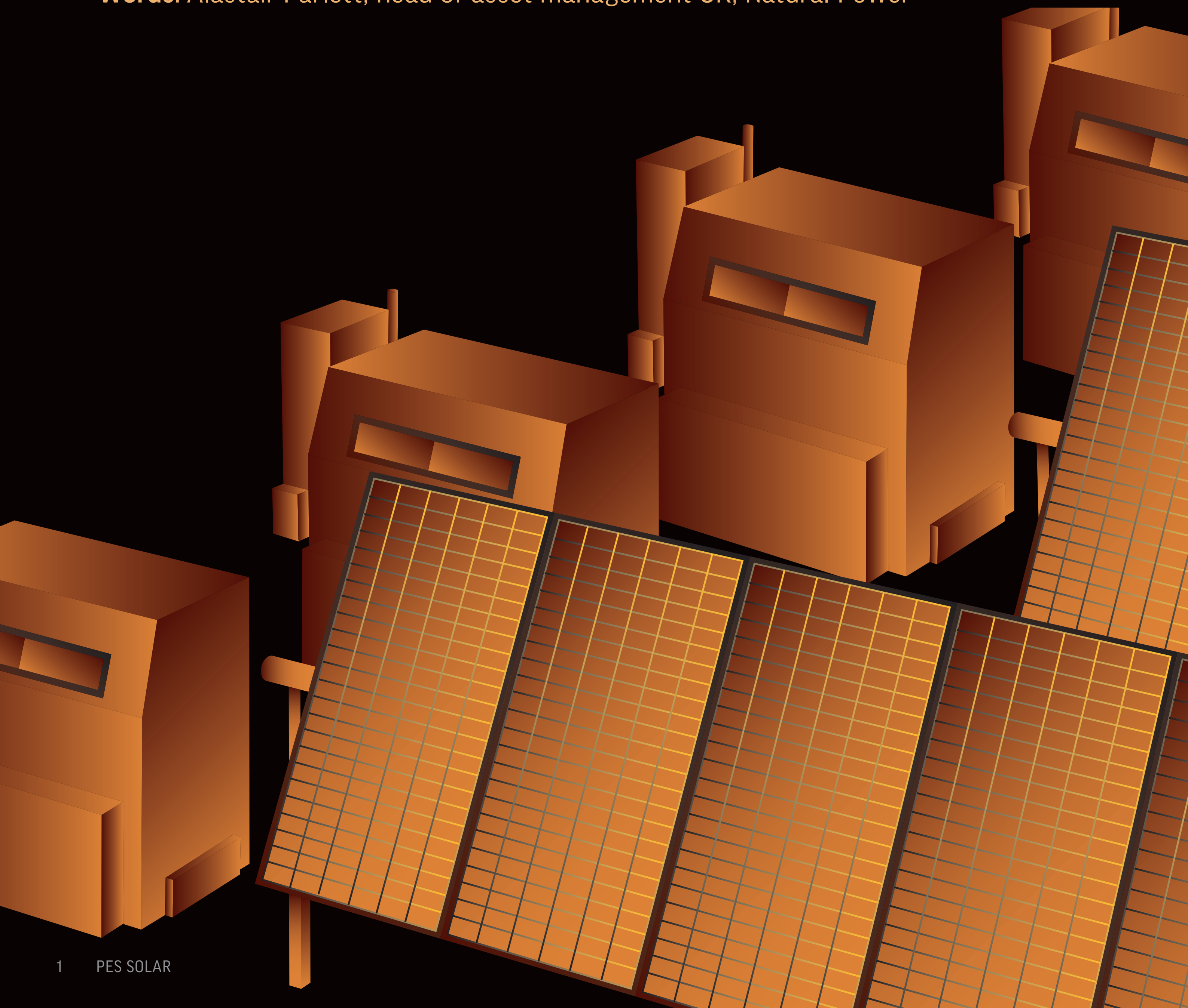
IS KNOWLEDGE REALLY POWER?

Yes it is, if we take what we have learned from asset management in other industries and apply it to operational safety in battery energy storage systems.

Words: Alastair Parlett, head of asset management UK, Natural Power



Utility-scale battery energy storage systems (BESS) are becoming a more common feature of the UK electricity network for the purpose of frequency regulation and balancing. There is also growing interest in the integration of storage systems with renewable technologies such as wind and solar.

This technology has a vital role to play in the global energy mix. It provides an answer to one of the biggest challenges faced by renewable generators, the intermittent nature of supply, offering a way to capture clean energy and balance energy generation against demand.

National Grid has highlighted energy storage as a key growth area and estimates that as much as 30GW installed capacity could be required by 2050.

BESS projects introduce new challenges for operational personnel who may be more familiar with more well-known technologies. However, we can effectively apply the knowledge and experience gained in technologies such as wind and solar to BESS projects. While the use of batteries is nothing new, what is new is the size, complexity, and energy density of the systems, and the Lithium-ion (Li-ion) battery chemistry involved. Since there is a lack of familiarity with BESS technology, there is also a lack of knowledge about and the hazards, electrical and chemical, associated with large Li-ion battery installations. And these hazards can lead to significant fire risks.

These risks are also exacerbated by the fact that many of the new users of BESSs are not energy specialists. Before, these systems would have been used by companies that had an in-depth understanding of their uses and potential dangers. Today, a buyer of a BESS is just as likely to be a property developer, council or university, and they will have a limited understanding of the inherent hazards.

These new and unfamiliar users give us a good reason to identify and look closer at the processes, systems and procedures needed to make sure BESS projects are safe and efficient. We also need to make sure their operation and management are compliant with the applicable legislation. In particular, we will look at how to address electrical safety and emergencies.

Key considerations for operational safety

To effectively manage operational safety, we need to look at four key areas: electrical safety, live working, emergencies, and work control.

Electrical safety

You will typically need to categorise the location of the BESS as a high voltage (HV) substation. This is due to the likely presence of HV switchgear, transformers and cable systems. You must therefore put suitable electrical safety rules and security arrangements in place to make sure the BESS is compliant with the applicable legislation.

Alastair Parlett

This includes the electricity at work regulations and the electricity safety, quality and continuity regulations. Only authorised personnel should have access to the BESS area, so you will need to think about what happens when sub-contractors or others visit. Electrical safety rules must also address the requirements for safety co-ordination across the control boundary with the distribution network operator (DNO), transmission licensee (TL), or another network operator.

Live working

Planned and reactive maintenance tasks associated with the battery installations will require work and testing on or adjacent to live low voltage (LV) apparatus. Only personnel qualified to do so should carry out these tasks. They should complete their work in accordance with specialised procedures and electrical safety rules. They should understand BESS technology; operating and maintenance procedures; and the application of the electrical safety rules. This will require formal training and authorisation.

Specialist work procedures will require the use of live working techniques, tools and equipment, including suitably rated arc-flash personal protective equipment.

In addition, the weight of individual battery modules (the weight of a 'cell' may be 30-40kg each) means that personnel should use suitable lifting equipment to remove or replace battery modules.

Preparing for emergencies

There is a risk of fire in battery systems. 'Thermal runaway', a cycle in which excessive heat keeps creating more heat, is the major risk for Li-ion battery technology. It can be caused by a battery having internal cell defects, mechanical failures and damage or overvoltage. These lead to high temperatures, gas build-up and potential explosive rupture of the battery cell, resulting in fire and/or explosion. Without disconnection, thermal runaway can also spread from one cell to the next, causing further damage.

Added to this, battery fires are often very intense and difficult to control. They can also be very dangerous to fire fighters and other first responders because, in addition to the immediate fire and electricity risks, they may be dealing with toxic fumes and exposure to hazardous materials.

Although a regular planned inspection and maintenance programme and fixed fire suppression systems provide effective mitigation, the fire risk assessment for the location and consultation with the local fire and rescue service should also inform the emergency response plan (ERP).

Two things are essential for early intervention in the case of emergencies: monitoring and immediate response. You should have continuous remote monitoring by a 24-hour control room (which may also act as a primary point of contact for stakeholders), and you need to have staff available and ready to go to a site immediately if there is an emergency.

You also need to regularly test ERP and emergency response procedures to make sure they are effective. This should take the form of exercises involving key stakeholders.

Work control

You need a robust work management process in place to make sure there is a safe system of work and that any work is carried out in accordance with health, safety and environmental legislation. This work management process will need to include access control procedures as well. A wide range of issues need consideration here, and the management systems and competency of personnel are important.

The work management process should ensure that:

- the work is clearly specified;
- only skilled personnel perform the work;

- suitable and sufficient risk assessment is performed, and method statements produced;
- there are appropriate control measures implemented;
- personnel are given the relevant and correct information to carry out the work safely;
- the work is not interrupted by or disrupts other work;
- monitoring and control are in place for high-risk tasks, for example, live working on LV apparatus.

Conclusion

We have identified that there are a number of key considerations when operating a BESS project, especially when it comes to management and safety.

Areas that house BESS projects are typically classified as HV substations. As such, access to and work on the BESS should be subject to suitable electrical safety rules, and only authorised and trained workers should undertake any work that's needed on a BESS. Additionally, live working on and adjacent to LV apparatus is necessary and needs specialised procedures.

Emergency preparedness should include procedures for dealing with Lithium-ion battery fires, and 24-hour monitoring through a control room should ensure early intervention in emergency. Supported by local resources, including HV support, personnel should be available to go to a site promptly in an emergency.

You also need a work management process to ensure compliance with legislation and the implementation of safe systems of work.

Experience suggests that systems and processes developed for use in the operation and maintenance of established renewables technologies, such as wind, are readily applicable to BESS projects, following suitable training for personnel. As a result, from an operational safety perspective, operators can apply common systems and processes to projects where BESS installations are integrated with other technologies, or to standalone BESS projects.

What is a BESS?

Battery energy storage systems (BESS) store energy via the use of a battery technology for it to be used at a later time. The BESS can be charged by clean electricity generated by a renewable source such as solar. Energy storage plays an important role in creating a more flexible and reliable grid system. For example, when there is more supply than demand, such as during the night when low-cost power plants continue to operate, the excess electricity generation can be used to power storage devices.

Types of BESS

BESS's use electro-chemical solutions and include some of the following types of batteries:

- Lithium-ion: these offer good energy storage for their size and can be charged/discharged many times in their lifetime. They are used in a wide variety of consumer electronics such as smartphones, tablets, laptops, electronic cigarettes and digital cameras. They are also used in electric cars and some aircraft.
- Lead-acid: these are traditional rechargeable batteries and are inexpensive compared to newer types of batteries. Uses include protection and control systems, back-up power supplies, and grid energy storage.
- Sodium sulphur: uses include storing energy from renewable sources such as solar or wind.
- Zinc bromine: uses include storing energy from renewable sources such as solar or wind.
- Flow: flow batteries are quite large and are generally used to store energy from renewable sources.

About Natural Power

Natural Power is an independent consultancy and service provider that supports a global client base in the effective delivery of a wide range of renewable projects including onshore wind, solar, renewable heat, energy storage and offshore technologies. It has a global reach, employing more than 400 staff across 11 international offices. Its experience extends across all phases of the project lifecycle from initial feasibility, through construction to operations and throughout all stages of the transaction cycle.

www.naturalpower.com
www.twitter.com/Natural_Power
www.linkedin.com/company/natural-power