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Design considerations to minimise fire hazards of grid-scale Battery Energy Storage Systems (BESS)

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ABSTRACT

Grid-scale Battery Energy Storage Systems (BESS) facilities are being constructed to support the rapid growth of renewable power generation and the need to provide energy storage / stability for fluctuations in the transmission network due to renewable power generation sources(e.g. solar, wind turbines) and profiles.

As lithium-ion battery technology has developed, so too has the size and capacity of grid-scale BESS. At the core of the BESS are thousands of battery cells, arranged into modules, which are housed in enclosures ranging in size from a single battery rack to large scale containerised systems.

A specific fire hazard for a BESS facility is the potential for a battery cell thermal runaway event. Such events can occur when a cell is over/under-voltage, over-current and/or in a high/low-temperature environment, resulting in venting of flammable and toxic gases into the battery module and enclosure.

Monitoring for, and preventing a battery cell thermal runaway event is largely the responsibility of the batttery system designer. Learnings from BESS fire events, such as the Victorian Big Battery (2021) has led to improvements in battery system design and monitoring. Specific guidance has also been published by the Victorian Country Fire Authority (CFA) regarding considerations in design for emergency response activities.

A number of potential fire hazards also exist in the associated Balance of Plant (BoP) design, and its operation; including the potential for escallation of a BESS unit fire and fire events in step-up transformers which must be considered as part of the overall facility layout.

As such, some of the key considerations in designing a facility layout include separation between BESS enclosures and BoP infrastructure, integrirty of the Battery Management System (to prevent battery cell thermal runaway events), active and passive controls (to manage deflagration events) and required emergency response activities.

This paper will consider learnings from BESS and Substation fire studies based on GPA's experience across a number of projects. We will outline the key factors that must be considered in identifying and analysing the potential fire risks for BESS facilities, applying BESS vendor supplied battery test results, as well as understanding potential for fire events associated with the BoP equipment and infrastructure, such that fire hazards and risks are reduced So Far As Is Reasonably Practicable (SFAIRP).

KEY WORDS

Fire Safety Study, Battery Energy Storage System (BESS)

BIOGRAPHY

Ryan is a mechanical engineer with 15 years of experience in top-tier mining company and as a senior risk consultant at GPA. He has extensive operational experience and successfully led the implementation of an innovative process safety management system at a large mining operation in the Northern Territory, applying a control focused approach to develop and implement a robust and effective system, before joining the risk team at GPA. Ryan has a practical approach towards Risk Management and has undertaken a number of fire safety studies for electrical assets including substations and BESS facilities.

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