ENERGY STORAGE SOLUTIONS

Aiming to be carbon-neutral is a huge undertaking, but one that governments worldwide are taking seriously, as they announce their ambitious targets to achieve this goal.

Using renewable energy such as wind and solar, plays a significant role in meeting this undertaking, but the need for a consistent, dependable source of power that can cope with the fluctuations of Mother Nature, has led us to focus on energy storage solutions(ESS).

Here we look at the development of ESS and the role of battery management and power control to provide solutions for today's requirements.

ESS - What is it and what's driving its development and advances?

Put simply, energy storage solutions are systems that capture energy for use at a later time. It's mainly Government regulations that are driving the advances in this area, such as Europe's new climate target to have 40% renewable energy sources by 2030, China, who still invest in coal, wanting to achieve carbon neutral before 2060 and the US Department of Energy looking to drive a decarbonised electricity grid by 2035.

We've also witnessed the significant rise in energy prices, which has also been a key driver for the need for energy storage.

As a result of these drivers, there's also been push in technology development, especially in the field of battery management, which as well as seeing a reduction in cost, has increased the capacity of energy that can be stored in battery systems.

So, ESS are big battery solutions - but why is battery management so important when it comes to this type of technology?

People think that ESS is just a battery system, but it's more than that - it's a whole set of subsystems. For example, that's why a battery management system (BMS) is so important, it's a way to monitor and manage the whole systems to ensure you optimise battery efficiency, whilst keeping the system itself, safe. Monitoring the battery pack to protect it from damage, help extend its life and operating within its safety limits is just one facet of a BMS.

How is ESS vital for the commercial sector?

The trend towards renewable sources is a huge step forward, but they can have limitations, such as only generating electricity under the right conditions – which is a drawback when demand is high and there's no wind or sun! This means that on average wind and solar are only productive for 35% of the time, conversely when electricity demand is low, grid operators sometimes need to switch off their wind farms. That's why grid frequency balancing, as it's called, is critical to maintaining national power supplies. This is where ESS play an important role in enabling power grids to function with more flexibility and reliability.

An example of a commercial energy storage solution is the container-based system often seen near wind and solar farms. It's not just a battery system, but comprises of 3 main subsystems:

1. The battery management system - for monitoring and managing efficient control and to optimise battery efficiency.
2. The energy management system - that includes all kinds of functionality, including electronics, to maintain the optimal and safe operation of ESS, including utility interfaces as part of a grid.
3. The power control system - which controls the output of the ESS and by doing so limits the cost of potential additional equipment, needed for the electricity grid.

The output generated from the system has to rely on regular frequency and voltage, to make sure that the energy inserted into the grid is compatible for everything. The last thing that grid operators want is grid shutdowns, so it's important to maintain efficiency and reliability of the systems.

What are the interests in ESS solutions for residential users?

Increasingly the same principles apply for residential users. Electricity isn't always used at the same time that it's generated.

We now see an increasing amount of solar panels being used, especially in Europe and Japan – on rooftops, parking

garages, and on our buildings. In the past, it has often been the case that you can sell back solar power to the grid, but now more and more governments and utility providers are phasing this out, so we need to be able to store energy too.

For example, ESS uses the same technology that is driving the latest generation of electrical vehicles (EV), charging an EV using a battery management system, which communicates with a home electricity system. The battery management system being used with EVs are becoming the brain of the car and an essential part of ESS for residential users.

Is there a role for ESS to play in the increasingly intelligent smart home?

Energy storage systems are becoming part of the smart home, communicating with the rest of the building.

This means that all the subsystems need to communicate with each other well, not only the battery storage system but also the inverter, switch panel, appliances, security system etc – again you need a battery management system to monitor them.

With all of these systems communicating with each other and sharing power, so that everything needs to be connected, how is the development of ESS changing connector design?

ESS, as discussed is all about communication, control and distribution of power. The same principles apply for connector design, but for ESS certain aspects are more important to ensure reliability of the whole system. ESS is a good example of technologies from different of sectors, like automotive or industrial, coming together. System designers and component engineers use the best of both worlds.

For instance, commercial ESS in remote locations need to run and operate for many years, so performance and reliability is key. A false meter reading is a costly error, especially if you need to send resource out to check. Even though typically these commercial storage systems are container style applications, they're protected by a metal case and are often air-conditioned because design engineers don't want to take the risk. They still see the need for sealed solutions to cope with potential moisture in the application, plus even in remote locations there is a need to deal with micro vibrations. When it comes to power, you need the right creepage and clearance distances for your power to connect, so there's not a need to go very small, in fact there's a trend to go larger to increase distances. A lot of component engineers look at the automotive interconnects markets, where a lot of the battery management developments are coming from. Robustness is key, and automotive interconnects need high performance, especially with regards to vibration resistance. It comes down to the fine details of an interconnect having the right amount of plating, the right porosity, even the right shape of the pin tip - that's what design architects and component engineers are looking for.

When it comes to designing solutions for ESS are there differences between regions?

Let's look at the battery pack itself, it's typical construction is based on a couple of cells being connected. The predominant system architecture to connect those cells in Asia is by means of a flexible printed circuit, which is lightweight, easy to assemble and cost effective. Until recently, the US and Europe were both focusing on discrete wire solutions, typically coming from the automotive area where discrete wire is a very common application. This increases the wire complexity, especially if you have more functionality, like control. So, we see it migrating, more flexible circuit architecture is being used in Europe and US, so that there's a kind of combination between flexible printed circuits with discrete wire, that requires flex to wire or wire to flex and connectors. Yes, there are differences, which is highly dependent on the system architects and what his or her preferences are.

What is the future of ESS? What trends are we expecting to see for energy storage solutions?

The obvious ones potentially is that we will see decreasing costs. The cost of manufacturing, plus the cost of installation is expected to reduce due to better building practices, helped along by advancing technology and economies of scale. We can also expect to see an increase in energy density, as already experienced in the automotive sector, where we see the battery capacity increasing. As a result, the amount of energy that we can store in a given volume of mass will increase as technology advances, alongside the increasing use of software and data analytics.

ESS will also continue to grow with the government's initiatives, which will lead to more energy and energy storage systems. It will also expand into new markets. We have seen the battery energy storage systems being used in automotive, in residential areas and in commercial and robotics. In the future, there will be a stronger focus on sustainability due to battery materials being mined etc, so with these environmental concerns there is a focus to look for new technologies to store energy.

Energy storage solutions are here to stay and play an enormously important role in our quest for more sustainable energy use for applications, not just commercial, but domestic and beyond - helping to drive technology and innovation.