through the north, west and east entrances as shown in figure 6 below.

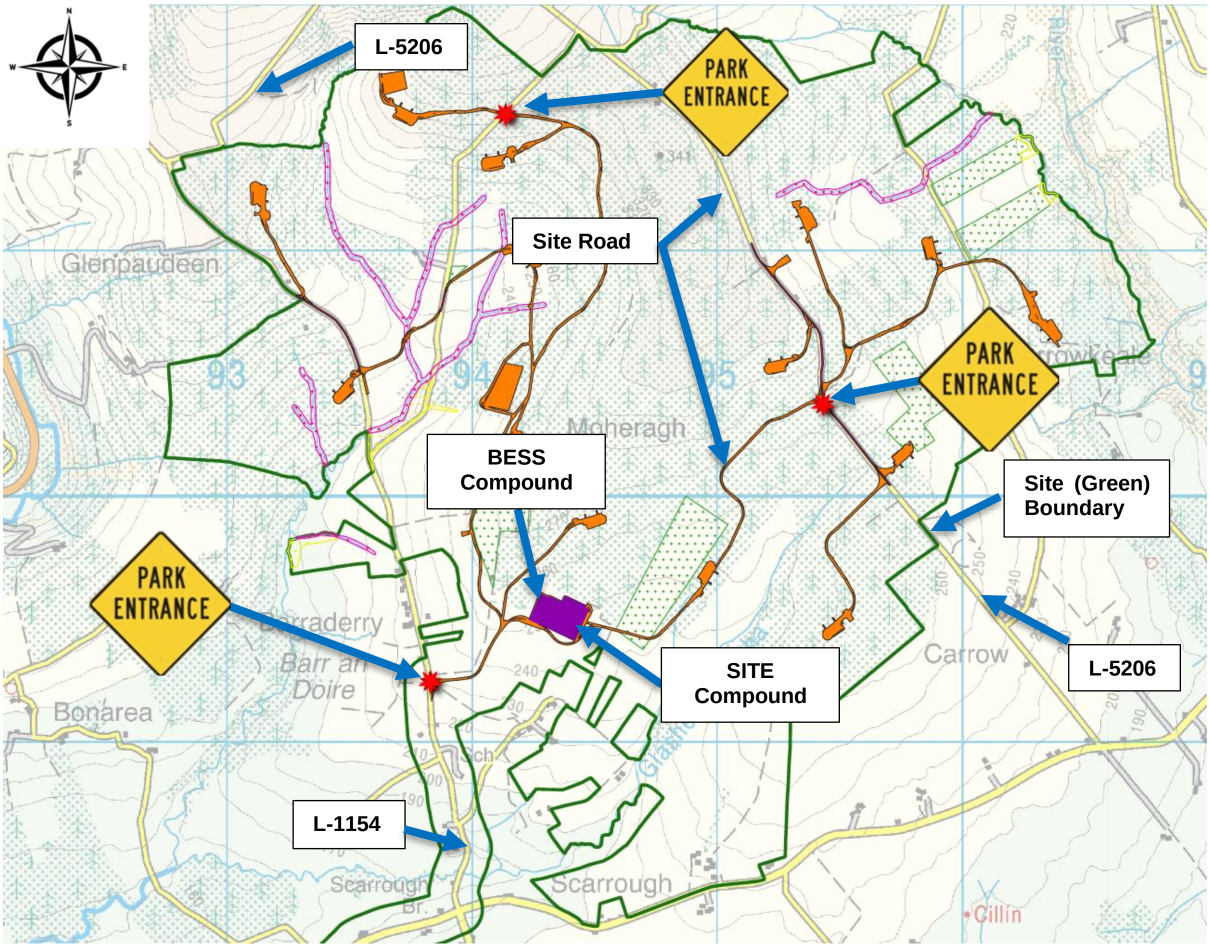


Figure 6 – Site Access

Access will include the following:

- At least 3 separate access points to the site to account for wind conditions/direction.
- Roads and hard standing will be capable of accommodating fire service appliances at 18.5 tonnes and other vehicles in all weather conditions. As such there will be no extremes of grade.
- Roads with passing places suitable for fire service appliances and vehicles.
- The road network on site will enable unobstructed access to all areas of the facility.
- Turning circles, hammer heads, etc. sized to the requirements to B5 of the Building Regulations.

6.6 Emergency Evacuation

External and internal audible and visual (e.g., strobe lights) alarm systems will be established that reflect specific on-site hazard analyses. Personnel will be trained on the significance of different alarms and the corresponding actions as outlined elsewhere in ER Plan. Descriptions of each alarm and corresponding actions will be clearly posted on the emergency information notice board.

Warning systems and alarms will be tested at least every three months or more frequently per manufacturer specifications and legal requirements. Tests will be documented. All site personnel, as well as those offsite who are likely to hear or see an alarm, will be made aware of tests so as not to cause undue concern.

Audible and visual warning devices, as well as addressable identification at control and indicating equipment (fire alarm panels) will be linked to:

1. Battery Management Systems (when a thermal runaway event is identified)
2. Detection and suppression system activation for early warning and timely evacuation in the event of an emergency.

Depending upon the nature of the emergency, weather and/or site conditions, roadways and exit routes as designated on the site map will be used for routes of evacuation.

An evacuation sheet shall be posted and orally communicated to site personnel. The evacuation procedures will be discussed at periodic safety meetings in addition to being covered during new employee orientation. Three evacuation routes A, B, and C are to be provided as shown in figure 7 below.

The prevailing wind direction is also indicated in figure 7 and Appendix B with a Windrose issued by Met Eireann from the closest weather station at Shannon Airport, Co. Clare.

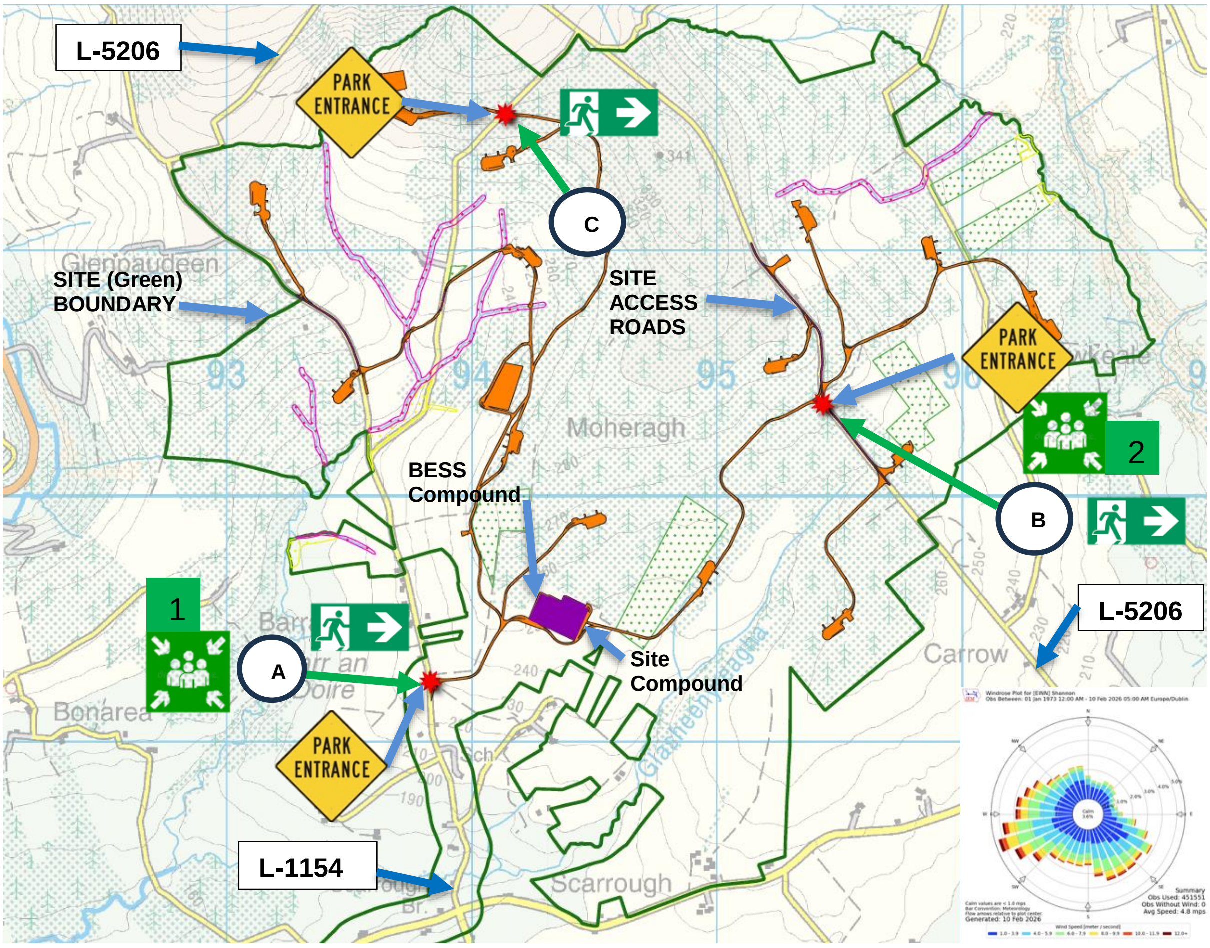


Figure 7 – Emergency Routes and Assembly Points

The location of the Assembly Points 1 and 2 are based on the prevailing wind direction and the proximity to exits routes A and B. An additional exit route will be provided north of the site shown as exit route

C. Personnel will to be aware of at least two exit routes at any point on the site (apart from limited dead-end roads to wind turbine locations) and be familiar with the evacuation routes and assembly points posted in the location indicated on the site map. An Information Box (IB) will be positioned at the Fire Services access points. The purpose of the IBs will be to provide critical information for first responders such as the Emergency Response Plan, to include water supplies for firefighting, drainage plans highlighting any pollution control devices, penstocks etc.

In the event of an evacuation, all personnel will meet at the designated Assembly Point 1 for further information. If the primary Assembly Point 1 point is inaccessible or hazardous, personnel will gather at the secondary Assembly Point 2 and inform the emergency coordinator (if not present) by radio or telephone. Emergency telephone will be installed at both assembly point to aid evacuation and communication.

The emergency response coordinator will inform personnel of a diversion to the secondary Assembly Point 2 by such mean as are available, to include radio or loud hailer. If personnel are unable to make it to the designated Assembly Points, they will seek shelter wherever possible and contact the emergency response coordinator for further instructions. Accountability of personnel shall be of the upmost importance and be conducted in a timely manner. Access points and routes will be kept unobstructed at all times so the emergency services will not be hindered in their operations when responding to emergencies within the site.

6.7 Fire Water

For Li-ion battery fires, water is the preferred suppression agent due to its immediate cooling capacity, availability, and ease of onsite storage and transport. Firefighting foams are not considered to be effective because they lack the ability to cool and can conduct electricity. Foams may also contribute to thermal runaway issues by insulating the burning materials and exacerbating heat rise. Dry chemical powders used in firefighting may extinguish visible flame but, similar to foams, do not provide cooling to heated battery equipment. Thermal runaway inside the battery may continue potentially causing reignition.

Energy storage systems present a unique challenge for firefighters. Unlike a typical electrical or gas utility, a BESS does not have a single point of disconnect. There are disconnects that will de-energise select parts of the system, but batteries remain energised. The following hazards might be encountered when fighting fires in BESSs:

1) Shock or arcing hazard due to the presence of water during suppression activities
2) Related electrical enclosures might not resist water intrusion from the high-pressure stream of a fire hose
3) Batteries damaged in the fire might not resist water intrusion
4) Damaged conductors might not resist water intrusion
5) Shock hazard due to direct contact with energized components
6) No means of complete electrical disconnect due to stranded energy

Due to these hazards, care and consideration should be applied when considering fire suppression by means of water inundation within BESSs. The appropriate use of water as an extinguishing medium should be assessed whether water reacts with the chemistries present or whether it is an appropriate extinguisher class.

The use of a substantial volume of firefighting water is currently recommended in many situations to extinguish fires resulting from incidents involving lithium-ion batteries. FM Global DS 5-33 (Li-ion BESS**)**: 2024 publication, provides loss-prevention recommendations for outdoor enclosures, separation, and protection and while not prescribing a quantity for outdoor fire water flow. The FM guidance recommends planning toward **'**robust water supplies' for extended exposure cooling.

Other international guidance recommends large water densities of the order of 1900 litres per minute for an outdoor (containerised/walk-in enclosures), BESS incident of 1MWh per container/enclosures. This fire water flow reflects current standards, insurer data sheets and fire service guidance focused on cooling with defensive tactics rather than an interior attack.

Several industry and research sources note a firefighting tactic/strategy of allowing the involved BESS unit to burn while using large volumes of water to cool the shell of the unit/container and protect adjacent BESS units and associated ancillary equipment.

A 1900 litres per minute flow is commonly used by utilities and fire services in pre-plans as a minimum for outdoor defensive operations. The fire water requirement for this site is based on this flow requirement and using the appropriate firefighting tactics for this BESS installation. In addition to attacking or cooling the fire involved BESS container, with the necessary flow of water, there can be a requirement to cool exposed BESS containers where radiated heat is a risk.

A hose stream capacity baseline of 1900 litres per minute (lpm) will be required to support exterior cooling and therefore 'defensive operations' employed by The Fire and Rescue Services. This flow requirement will be required for defensive cooling for one BESS container with a power rating of approximately 1 MWh (Mega Watt hour) to cool and control thermal runaway. As the adjacent containers will be positioned with a minimum spacing of 6.0 metres, there will not be a requirement to cool adjacent BESS containers that are not involved in the fire outbreak. Separation distances of 6.0 m and 60 minutes container walls fire resistance (120 minutes between opposing containers) is sufficient to reduce the radiant heat flux, to eliminate the risk of fire spread, from an ignition source (container with thermal runaway) to a receiver, which in this case will be an opposing BESS container unit.

Based on 1900 lpm flow rates, separation distances and an extended period of intervention by The Fire Services of 4 hours a static storage requirement of 500,000 litres of water will provided on site in two separated above ground static storage tanks of capacity of 250,000L (see calculation in Appendix C). The two static storage tanks will be hydraulically connected to allow take-off of all water supply from either tank outlet. An area around both static storage tanks will include a suitably designed hard-standing area at 18.5 tonnes for fire appliances as applied to the access routes. The tanks are positioned on the west and east sides of the BESS compound to take into account alternative wind conditions during the fire outbreak.

The static storage tank outlets will be a maximum distance of 3.0 m from the hard standing to facilitate connection of hard suction pipes. The inlets to the tanks from the water main will be a minimum of 100 mm diameter terminating in a float valve or similar. Pipes will be metal where exposed. The static storage tanks will be monitored for water level. A low-level alarm probe will be fitted at a high-level position, typically at 90% contents of the tank.

Signage in accordance with BS 3251: 1976 will be provided to indicate the location of the static storage tanks. The signage will be located and sized to ensure they are clearly visible from the access route. Signage will indicate “FIRE FIGHTING WATER SUPPLY” and the capacity of the tanks 250,000 litres”.

6.8 Fire Water Contamination and Toxicity

Firewater from a lithium-ion BESS fire will pick up toxic and corrosive by-products such as hydrofluoric acid, heavy metals, electrolytes, plastics, etc. This contamination occurs quickly, even in early runoff. Contaminated water cannot be reused in firefighting streams for health and safety reasons with increased firefighter exposure risks and possible damage to pumps, hoses and nozzles**.** In addition, reapplying contaminated water to hot batteries containers may aerosolize toxic compounds**,** worsening inhalation hazards. The practice on this site will be to comply with industry best practice and to treat all firewater as hazardous waste requiring capture and disposal after a fire incident.

The fire-water retention design for this BESS compound will include capture, contain, and hold contaminated runoff from the worst-credible fire scenarios while keeping it away from drains, groundwater, and off-site receptors. After the fire, the retained water will be sampled, treated, or removed by licensed hazardous-waste contractors**.**

The objectives of the fire water containment are to:

- Contain all firewater and contaminated rainfall from a worst-case BESS fire without uncontrolled release.
- Segment the compound so a single incident doesn’t flood the entire compound or escape the boundary with necessary bunding.
- Provide positive isolation of surface water drains (automatic/manual penstocks), defaulting to “closed on alarm.”
- Be chemically compatible with expected contaminants (HF, metals, electrolytes, plastics by-products) and allow safe sampling, treatment, and removal.

The sizing of the fire water retention capacity is calculated in Appendix D by the addition of the fire flow driven volume and the concurrent rainfall on the catchment. The highest 41-year period of rain fall over a 24-hour period for the area was sourced from Met Eireann’s historical data. The hardstand/roof area for the BESS compound is calculated to be 4,140 m^2 with a runoff coefficient of 1. A 15% freeboard to prevent the possibility of overtopping with the most adverse wind exposure case is not applied as the runoff water will be contained in a sealed tank(s).

Dedicated Firewater Retention Tank(s) below ground, will be provided above ground to provide the most effective and suitable measure for retaining firewater. The tanks will be rendered impermeable by the use of an appropriate liner and integrity tested. All integrity testing of the tanks will be completed by a suitably qualified competent person and be in line with the Environmental Protection Agency's (EPA) guidance.

All the BESS compound drainage systems will divert automatically to the firewater retention tanks on activation of the site fire detection and alarm system. If storm water management is being used for the dual purpose with firewater retention, then the outlet will be fitted with an automatic valve linked to the fire detection system. Automatic shut-off valves will be tested and maintained as per the site's Safety Statement and Maintenance Procedures. The fire water retention tanks will be kept clean, and free of debris.

The bunding of this compound will include low continuous bunds/kerbs at 300 mm around each BESS row, with graded pads sloping toward captured channels. The design joints and penetrations will be liquid tight. Reinforced concrete with chemical-resistant coating/liner rated for acidic water (HF) and solvents from electrolytes will be used. The compound bunding will not be used to provide firewater retention. The primary purpose of a bund is to contain the fire water when cooling is being provided to a container unit.

6.9 Pre-Fire Event Readiness

Before an emergency happens, plans and procedures are created and refined through training and simulations and therefore preparedness. This includes communication, training/educating staff/contractors and ensuring necessary equipment is available.

6.9.1 Communications

Timely and efficient communications are essential to deal with an emergency response situation. All staff and contractors on site shall be provided with handheld radios/phone to enable effective communication. Emergency transmissions will be clearly announced using signal words such as 'urgent' or 'mayday.' These signal words give priority to the radio transmitter to proceed with their message. If emergency radio/phone communications are interrupted or unclear, employees will proceed to the Assembly Points. All hand-held intrinsically safe radios/phones will be recharged daily with back-up batteries ready for use.

6.9.2 Safety Training

Initial training for all site personnel/contractors on the Emergency Response Plan (ERP) will be undertaken upon the commencement of employment or contract. Refresher training of the ERP to site personnel shall be conducted at least annually. Documentation of ERP training will be maintained and documented in the site fire safety register. Emergency evacuation drills will be held at a minimum on a quarterly basis and shall be documented in the fire safety register. At least on an annual basis, the fire and rescue services and other emergency response personnel will be invited to participate and assist with critique of evacuation drills. Table-top exercises will be employed to train personnel with procedures for different emergency scenarios that could be encountered at the site. The site Emergency Response Coordinator and designates will be trained in their specific duties in an emergency situation.

Operator/maintenance personnel will receive supplier/manufacturer approved training on the specific characteristics of the energy storage system. All personnel will be training in the wearing and use of PPE. All training of PPE will be conducted by a competent person and documented in the fire safety register.

6.9.3 Emergency Electrical BESS Shut Down

In the event of a BESS fire emergency, the installation will be shut down immediately to prevent injury, or equipment damage. A comprehensive electrical shut down procedure will be provided ensuring power and isolation is cut to the BESS compound. This procedure will be executed immediately in the event of a suspected fire, alarm action or discoverer of a fire in the BESS compound.

6.9.4 Grass/Wildland

The site around equipment and infrastructure will be free of combustible vegetation with only a ground cover of maintained vegetation adjacent to the BESS compound. Flying embers from off-site fire may inundate the area during fire events. Where fire breaks are required, they will be inspected regularly prior to the fire season and kept vegetation free. Fire breaks will be at least six metres wide. This will also apply to access routes. Grass land fire-fighting tools such as beaters, buckets, knapsack sprayers and pumps will on hand on site and ready to use.

6.9.5 Hot Works, Welding and Open Flame

The Emergency Response Coordinator will be nominated to authorise hot works. This person will have experience and training in the problems associated with hot work and be of suitable status to ensure compliance with procedures. Before any hot work starts, a hot work permit will be obtained from the Emergency Response Coordinator. The permit will not be issued without first considering the significance of any other permits to work in the vicinity. The permit will only be issued for a specific task that is to be undertaken in a clearly identified area. Hot work permits will not be issued for protracted periods and separate permits will be issued for work which extends from morning to afternoon periods.

6.10 Fire Event Responsibilities and Actions

In the event of a fire outbreak, it is essential to act quickly and calmly. The procedures for the assigned persons as outlined in the ERP must be followed immediately. If the BESS facility is staffed or unstaffed, the procedure for a suspected fire event will be similar. If fire or thermal runaway is suspected (visible smoke, hissing, popping sounds, or alarms) treat as a confirmed fire event**.** The following actions must be taken by the Emergency Response Coordinator and designates or Alarm Receiving Centre (ARC) for a fire or suspected fire, immediately:

6.10.1 Fire Event – Actions to be Taken Immediately

1. Raise the Alarm:

(a) Monitor fire detection, smoke, gas, and thermal alarms within the BESS.

(b) Activate site emergency alarm.

(c) Initiate the BESS site's "**EMERGENCY SHUTDOWN PROCEDURE**".

(d) Call the Emergency Services (112 or 999) Fire and Rescue Service immediately. See contact list in Appendix D .

(e) Use the E.T.H.A.N.E. acronym used by emergency services to report the incident.

- E – Exact location: Provide the precise location of the incident on the site.
- T – Type of Incident: Describe the nature of the incident, what is on fire etc.
- H – Hazards: Identify the dangers involved including explosion or vapour cloud etc.
- A – Access: Detail the best and safety routes on the site to the emergency on site.
- N – Nature of Casualties: Report the estimated number of injured persons etc.
- E – Emergency Services: List which emergency services are already in attendance and what additional resources are required.

(f) Notify the system owner / grid operator as per the Site Emergency Plan.

(g) Remote control (if applicable): The ARC will activate remotely fire suppression equipment. Push notifications will be used for systems with remote apps to be sent devices of designated users, allowing them to view system events and potentially initiate actions remotely.

2. Ensure Personnel Safety

(a) Evacuate all staff and contractors and non-essential personnel to the designated assembly points (at least 100 m upwind of the BESS). Ensure the site assembly points are clear and not affected by the incident.

(b) Account for all staff, contractors, and visitors who were working in the site. If any personnel are unaccounted, a communication shall be made through out the facility in attempt to locate the person(s) missing. As the person(s) is equipped with a facility radio, an emergency transmission will be communicated in attempt to locate the person(s).

(c) Deny re-entry to the affected area until the all-clear is given by emergency services when present.

(d) Account for all personnel using the site roll call sheet.

(e) Do **not** attempt to enter or suppress a fire inside a BESS enclosure.

3. Isolation and Hazard Reduction (if safe to do so)

(a) Use the emergency stop switch or disconnect at the main isolation point.

(b) Activate remote or local system shutdown.

(c) Isolate DC and AC electrical feeds via emergency disconnect switches

(d) Isolate and shut down HVAC systems immediately that could spread vapours into buildings or switchgear areas.
(e) Follow Lockout/Tagout (LOTO) procedures to prevent inadvertent reenergisation.
(f) Shut down auxiliary equipment in the fire-affected area
(g) Operators are not to attempt suppression of BESS fires due to risk of thermal runaway, toxic gases, and electrical hazards.
(h) Do not attempt manual disconnection if flames or heavy smoke are present.
(i) Confirm isolation of high-voltage systems with the utility provider.

4. Protect Surrounding Areas

(a) Remove flammable materials from the vicinity if safe to do so.
(b) Close containment doors, fire dampers, or ventilation louvres (if installed and remotely operable).

5. Operator Communication Responsibilities During the Incident

Provide the responding Fire Services' Incident Commander with:

(a) Site layout drawings, including BESS layout diagrams, fire water tanks, access routes, disconnect switches, and hazardous material (e.g., stored fuel, chemicals nearby) storage.
(b) Status of isolation/disconnection.
(c) Details of battery chemistry and manufacturer safety data sheets (SDS) for the batteries and associated chemicals.
(d) Windsock location on site with wind direction and conditions indicated.
(e) Details of the installed fire suppression systems.
(f) Information on monitoring systems (gas detection, thermal imaging).
(g) Maintain communication with the incident commander and supply ongoing technical input.
(h) Prevent unauthorised access to the site perimeter.
(i) Support utility providers in confirming grid isolation and safe restoration.

6.10.2 Fire Event – Tactical Firefighting

When the fire brigade is in attendance at the incident the priorities will be life safety, hazard containment, and controlled extinguishment. A dynamic risk assessment will be conducted by the Incident Commander after liaising with the Emergency Response Coordinator and designates, incident reccy, and consulting with pre- incident plans. A defensive strategy is preferred to allow a controlled burn if fire is inside a sealed container and the risks to the other exposed container unit(s) is low and controlled. This will be achieved by applying an external water spray or mist for cooling the fire involved container, electrical equipment, and exposure hazards. Thermal imaging cameras can be used to monitor heat radiation to adjacent units. Large volumes of water may be required to maintain external container temperatures below critical thresholds for cooling, to prevent thermal runaway spreading to other container units.

The following tactical guidance will apply to a lithium-ion BESS fire:

(a) Establish a safety perimeter around the affected container (minimum 50 m; adjust based on wind and smoke plume).
(b) Use binoculars to determine scene size-up.
(c) Consider toxic gases (HF, CO, VOCs) and apply respiratory protection.
(d) Structural firefighting PPE (turnout gear) with self-contained breathing apparatus (SCBA) is the norm for initial and defensive firefighting.
(e) SCBA is mandatory in or near the hot zone, due to HF and CO.
(f) Use portable gas detection to monitor hydrogen and CO concentrations.
(g) Avoid forcible ventilation unless necessary; venting may release toxic and explosive gases.
(h) Anticipate thermal runaway propagation to adjacent battery modules.
(i) Firefighting tactics in most cases will constitute a defensive strategy (cooling the effected unit, allowing a controlled burn).
(j) Rotate crews to manage heat stress during long-duration cooling.

Gas-tight suits are not normally required for firefighting, because of the reduction in mobility and heat tolerance**,** making hose handling and long-duration cooling impractical. They are not flame-resistant, so they present a hazard in high-heat environments. In the recovery phase where there is no active firefighting, gas-tight chemical suits with SCBA are appropriate under hazmat protocols. Such activities may include, entering confined areas or enclosures with high HF concentrations, handling debris, ruptured cells, or electrolyte spills and sampling and pumping contaminated firewater.

6.10.3 Fire Event – A Vapour Cloud

A Vapour Cloud from a BESS fire is one of the most dangerous aspects of a BESS incident. Lithium-ion batteries undergoing thermal runaway release large volumes of flammable gases (hydrogen, carbon monoxide, hydrocarbons) mixed with toxic and corrosive vapours (HF, VOCs, particulates)**.** These clouds can be invisible and may accumulate in low or confined areas and can ignite or explode if within flammable limits and exposed to a spark or ignition source. In the case of a vapour cloud from a BESS fire the following additional measures will be taken by the fire and rescue services:

(a) The focus will be on containment, dispersion, and monitoring rather than "fighting" the vapour directly.
(b) Evacuate and keep all personnel upwind. Establish an exclusion zone at least 50 m and expand if the wind is calm or gases are pooling.
(c) Do not enter vapour clouds as the cloud atmosphere may be within explosive range at the lower explosive limit.
(d) Use multi-gas detectors (LEL, CO, H_2, HF) and thermal imaging**.**
(e) Establish continuous atmospheric monitoring around the BESS and downwind.
(f) Monitor the wind direction and reposition exclusion zones dynamically as necessary.
(g) Inform the Local Authority if the vapour cloud could potentially travel beyond the site.

(h) Natural ventilation is preferred: allow the vapours to dissipate with the wind. Use large-volume water spray/fog streams (not solid streams) to knock down and dilute vapours, encouraging mixing and dispersion.

(i) Avoid actions that might force vapours toward ignition sources.

(j) Prohibit radios, vehicles, or cutting tools in the exclusion zone unless intrinsically safe.

(k) Use intrinsically safe lighting and communication equipment only.

6.10.4 Post Fire Event – Operators Actions to be Taken After Fire Incident

Even after fire knockdown, re-ignition is highly likely due to latent thermal runaway. A fire watch will be maintained for at least 24 hours with monitoring by thermal imaging. Hazards after a fire will be identified at the time of installation such that recommendations for personal protective equipment (PPE) are available for clean-up crews and hazardous materials (HAZMAT) teams. This may include respirators to protect personnel from toxic gas that continues to be generated from hot cells. The following action will be taken:

(a) Do not re-enter the BESS enclosure until cleared by The Fire Services.

(b) Assist in incident reporting with photos, sensor logs, and personnel statements.

(c) Arrange for safe removal and disposal of damaged battery modules through certified hazardous waste handlers. Care will be taken to ensure that damaged batteries containing energy have been safety de-energized in accordance with disposal procedures, if possible, before handling and disposal. If unable to completely de-energize batteries involved in a fire, care will be taken with handling or dismantling battery systems involved in fires as they may still contain hazardous energy levels.

(d) Coordinate with environmental and hazmat teams to sample air and water.

(e) Do not attempt to restart or re-energize the BESS until cleared by The Fire Service and the equipment suppliers/manufacturers.

(f) Arrange for inspection by the OEM, insurance representatives, and regulatory bodies.

(g) Initiate environmental remediation for contaminated fire water runoff.

(h) Document the incident and initiate a formal root cause investigation.

(i) Update training and emergency response procedures as needed.

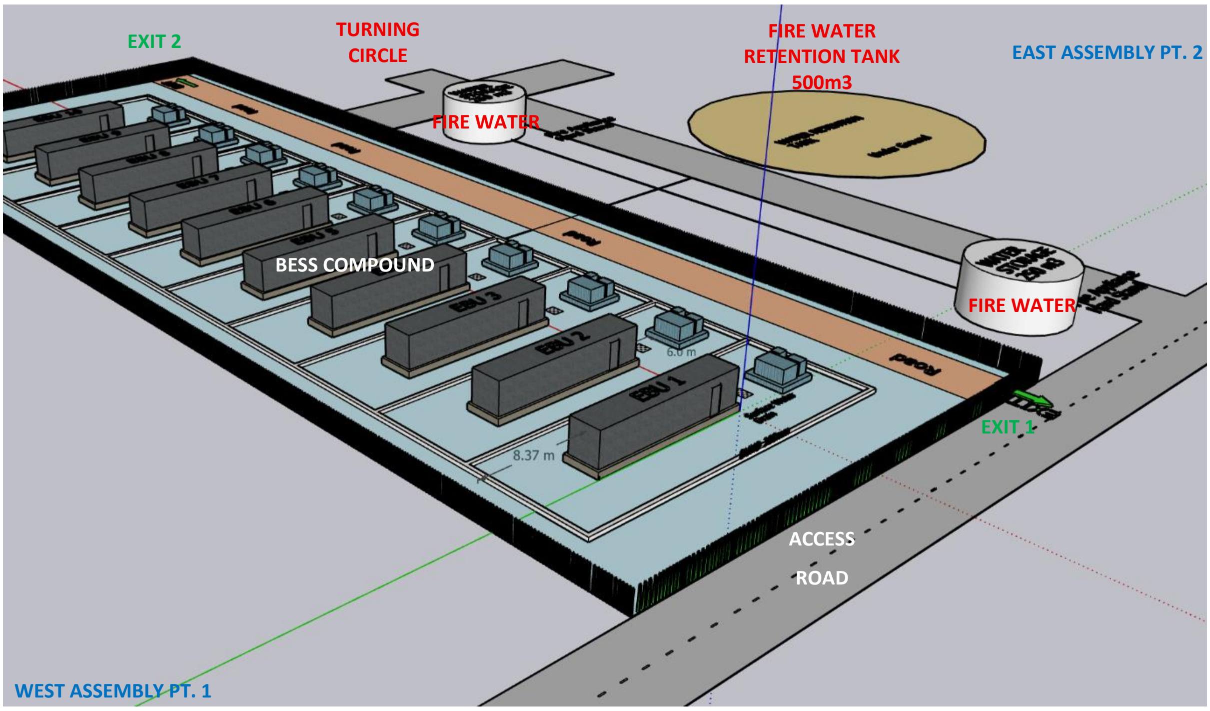
7 SUMMARY

The aim of this Report is primarily to provide An Coimisiún Pleanála with a detailed outline of the analysis, assessments and procedures that will be carried out in the design, construction and commissioning of this proposed BESS installation to mitigate the risks from a fire/explosion emergency. Such mitigation analysis in design, procedures and actions is necessary to protect lives and safety of site personnel, emergency service personnel, to protect the environment, to minimize damage and disruption, and to ensure a swift return to normal operations following a critical emergency. The approach taken is based on the systematic reduction of the risks as far as reasonably practicable, whilst recognising that ultimate responsibility for the safe design and running of these facilities rests with the site operator. This report outlines design factors that contribute to reducing the escalation in the severity of an incident, critical facilities for The Fire and Rescue Service, and safeguarding for the environment through fire water retention.

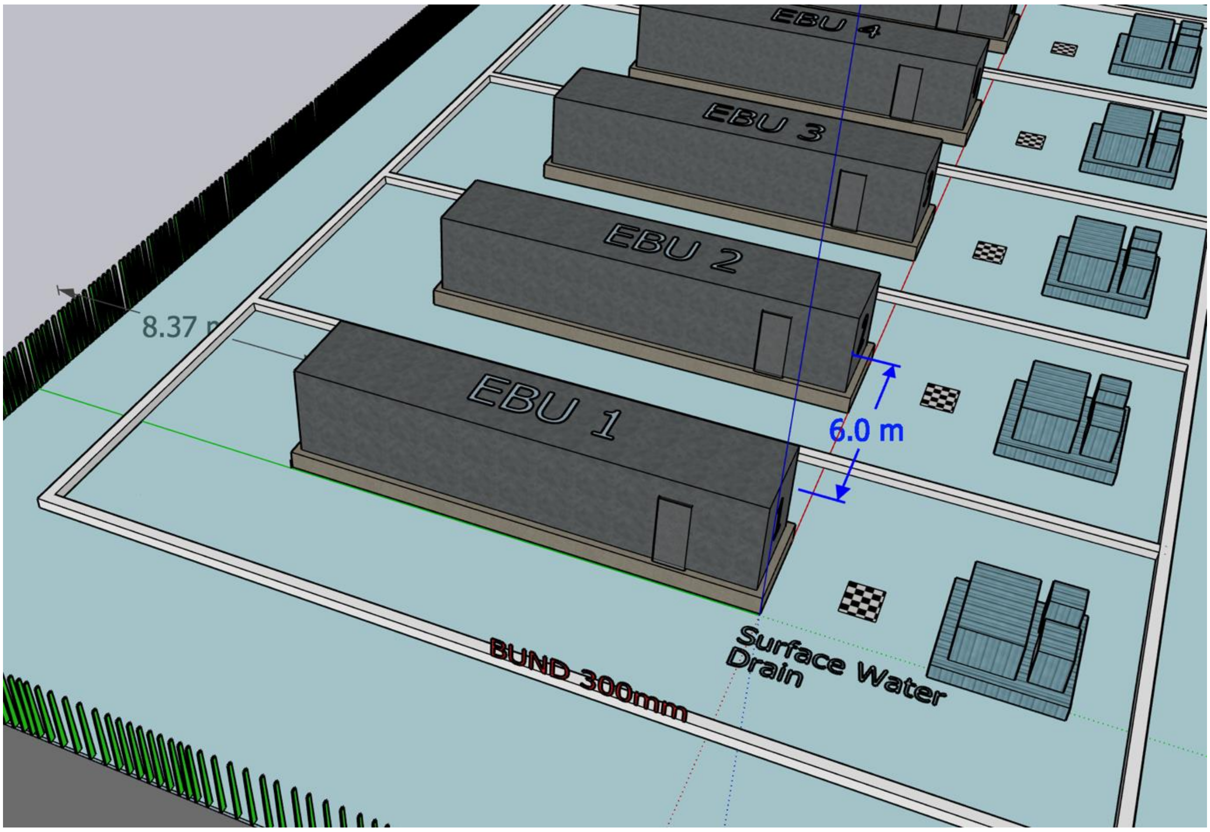
The provision of the large quantity of water in static storage tanks is key to the fire safety strategy for this remote site. Water in abundance is necessary to attempt to control thermal runaway and to prevent fire spread on the site over an extended incident period of 4 hours. Fire water retention is achieved using the BESS compound bunding and a fire water retention tank, which will allow in post fire situations the water to be sampled, treated, or removed by licensed hazardous-waste contractors**.**

The report does not seek to provide a full specification or opinion on the entirety of a BESS system design. Instead, the aim is to limit the content to such matters that directly relate to facilitating a safe and effective response, by the Operator and The Fire and Rescue Service, to a fire or vapour cloud release involving a BESS installation.

8 APPENDICES



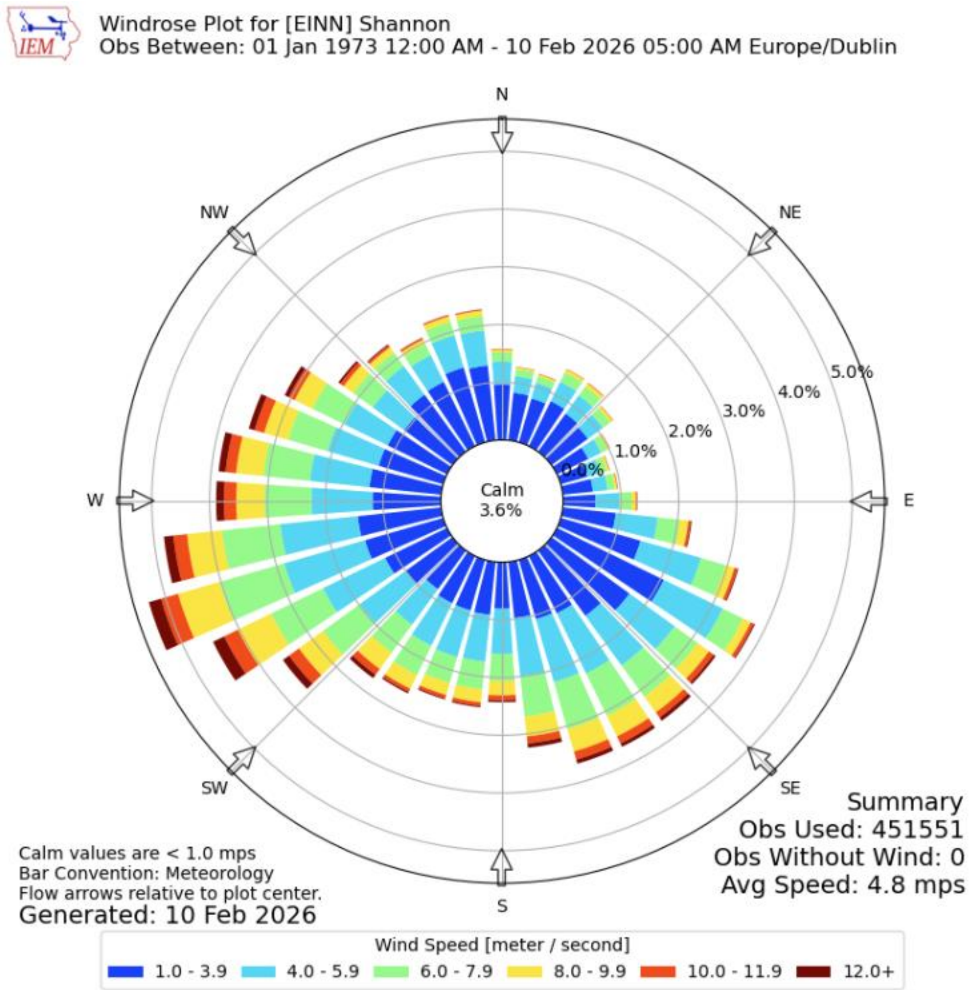
8.1 APPENDIX A1 – BESS Layout Diagram



8.2 APPENDIX A2 – BESS Layout Diagram

8.3 APPENDIX B – Prevailing Wind

The prevailing wind direction is predicted for the site with a Windrose issued by Met Eireann from the closest weather station at Shannon Airport, Co. Clare.



Windrose for Prevailing Wind Direction

8.4 APPENDIX C – Fire Water Flows

The quantity/flow of firefighting water is determined by the formula below which is based on international best practice, where a BESS container is involved in a fire outbreak and a separating distance has been provided to adjacent containers:

Flow = 1900 × $\mathbf{C_f}$ involved + 250 × $\mathbf{C_{ex}}$ exposures

$\mathbf{C_f}$ **– involved**: likely to be involved (fire) containers (initial unit(s)).

$\mathbf{C_{ex}}$ **– exposures**: immediately adjacent containers or critical equipment needing cooling.

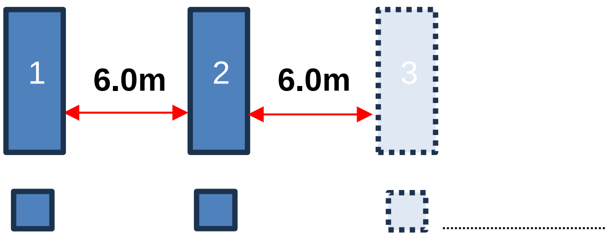
Duration (hours). Plan 3 – 4 h as a baseline for lithium-ion container events (re-ignition/long cooling tails are common). In constrained access or high-energy containers, plan up to 8 - 12 hours**.**

Total Volume (litres)

Volume = Flow (litres/minute) × 60 × Duration (hours).

For the wind farm BESS installation, the total volume of water on site available for firefighting is calculated accordingly with the following assumptions:

(a) Separation distance between the opposing faces of the BESS containers is a minimum of 6.0 m.



Appendix B – BESS Unit Separation Distances

(b) Each BESS container has 60minutes fire rated enclosure to limit the radiation heat flux to apposing containers.

(c) As a result of the separation distances, no immediately adjacent BESS container will require cooling.

(d) Planning an extended period of firefighting at 4 hours duration.

(e) The required quantity of fire water on sited is calculated as follows:

(Fire Container + Exposed Container) x (Fire Duration in Min.)

Flow = ((1900 × 1) + (250 × 0 exposure)) x (4 x 60)) = **456,000 litres = 456 $\mathbf{m^3}$**

8.5 APPENDIX D – Fire Water Retention

The sizing the fire water retention capacity is calculated by the addition of the fire flow driven volume and the concurrent rainfall on the catchment.

$V_{retention} = (Q_{fire} \times 60 \times t_{duration}) + (I_{rain} \times A_{impervious} \times C)$

Where:

Q_{fire} = planned firefighting flow (litres/min) for your worst-credible BESS scenario (e.g., (1900 + 250) litres/min defensive cooling for 1 container/unit involved and 1 container/unit exposure).

$t_{duration}$ = 4 hours worst case for defensive BESS cooling, which will be validate from UL 9540A and CSA TS-800 results of the lithium ion battery chemistry.

i_{rain} = design rainfall during incident (highest 41-year period of rain fall over a 24-hour period for the area sourced from Met Eireann's historical data). The historical records show that the nearest weather station at Cooga, Lower Doon, Co. Limerick (14 km from the site) from the 1^{st} of October 1984 to the 30^{th} of November 2025 that the highest rainfall over a 24 hour period occurred on the 3^{rd} and the 4^{th} of Nov. 2024 at 88.9 mm.

$A_{impervious}$ = contributing hard-stand/roof area routed to containment at 4140 m^2 for this BESS compound.

C = The runoff coefficient will be assumed to be very efficient and equal to 1.0 for the hardstand).

Add a 15% freeboard to prevent the possibility of overtopping with the most adverse wind exposure case (if exposed). Not applicable in this case.

Therefore, the Carrow Wind Farm BESS fire water retention requirement is calculated to be:

$V_{retention} = ((Q_{fire} \times 60 \times t_{duration}) + (I_{rain} \times A_{impervious} \times C)) \times 1$

$V_{retention}$ = ((1900) x 60 x 4) + (0.0889 x 4140 x 1.0) x 1

$V_{retention}$ = (456,000 + 368) x 1 = **456,368 litres or 500 m^3**.

8.6 APPENDIX E – Emergency Contact List

Emergency Contact List	
Fire and Rescue Services	112 or 999
Ambulance Services	112 or 999
Tipperary University Hospital, Clonmel	052 617 7000
Tipperary Town, Garda Station	062 80670
ESB Networks	1 800 372 999
BESS Battery Manufacturer/Supplier	00 - XXXXXXX/086-XXXXXXX
Emergency Response Coordinator	00 - 1234567/085-1234567
Operational Regional Manager	00 - 2345678/087-2345678
Tipperary County Council	0818 065000

END OF REPORT