Battery Energy Storage System Safety Concerns

7000Acres Response to:

Volume 7 Framework Battery Safety Management Plan Document Reference: EN010142/APP/7.13

Volume 6 Environmental Statement Chapter 3: Scheme Description Document Reference: EN010142/APP/6.1

Volume 6 Environmental Statement Appendix 17-5: Unplanned Atmospheric Emissions from Battery Energy Storage Systems Document Reference: EN010142/APP/6.2

Deadline 2 Submission – 14th November 2024

Executive Summary

There have been over 35 recorded serious thermal runaways in Battery Energy Storage Systems (BESS) worldwide. In 2020 a 20 MWh BESS in Liverpool took over 11 hours to contain and resulted in an explosion and release of toxic gasses.

The Applicant has not provided any evidence why a BESS is an essential part of this development.

The Applicant has applied a Rochdale Envelope to this scheme but has not complied with the requirements of Advice Notice Nine, in particular very scant information is provided on the design of the scheme.

The BESS design does not identify how sufficient water to fight a battery thermal runaway will be provided at each BESS location.

The assessment of unplanned atmospheric emissions considers battery fires but does not appear to consider any emissions from a thermal runaway.

Contents

1 Introduction

7000Acres represents a large number of local residents concerned about the impact of the Tillbridge industrial solar NSIP and three other solar NSIPs in the locality. This document identifies concerns over the design and safety of the Battery Energy Storage System (BESS) proposed by the Applicant.

2 National Policy Statements

There are no National Policy Statements that address BESS: battery storage is not included in EN-1 or EN-3. BESS are excluded from the NSIP process and are addressed in the Infrastructure Planning (Electricity Storage Facilities) Order 2020 and determined through the Town and Country Planning Act by LPAs. The Applicant has not provided a clear statement on why a BESS is required to support this solar generation scheme. One of the joint venture partners in this scheme is a partner in the Mallard Pass solar scheme, where a BESS is not included in its DCO. Therefore, a BESS is not an essential element of a solar generation scheme.

3 National Regulations and Guidance

At present the Health and Safety Executive (HSE) has chosen to exempt itself from regulating BESS, choosing to define battery systems as "*articles*". A strong case has been made (Fordham, 2021) that the Control of Major Accident Hazards (COMAH) Regulations should be applied to BESS, as the quantities and types of dangerous substances released during a BESS thermal runaway fall under the aegis of COMAH.

The National Fire Chiefs' Council is in the process of updating its guidance material on BESS Safety (Draft NFCC , 2024). The updated draft guidance includes

recommendations on the quantities of water required to cool a battery thermal runaway and the adjacent area.

4 The Hazard

Li-ion batteries can fail by “thermal runaway” where overheating in a single faulty cell can propagate to neighbours with energy releases popularly known as “battery fires”. These are not “fires” at all, requiring no oxygen to propagate. They are uncontrollable except by extravagant water cooling. They evolve toxic gases such as Hydrogen Fluoride (HF) and Carbon Monoxide (CO), as well as highly inflammable gases including Hydrogen (H2), Methane (CH4) and Ethylene (C2H4). These in turn may cause further explosions or fires upon ignition. The chemical energy then released can be up to 20 times the stored electrochemical energy (Fordham, 2021). In the case of the Liverpool BESS thermal runaway, parts of the container were blown 23m. Li-ion batteries are tightly regulated in aviation, under the category of Dangerous Goods, as even thermal runaways in handheld devices have led to accidents and serious incidents. Two cargo ships have been destroyed in 2023 when thermal runaways in electric cars being transported have led to uncontained fires. The Applicant implies in their documentation that the BESS might be designed to burn out, but no further detail is given.

4.1 BESS Incidents Worldwide

There have been over 35 recorded BESS fires and thermal runaways since 2017. For example, a 20 MWh Liverpool BESS thermal runaway in September 2020 resulted in fire, explosion and release of toxic gases (Merseyside Fire and Rescue Service, 2022). It was theoretically protected by a fire suppression system that failed to activate, but even if it had activated it would have made little impact on the resulting thermal runaway and explosion. BESS are susceptible to “thermal runaway”, the condition when an electro- chemical cell increases its temperature

through self-heating in an uncontrollable fashion and progresses when the cell's heat generation is at a higher rate than it can dissipate, potentially leading to off-gassing, fire, and explosion. Once water was applied to the Liverpool BESS, the resulting run-off contained Hydrofluoric Acid (HF), a highly toxic substance which can dissolve concrete and whose fumes can be fatal to life. The incident released a plume of toxic gas. Efforts to douse the thermal runaway were hampered by the lack of available water from the hydrants (Merseyside Fire and Rescue Service, 2022). In total it took 11 hours to fully extinguish the runaway.

4.2 Fighting a BESS Thermal Runaway

As identified by Fordham, "*extravagant*" water cooling is required for extended periods of time to douse a BESS thermal runaway. To ensure sufficient water is available to fight a thermal runaway, the water should be stored on site, as the small rural water mains cannot be relied on to provide the large volume of cooling water required.

To reduce the risk of an explosion, inflammable gas is best managed by venting, but that releases a toxic cloud.

A planning application for a 50MW BESS (Leeds Planning Application, 2023) was withdrawn by the Applicant when Yorkshire Fire and Rescue raised objections (Yorkshire Fire and Rescue, 2023). Yorkshire Fire Brigade made a number of important points in their letter to the Planning Authority:

- *"The risks of vapour cloud, thermal runaway and explosion are unfortunately very real and are becoming more common as we see an increase in the number of BESS installations rise.*
- *There is currently no definitive or 'preferred' way of putting out a lithium ion/lithium iron fire. There are in effect two main options, one being to let it*

burn, the other being to use significant amounts of water for a protracted period.

- *In this case, should the let it burn approach be taken, it may create a chain reaction from one unit to the next. Therefore, even in this case, there is a high possibility that attending crews will require large amounts of water to protect the exposure risks and disperse the vapour cloud (to ensure it remains below the explosive thresholds). This is likely to continue for the period of multiple hours whilst the unit(s) burns itself out.*
- *Due to the large amount of water required, the Environment Agency will need to be consulted, as the water run-off will be contaminated.*
- *Guidance suggests that lithium ion/lithium iron batteries should be doused with significant amounts of water, and ideally subject to full submersion of the batteries for a period of 24 hours. Taking a two ground monitor attack for 24 hours, would apply 5,472,000 litres of water (to confirm that is approx. 5.5 million litres). The run off of these tactics would likely have a significant impact on the surrounding area, we recommend the Environment Agency consider this impact."*

Case studies of thermal runaways in BESS worldwide are reported (California Public Utilities Commission, 2023) in a US study. Attachment F to the report considers the Victoria Big Battery Project thermal runaway in July 2021. The project is a 300MW/450MWh transmission-sited project installed at the end of 2021. The site design includes 212 Tesla Megapacks, each about 1.5 MW. The thermal runaway was allowed to self-extinguish, which took 3 ½ days. Of note is:

"How thermal runaway spread to an adjacent Megapack was of particular concern as the systems were evaluated under UL 9540A [Note: this is standard quoted by the Applicant in their Battery Safety Management Plan] testing methods and their spacings were designed to mitigate inter-pack propagation. ESV required this issue

to be addressed in Tesla's investigation. ESV also noted that, "Designers are also working to ensure that Megapacks are engineered to fully mitigate the risk of fire propagation from one unit to another under Victorian climatic conditions," suggesting that propagation to the second Megapack may have been aided by weather factors such as wind, ambient temperature, and/or humidity. An investigation conducted by Fisher Engineering, Inc. confirmed that untested wind speeds were a key contributing factor, reaching up to 36 miles per hour during the event compared to a maximum of 12 miles per hour under the UL 9540A testing environment. In an interview, ESV characterized this situation as a "*near miss" when considering an event like this in the context of other times of the year with higher temperatures and stronger winds."*

Other post incident safety investigations (DNV GL, 2020) confirm that technical and safety testing of utility scale BESS is insufficient and lagging the technology.

Another serious incident reported was the Elkhorn Battery Energy Storage Facility (Moss Landing, California) in September 2022. The Elkhorn Battery Energy Storage Facility is a 182.5 MW/730 MWh transmission-sited project installed in August 2021. The facility is designed as an outdoor array of 256 Tesla Megapacks (Monterey County 2022c), similar to the Victorian Big Battery Project. In this case:

"*On September 20, 2022 a fire was detected at about 1:30 a.m. and fire crews arrived shortly thereafter. Fire crews followed a pre-planned strategy, based on their training, to not attempt to extinguish the thermal runaway and to instead focus on protecting surrounding structures with water spray. The fire was extinguished in 5 hours by about 6:30 a.m., then the thermal runaway process continued and released gas (including hydrogen fluoride) into the surrounding community."*

5 Tillbridge BESS Design

The Tillbridge BESS design differs from many other schemes as it is distributed over up to 140 locations within the overall scheme boundaries. Due to the Applicant's byzantine documentation and frequent cross-references, it is difficult to gain any detailed knowledge over how the Applicant intends to implement a BESS: following an exhaustive examination of the documentation it is evident that no detailed information has actually been made available. It is obvious that the Applicant's "design" appears to be more of a concept and is not mature enough to be assessed during this Examination. In effect the Applicant is seeking a blank cheque for a BESS based on some vague details. Although 7000 Acres accepts that applying a Rochdale Envelope to the BESS design is relevant, as battery technology might evolve before a design is developed, the Application fails to comply with PA 2008 Advice Notice Nine, which states:

- *"the level of information required should be:*
  "sufficient information to enable 'the main,' or the 'likely significant' effects on the environment to be assessed […] and the mitigation measures to be described""
- *"the need for 'flexibility' should not be abused:*
  "This does not give developers an excuse to provide inadequate descriptions of their projects."
- *"the DCO application documents should explain the need for and the timescales associated with the flexibility sought and this should be established within clearly defined parameters;"*

The current dDCO and associated documentation clearly fails these tests set in Advice Notice Nine.

5.1 Tillbridge Onsite Water

The Applicant's Framework Battery Storage Safety Management Plan, page 8, states that:

"The BESS Stations will be designed to integrate pressure fed fire hydrants and/or static water tanks (tanks can be integrated above or below ground) for firefighting, depending on available water supply. Water provision will be designated for the cooling of adjacent BESS or ESS equipment. Water tanks will be located at least 10m from the nearest BESS enclosure. Water access points, whether hydrants or tank connections, would be located in consultation with the Lincolnshire Fire Rescue (LFR) to provide redundancy and safe operating distances for firefighters with 30 – 50m, which is considered an optimal safe distance."

Most of the battery units are shown as being located in the middle of fields, with no mains water available, and yet no stored water facilities are shown. Even for an indicative design, facilities for storing water should be included in the draft design. The current NFCC BESS Guidance states that 1,900 litres of water per minute for at least 2 hours should be available; this will be required for each of the BESS modules, although some collective storage may be possible. As Advice Notice Nine requires the Applicant to apply a "*reasonable worst-case assumption*", then the design should include the water requirements stated in the current NFCC Guidance. The Applicant's Framework Battery Safety Management Plan paragraph 7.6.2 references the US National Fire Protection Association standard, NFPA 855, which requires a sprinkler system of 0.3 gallons per minute per cubic foot. All design parameters should comply with UK standards, unless it is stated that foreign standards have been adopted as they are higher.

As an example of the volumes of water required, during a recent Tesla car fire the BEV [battery electric vehicle] battery kept re-igniting, took 4 hours to bring under

control and used 30,000 (US) gallons of water [113,562 litres]. This was for a 100 kWh BEV battery, designed with inter-cell thermal isolation barriers.”

During a thermal runaway, the surrounding area must be cooled to prevent the incident expanding. Therefore, the volume of water held on site must be proportional to the energy storage capacity of the BESS, not just the physical volume of the BESS. This is another reason why the storage capacity of the BESS must be capped, in order to ensure that the water held onsite is sufficient for cooling a thermal runaway and the area surrounding it.

5.2 Emissions

Volume 6 Environmental Statement Appendix 17-5: Unplanned Atmospheric Emissions from Battery Energy Storage Systems Document Reference: EN010142/APP/6.2 defines a thermal runaway but then only considers fires in the rest of the document. The Applicant should confirm the emissions generated by a BESS thermal runaway, as that is the more serious type of incident.

Evidence demonstrates that lethal concentrations of emissions are produced in BESS thermal runaways (Larsson F, 2017). Therefore, the Applicant’s assessment must take account of these real-world examples.

6 References

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