BESS: key risk factors

As the energy crisis continues and the world transitions to a carbon-neutral future, Battery Energy Storage Systems (BESS) will play an increasingly important role. BESS can optimise wind & solar generation, whilst enhancing the grid's capacity to deal with surges in energy demand. BESS are able to store excess energy in periods of low demand and can be discharged into the grid during periods of high demand. Operators are able to receive a higher price per Megawatt hour for their stored energy; this provides financial incentives for meeting surging energisation needs. Combined with the continued fall in Lithium-ion prices over the last decade, this has made BESS an increasingly attractive sector.

So what's the catch? Lithium-ion batteries are seen to be combustible and hazardous. There have been a number of high-profile BESS insurance claims in recent years, so insurers require projects to demonstrate first class risk mitigation and planning.

Thermal runaway & site layout

When insurers are reviewing a BESS project, their primary concern is thermal runaway. Thermal runaway is an uncontrolled exothermic reaction that raises cell temperature and can propagate between cells, occurring when a cell achieves elevated temperatures. Thermal runaway can occur due to mechanical and electrical breakdown, thermal failure, internal/external short circuiting, or electrochemical abuse, leading to a fire.

During the design and planning phase, the project's layout of the battery containers is of crucial importance; insurers would like as much space as possible between battery containers, with a minimum of 4.5 metre spacing. If a project site is constrained by the available space between containers, suitable fire walls between them can help to prevent propagation.

If a project's thermal runaway exposure is not effectively managed, insurers could impose thermal runaway or fire sub limits, higher premium ratings and increased deductibles.

Probable Maximum Loss

Probable Maximum Loss (PML) is an insurer's risk analysis of a project's 'worst case' loss scenario. For BESS projects, the PML is likely to be a thermal runaway event that causes the total loss of one or more battery containers. The PML could be calculated as follows:

- **Loss Scenario 1:** a project has 4 containers with a value of £1,000,000 each. There is less than 1.5 metre spacing between containers, and no fire walls installed. Insurers could foresee in their risk analysis that with inadequate spacing, fire would spread to all 4 containers and would result in a total loss of all 4 containers, valued at £4,000,000.
- **Loss Scenario 2:** a project has 4 containers with a value of £1,000,000 each, spaced 4.5 metres apart. Underwriters could take the view that only one container will be lost if there is a thermal runaway event, as the spacing adequately addresses the chances of fire propagation between containers. The PML is therefore limited to the 1 container valued at £1,000,000.

The lower the PML that insurers think a project has, the more favourable the of terms of coverage available. Early engagement on the project layout is highly recommended, so that developers can be advised on the best separation measures for their site design.

Industry standard: UL9540a

Insurers will always ask for proof that the manufacturers batteries have undergone successful UL9540a testing - the UL9540a is a test method for evaluating thermal runaway fire propagation in BESS. The batteries are tested on how capable their fire suppression technologies are at preventing thermal runaway from spreading. The UL9540a is not a type certification that are typical of wind turbines; however, successful testing demonstrates that the batteries meet the current industry safety standards.

Battery Management System (BMS)

Insurers will review the Battery Management System's ability to identify, control, and eliminate potential risk scenarios. Battery Management Systems should have:

- Recording, monitoring, and analysing of the battery's recharging/discharging rate, to prevent over-charge/discharge - this helps identify abnormal battery conditions and maintain optimum battery health
- Fire detection systems which are industry standard certified, such as NFPA855 or equivalent
- Effective suppression systems that can isolate cells when critical imbalances have been identified, cutting the flow of electrons or ions from the affected cells
- Remote offsite monitoring, allowing for 24/7 surveillance of the site
- Cyber security

Container design

Gases being given off by battery cells are an early indicator that a thermal runaway event is occurring, so early detection of gases is critical before a build-up can become volatile. In conjunction with the BMS, the containers should have some of the following characteristics:

- Sensitive monitoring and sensor systems which can detect gases such as methane and hydrogen
- Ventilation systems which are able to remove flammable gas to prevent a build-up which could result in explosion
- Temperature and moisture management systems which can maintain the optimum conditions for the batteries

Fire response

Emergency response planning should be undertaken in collaboration with local fire services. Insurers will ask for a detailed fire response plan and confirmation that the local fire department is trained to deal with electro-chemical fires, as well as having planned a means of response.

Fire crews may look to contain a thermal runaway event rather than extinguishing it. If a thermal runaway event has occurred, the batteries could be heating up at 100s of degrees a minute. Fire fighters will look to cool the areas around the battery in containment measures, aiming to reduce the radiant heat. The containment measure will allow the battery to burn itself out but not spread to adjacent containers. It can take several days for the batteries to cool and be fully extinguished, so it's important that the site has sufficient access to water sources.

Conclusion

The continued development of BESS will be at the centre stage of a clean and secure energy future. Providing effective risk solutions will go hand in hand with the future development of this sector. Although there are risks and hazards involved, early engagement and thorough planning can mitigate the risks and help maximise the BESS potential.

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