Statkraft Fire Safety

The intention of this report is to provide information on how Statkraft manage fire safety across our Greener Grid Parks, with particular reference to Battery Energy Storage Systems (BESS).

1. Greener Grid Park Safety Overview

1.1. Introduction

Greener Grid Parks include synchronous compensator technologies as well as Battery Energy Storage Systems (BESS). Deploying energy storage at scale is essential to facilitate increasing levels of renewable energy on the electricity system, as wind and solar are variable in their output, not always generating electricity when it is needed. Energy storage technologies are a key part of a decarbonised electricity system and their deployment supports Government policy on climate change and energy security.

Renewable energy generation and energy storage are highly complementary technologies, combining to address the issues arising out of intermittency, especially at very high wind penetration levels.

Most grid-scale battery-based energy storage systems use rechargeable lithium ion battery technology. This is similar to that used in smartphones and electric cars but aggregated at scale to deliver electricity storage capability.

As energy storage systems become more common and are an increasingly important part of our global energy transition, it is only natural that communities being introduced to a new technology will have questions. Most important is to address any concerns people may have from a health and safety perspective. Safety is fundamental to the development of energy storage systems. Each energy storage unit has multiple layers of prevention, protection and mitigation systems. These minimise the risk of overcharge, overheating or mechanical damage that could result in an incident such as a fire. A global approach to hazard management in the development of energy storage projects has made the lithium ion battery one of the safest types of energy storage system.

2. Safety Measures

Safety management is a fundamental feature of all lithium-ion energy storage systems. Everything is done to prevent, mitigate and protect against potential hazards. Safety incidents are, on the whole, extremely rare.

2.1. Prevention

The safety systems for a battery storage project operate on multiple layers from the individual battery cell right up to the whole storage system.

The first layer is **monitoring**. Every individual cell is being constantly monitored by automated systems that track current, voltage, temperature and other critical information. These systems are generally known as Battery Management Systems (BMS) and are designed to ensure that the batteries are continually monitored and protected to prevent hazards occurring and to maintain the reliability of the batteries, so they are ready to deliver power to the grid when needed.

As soon as the BMS detects that a specific battery cell, or group of cells, is acting in a way that it should not, it can reduce the flow of electricity through the cell, switch it off or disconnect it completely from the power supply. The BMS also works to identify problems before they occur. It allows the operators to know the state of health of the individual battery cells so that any deterioration or fault can be detected, and appropriate maintenance carried out.

It is important that batteries are kept cool. This is to ensure they are operating safely, and it also improves the performance and operating life of the battery. Energy storage systems contain cooling and ventilation systems. These maintain the batteries at a stable operating temperature and remove excess heat in the event of potential overheating. These systems may use ventilation, air conditioning or liquid cooling to help prevent batteries from overheating.

It must also be noted that grid-scale energy storage systems must apply for planning permission and meet the relevant Authority planning requirements, including any appropriate fire safety assessments.

2.2. Mitigation

In the unlikely event of a problem occurring and the BMS failing to prevent it, energy storage systems have additional design measures such as alarms, fire detection and suppression systems. These suppression systems use techniques such as inert gas, foam suppression, fire sprinklers or water mist etc. to control fires. Battery energy storage project developers also work in advance of the construction of the project with the local Council, first responders and fire services to ensure they understand the kinds of technologies used in a storage facility and how best to work together to deal with any problem that might arise. As battery fires can release flammable gases, it is important that first responders and fire services in an area where a battery energy system is operational are aware of these risks and have plans in place on how to deal with any potential hazards.

The European Advanced Rechargeable and Lithium Batteries Association (RECHARGE) provides technical and legislative expertise on lithium batteries and works to ensure best practices and standards for the use of this technology. They carry out work on lithium ion battery safety and have published a rescue and training manual for first responders and fire services regarding lithium batteries in storage facilities. This guidance is incorporated into the design mitigation strategies for the BESS units.

2.3. Protection

To provide an additional layer of protection, batteries for energy storage systems are also generally housed in separate containers. This reduces the risk of a problem in one container spreading to the rest of the facility.

3. Safety Standards

Our Teams develop and operate BESS units to very high international safety standards. The safety of people working on BESS sites and those living nearby is our highest priority. Lithium-ion batteries are used safely and securely in countries and on countless sites across the world. Properly designed lithium-ion batteries can and are operated safely every day. A key part of ensuring any technology is used safely is to identify any potential risk, no matter how small and ensure it is guarded against. Potential hazards are mitigated to safe levels with careful and thoughtful management and design.

A concern raised by some communities living close to sites identified for battery energy storage units centres around fire safety. In the absence of proper prevention and protection measures a battery cell can become overheated due to a fault or short-circuit. Either one of these could cause what is known as a ‘cell failure’. When multiple cells are present there is a risk of a ‘thermal runaway’ where adjacent cells overheat and fail in a cascading reaction. This can lead to a fire and the release of toxic or flammable gases such as carbon dioxide or hydrogen fluoride.

A short circuit can also happen if a lithium-ion battery is damaged, penetrated or crushed mechanically. This risk is typically highest during shipment and installation. Once up and running the batteries are installed inside flame resistant containers. The interior layout of the container also helps prevent the risk of thermal runaway as batteries are placed in separate racks with spaces in between to prevent any potential fire spreading. This is in addition to housing the battery system in separate containers as outlined in the previous section.

Most importantly, safety is incorporated in the design, manufacture and transportation of the batteries in order to minimise the occurrence of defects which could result in a potential hazard. Lithium-ion batteries are subject to strict testing requirements set out in the United Nations regulations on the Transport of Dangerous Goods (UN/DOT 38.3) prior to transportation. These provide for the safe packaging and shipment of lithium-ion batteries and require a variety of testing under different altitude, vibration, impact and thermal conditions before transportation. Manufacturers of lithium batteries and products using lithium batteries must account for these testing requirements in the design, manufacture and distribution of their products.

There are also many established international standards which lithium ion battery manufacturers systems must comply with to ensure products are designed, manufactured and tested for safety, quality

and reliability. Testing to these standards is conducted by the Original Equipment Manufacturer (OEM) of the batteries. International codes and standards are regularly updated using real world experience and tests to ensure advancement in overall industry efficacy and safety.

Installation of the battery storage system at the site is finalised via site acceptance testing. The purpose of this testing is to ensure that the system is installed properly, and that battery management and protection systems are working properly. This testing is carried out in cooperation between the battery system operator and the supplier.

Lithium-ion battery designers are constantly working to find new ways to ensure the safe use of this essential technology. Further technological advances, such as continued improvements in the safety characteristics of the LIB's as well as development of solid-state lithium ion batteries (which eliminates the liquid electrolyte and will improve design safety further) are also on the horizon.

The international energy consultancy, DNV GL, have also created global best practice guidelines for the safety, operation and performance of grid connected energy storage systems. These guidelines were created in conjunction with numerous industry bodies, associations, universities and technical experts and contain a wide ranging set of recommendations in areas such as storage system design and safety, risk management, testing and coordination with planning authorities which is adopted as best practice within the industry.

4. Statkraft Safety Systems

In addition to the measures set out in Sections 2 and 3, the Statkraft project team develop the following safety documents during the design phase to ensure fire safety risks are considered and mitigated as best as reasonably practicable. The following documents capture the safety requirements of a Greener Grid Park.

1. Fire Strategy Report
2. Fire Risk Assessment
3. Evacuation strategy
4. Fire Safety Drawings
5. A Fire Safety Manual is produced containing design information and operational records. In addition, it will provide a full description of the fire safety design, in regard to the management of the buildings, housekeeping and other functions. Thus, providing a continuously updated record of all aspects of the buildings and the buildings users that affect its fire safety.

5. Specific measures for a Greener Grid Park

As well as the specific fire safety techniques used for a battery energy storage system, safety of the Greener Grid Park as a whole is to be factored into the design. Some of the safety features Statkraft include are:

- The outdoor oil-insulated transformers will be separated from adjacent structures and from each other by Fire Resistance Barriers (Fire Wall), spatial separation, and provided with an enclosure that confines the oil of a ruptured transformer tank for the purpose of limiting the damage and potential spread of fire from a transformer failure. The containment area will be designed to accommodate the maximum spill from a ruptured transformer tank;

- Spatial separation between the transformer and the synchronous compensator building or the facing elevation wall of the building;

- Direct consultation with the fire department prior to construction;

- Automatic fire, gas and smoke detection (beam based);

- Automatic fire suppression (e.g. sprinklers – water and/or gas based);

- Use of fire-resistant non-combustible materials/enclosures;

- Air ventilation and temperature control in battery containers to prevent overheating;
- Regular maintenance and testing of BESS and synchronous compensators;

6. Conclusion

The use of lithium-ion in rechargeable batteries is well established globally. Over the last 50 years it has reached widespread adoption in consumer electronics and in the last decade with electric vehicles and grid-scale energy storage systems. However, the sector is far from static, continually applying new best practices and learning from experience to design energy storage systems that operate as safely as possible.

There are over 8.7 million fully Electric and Plug-in Hybrid cars in use around the world, and over 12 GWh of stationary battery storage in operation (equivalent to approximately 1.2 billion iPhones), yet battery fires are a rare occurrence due to the multiple levels of prevention, protection and mitigation measures that go into their design, manufacture, distribution and operation.

Safety is fundamental to the development and design of energy storage systems. Each energy storage unit has multiple layers of prevention, protection and mitigation systems that minimise the risk of overcharge, overheating or mechanical damage that could result in an incident such as a fire. There are also international best practice guidelines for industry to aid developers in the design and operation of battery storage systems in a safe and secure manner. A global approach to hazard management in the development of energy storage projects has made the lithium-ion battery one of the safest types of energy storage system.