Industrial power storage systems: the technology makes all the difference

All power storage systems allow you to store energy for later use as needed, regardless of when the power was generated. However, differences in functionality and technology have considerable impacts on the actual use and economic efficiency of such systems. PES brings you the latest up to date information to help you make your choice.

In conventional power storage systems, cells are connected in series. Since it was technically impossible to change this until recently, this concept has remained unchallenged for too long. The possibility of connecting storage system cells entirely in parallel marks a real paradigm shift for power storage.

"To understand the extent to which parallel connection has affected and indeed improved the design, operation and performance of a power storage system, you need to look at the numerous problems posed by series connection," explains

Wolfram Walter, the inventor and developer of parallel connection in power storage systems and Managing Director of ASD Automatic Storage Device GmbH (Umkirch, Germany). “Because the fact that all of these problems are solved in one go really underlines the innovative advance made here.”

Problems with conventional power storage systems

When configured and designed with series-connected cells, power storage systems only function at their best when matching battery cells are installed. Matching here actually means almost identical; that is to say that the cells used are from the same batch from the same manufacturer, are the same model and have an identical internal resistance, state of charge and state of health.

When new and equipped with cells which fulfil all these requirements, a series-connected storage system functions smoothly – at least at first. For with every single charge and discharge process, the storage system moves further away from the ideal conditions described above. Each cell used in the storage system undergoes its own individual ageing process, which means that the state of charge and state of health of cells within a storage system gradually vary more and more. The usable capacity of the overall system therefore constantly and significantly decreases once commissioned.

The weakest cell determines overall performance

This is because the weakest cell of a series-connected storage system disproportionately affects the overall performance of the entire system. If a single cell in the system is operating at only 60% of its initial capacity, for example, then the capacity of the entire series-connected cell block also drops to 60% – altogether irrespective of the condition of the overall system. The first battery cell to reach its 100% full charge terminates the charging process of the overall system; otherwise, that cell would be destroyed.

The same applies to the cell which reaches its final discharging voltage first. It stops the entire block from discharging, likewise in order to avoid being destroyed. As the cells gradually arrive at different states of charge and health, a block is more likely to run into difficulties the more charging cycles it has completed.

The useable capacity in the system therefore steadily continues to decrease. If a cell has lost so much capacity that it significantly limits the system, it cannot be exchanged for a new cell due to the requirements of the system, as then neither the capacity, nor the internal resistance nor the state of health of the new cell would match the older cells remaining in the system.

“A system repaired in this way will never function properly again. The worst-case scenario here would see the failure of a single cell render the entire storage system not just sluggish but in need of being replaced in full,” says Wolfram Walter. “This fundamentally calls into question whether it is worth investing in series-connected power storage systems at all.”

Designing within tight parameters

Direct current from battery cells must be transformed into alternating current or alternating voltage in order to supply downstream systems and consumers from a stationary battery storage system.

The inverter installed for this requires a specific voltage on the battery side, which is typically between 24 and 60 volts. This voltage can be attained with a chain of around 14 to 20 cells, depending on the cell chemistry and the type of inverter used. This significantly limits the capacity design of storage systems – both fundamentally and subsequently.

Once a conventional series-connected storage system has been designed, it is practically impossible for it to be further adjusted or subsequently scaled, as the set input voltage of the inverter also determines the minimal and maximal number of cells.

“Even foreseeable or planned changes that exceed the original output or capacity of a storage system whose size has already been configured cannot be achieved in a way that will last using conventional technology,” adds Wolfram Walter.

The solution: connect cells in parallel

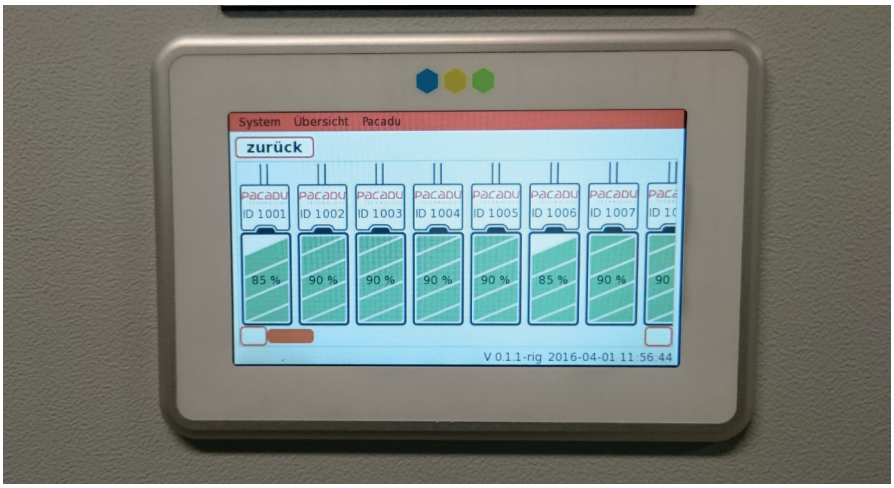
The possibility of connecting cells in storage systems in parallel creates considerable freedom in the choice of cells and the composition of batteries. In contrast to other storage systems, it is no longer necessary, for example, to install matching cells with identical states of charge and health – quite the opposite: Almost any cell can be connected. As the circuit board is mounted onto one or multiple cells connected in parallel, each one can be controlled separately and adjusted by inputting a few parameters into the connected cell. This control method makes it possible to combine completely different cell types, capacities and technologies in one power storage system.

The second significant advantage of the technology used here, known as Pacadu, is its scalability: It not only creates the general possibility of easily increasing or reducing battery size, without interrupting operation, at any time and at virtually any point after being commissioned, but also offers reserves for both capacity and output. No other power storage system offers this kind of flexibility.

Power storage system in action: offshore platform

The self-sufficient and thus unmanned gas processing platform P11-E from Oranje-Nassau Energie B.V. (ONE B.V.) is located approximately 50 km from the Dutch coast. Up and running since November 2016, this gas processing platform is one of the first platforms to be powered predominantly by renewable energy. An ASD power storage system connected in parallel works in harmony with the photovoltaic installations and wind turbines there.

In addition to production facilities, the platform is furnished with a shelter for eight people, a helicopter landing deck and a five-tonne crane. The continuous load from consumers is around 2 kW; power is produced by five wind turbines, each with an output of 1 kW, and a solar installation with an output of 15 kWp. If the PV installation and wind turbines fail to supply enough power, a power storage system



controlled by Pacadu with a capacity of 192 kWh and an output of 60 kW supplies the platform with power.

In this off-grid system, a diesel generator only steps into function as a substitute grid and charge the power storage system during periods of calm or if sunshine hours are limited. The output of the diesel generator had to be 60 kW so that it is capable of supplying the fire extinguishing system with sufficient power, should an emergency arise.

The power storage system has been specially designed for an output of 60 kW – which is exceptionally high given the base load of around 2 kW– in order to keep the operating time of the diesel generator as low as possible for each charging process. This is because the economic operation of the generator reduces consumption, saving costs in several respects – not least because the diesel consumed must be delivered by a supply vessel.

An extraordinary system for an extraordinary project

Operating a platform in the North Sea – especially an unmanned platform – requires extremely reliable equipment. After all, the autonomous operation must be able to run without any interruption.

The power storage system meets this requirement and as a result, there is no need to keep back-up equipment in reserve: This is only possible by connecting the battery in parallel, which maintains the capacity and performance at a consistently high level by preventing any weak modules from impairing the entire system, as explained above.

What is more, the storage system allows for so-called hot swapping, where system components or modules can be exchanged during ongoing operation. “Interfaces for platform control even make it possible to take readings and perform maintenance remotely,” explains Andreas Jansen, Control and Automation Supervisor at ONE B.V. “From the commissioning of the platform, the ASD storage system has functioned as steadily and resiliently as expected.”

Every industrial power storage system has unique requirements

Any industrial enterprise planning to purchase a power storage system will have little use for a run-of-the-mill standard storage system. After all, for a storage system to be economically viable, it needs to be the correct size to meet the needs of the business. And this design specification depends on the purpose of the storage system – in the case of the power storage system on the offshore platform above, for example, this meant an unusually high output despite comparatively low base load.

The fact that a power storage system means that less power needs to be bought from the public power grid, if a source of energy is available, is one advantage. Yet, even if no power is generated on site, a power storage system can be very useful in other ways, such as when a company wants to be able to independently supply power to core processes for a certain amount of time. To give a simple example: if a power storage system prevents machinery critical to production from coming to a standstill, such an investment would pay off after the first power outage.

Power storage systems can also prevent major damage and extensive clean-up work, as would occur if an injection moulding machine came to a sudden halt. Any process where a disruption would be unacceptable or directly lead to significant costs must be identified and taken into consideration when designing the storage system.

What is more, power storage systems safeguard power supply as they can quickly and easily cover any temporary increase in demand. “This kills two birds with one stone because, in addition to safeguarding supply, storage systems also enable what is known as peak shaving, i.e. avoiding peak loads when drawing power from the public grid,” explains Wolfram Walter.

He believes power storage systems will more than likely grow in importance and popularity. “After all, they help balance power generation and consumption, and in doing so, they offer more than just the potential to reduce energy costs.”

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