Latest Developments in Battery Connector Technology for Commercial Energy Storage Systems

New Components Can Lower Applied Costs, Improve Safety and Enhance Operational Efficiency

A JAE White Paper

Commercial Energy Storage Systems

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According to a 2014 report by research firm *IHS*, the grid-connected energy storage market will increase from 340 MW in 2013 to more than 6 GW in 2017. A February 2014 *GTM Research* report, *Distributed Energy Storage 2014: Applications and Opportunities for Commercial Energy*, estimates that between 2014 and 2020 distributed energy storage deployments in the U.S. will reach 720 MW – a 34 percent cumulative annual growth rate.

A growing market spurs innovation and this JAE white paper focuses on one such innovation in the energy storage systems market: next-generation battery connectors. In this white paper we compare old-style battery connectors to today's newest components –connectors specifically developed for use with commercial energy storage systems. In each instance we'll consider cost, safety, operational efficiencies, and other factors.

Cables and bus-bars: proven, low-tech, low-cost components

As any design engineer knows, commercial energy storage systems typically consist of racks of interconnected battery modules that function as a single unit. A grid-related storage system may comprise hundreds or even thousands of batteries. A storage system to be used only as a source of backup power will consist of considerably fewer. Traditionally, battery modules have been connected by bus-bars or jumper cables.

In short, bus-bars and jumper cables are proven, reliable and inexpensive connectors that can be used with virtually any type of battery. It's no surprise then that these components are – and have been for many years – the battery connector of choice.

Additional considerations

As noted, cables and bus-bars are low-cost versatile components that get the job done. Accepted at face value it's hard to find fault with these facts. Good business people and smart design professionals though are usually not ones to readily accept facts at face value.

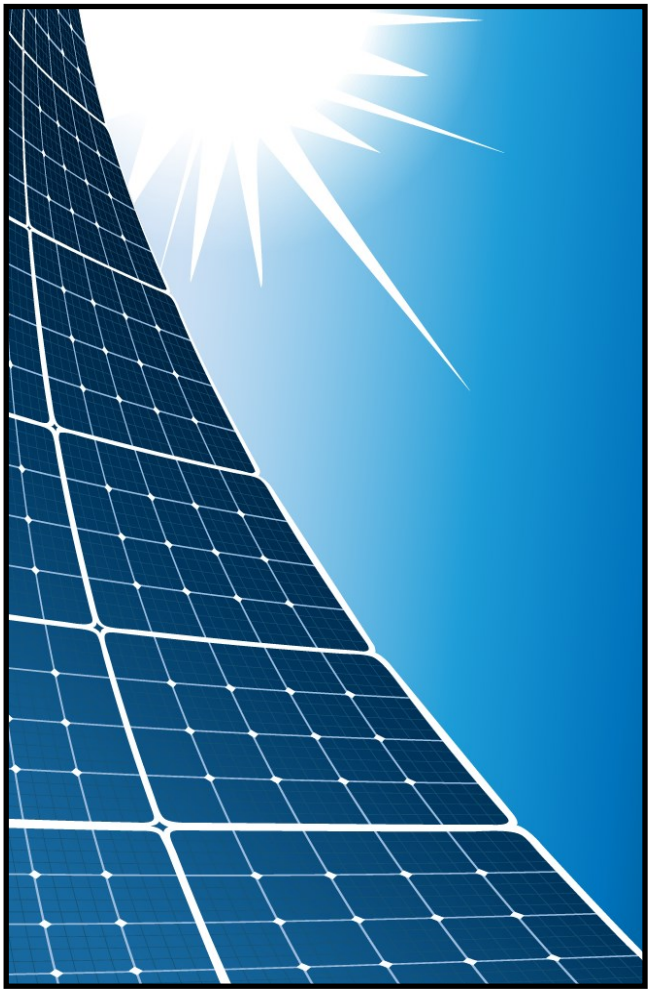
Here then, are additional factors to consider:

- **Cost of manually connecting battery modules** – Granted, the components are cheap and easy to work with. That said, as each cable and bus-bar connection requires hands-on work by a technician, storage system installation is a time-consuming, labor-intensive job. Especially considering that any one system may require hundreds or even thousands of battery modules. Also, there will inevitably be human errors and oversights. These applied costs cannot be overlooked.

Traditionally, battery modules have been connected by front bus-bars or jumper cables.

- **Cost of frequent on-site inspection, monitoring and maintenance** – Energy storage systems require regular inspection, monitoring and maintenance to ensure safe operation and optimum performance. Frequent monitoring of battery temperature of course is needed to make sure the system runs safely. Regular readings on current levels and other safety and performance data are also needed. With the majority of today's storage systems technicians must take these readings on each individual battery module. Again, this is time-consuming, labor-intensive work, the applied costs of which cannot and should not be overlooked. Consider, for example, that one 5MW power station could use as many as 1400 Li-Ion batteries.

- **Safety** – In conventional storage systems, battery terminals will be either on the front or the back of the unit. This ensures easy access for monitoring and maintenance. It also presents a safety issue. That's because technicians – and everyone else – will be completely exposed to the most dangerous part of the system. Thus increasing the odds for accidents and injuries.



The growing energy storage systems market spurs innovation .

- **Space requirements** – In addition to safety issues, the jumble of cables and bus-bars, the protruding battery terminals and the extra room needed for a technician to operate will require more space, something that can often be at a premium and also add cost.

- **Appearance** – Finally, if aesthetics are important – and we know it's hugely important to some companies – the cluttered, messy look of cables and bus-bars may be decidedly unappealing. This likely isn't an issue for grid-related storage systems but for a brand-conscious company whose storage system serves as a backup power source for its data servers aesthetics well may be an issue.

To summarize, the biggest reasons to question sticking with old-style battery connectors are applied costs and worker safety. Depending on system location and brand DNA, space requirements and aesthetics may also be factors.

The tipping point for next-generation battery connectors

Given the growth of the commercial energy storage systems market, advancement in battery connector technology was inevitable. As more and more systems are being designed and deployed using exponentially more battery modules, the applied costs related to installing and operating these systems have driven the market to a tipping point. That tipping point has triggered the development of more efficient, cost-effective and safer battery connector technology.

As in most instances of technological innovation, the next generation of battery connectors automates processes and reduces manual labor. Less human involvement means lower applied costs and less risk of accident and injury.

Advanced energy storage systems components: Features, benefits, drawback

Today's new storage systems battery components offer designers and manufacturers of integrated storage systems, and their customers, the very real potential to significantly lower applied costs. Additionally, operational efficiencies can be improved, and workplace safety enhanced.

Now, a review of pertinent details starting with the sole drawback:

- **Higher upfront cost** – As you would expect, high-power, next-generation battery connectors require a bigger upfront investment than old-style connectors – components that are essentially commodities.

- **Significantly and permanently lower applied costs (installation and servicing)** – This benefit, combined with the next, is what makes the next-gen battery connector the new "must-have" component for the commercial energy storage systems market. As noted earlier, making and terminating battery connections using old-style components can be a slow and inefficient process. The new, advanced-level connectors remedy this drawback. Terminals and jumpers can be done away with altogether. Instead, they are replaced by a single connector that enables the module to be easily plugged into the back panel. Additionally, servicing or replacing the battery can be done simply by pushing or pulling it into or out of its slot. No tools required.

- **Significantly and permanently lower applied costs (monitoring and maintenance)** – A common feature of the newest components is the integration of power and signal into a single connector. Signal contacts are in a separate unit within the same connector, and can be easily harnessed before being attached to the main connector body. With this set-up the system operator can transmit a steady feed of all battery data, such as temperature and current levels, to a central monitoring unit.

  As inspection, monitoring and maintenance are labor-intensive activities, this signal capability offers system operators the opportunity for a substantial reduction in personnel costs. And, potentially, more effective monitoring and a safer system.

  The reduction in applied costs discussed in the above two bullet points can ultimately compensate for the added costs of next-gen components. Over time, it's likely the cost-savings will more than cover the extra cost of the advanced connectors.

- **Enhanced safety** – Next-generation battery connectors increase the overall safety of commercial energy storage systems in two ways: (1) The connector and high-power contact is on the back of the module, away from the technician and everyone else. (2) With signal integration, most routine monitoring can take place at a centralized location, substantially reducing the number of times the technician actually comes in contact with the battery.

The commercial energy storage systems market is dynamic and growing, and the components that make up these systems are evolving.

- **Conserve space, look great** – Without the jumble of cables, without protruding terminals and busbars, and without the extra room needed for a technician to safely do his job, system operators can make more efficient use of space. Since commercial energy storage systems are often set up in customized shipping containers space is usually at a premium. So, the more power that can be fit into each container, the more economical each system will be. Additionally, these connectors help companies project a clean, neat and streamlined image.

The commercial energy storage systems market is dynamic and growing, and the designs, batteries

and components that make up these systems are evolving. The pace of innovation accelerating. This white paper is offered in an effort to apprise you of and alert you to one of the latest developments.

The DW Series from JAE: next-generation battery connectors specifically developed for use in energy storage systems.

6 Key Factors to Consider When Considering Advanced Battery Connector Technology

1. **Suitability**: Look for the size that best meets the need. Power requirements will depend on the battery and system, so select one that is best suited for that application.

2. **Power and Signal**: The best connector will integrate both power and signal in an efficient and safe design. For example, specifically look for one-action mating and un-mating for the whole connector. Avoid components with separate actions for power and signal.

3. **Ease of Assembly**: The connector wires should be easy to assemble into a cable harness. By having a signal portion that can be assembled separately before insertion into the main body, the signal harness can be done in an easy and efficient way. And having connector-integrated bus-bars for power allow for a reliable and customizable power path.

4. **Ease of mating**: Batteries can be large and difficult to move. The connector needs to make alignment easy. Generous mating guides and a floating interface to allow for extra room to easily align the connectors are definite pluses.

5. **Reliability**: The connector must be robust enough for the environment and application. The contacts themselves also need to be highly reliable to ensure that the signals are not interrupted. To ensure that the signal is never lost look for signals sockets that maintain two points of contact, similar to the type used in automotive applications.

6. **Safety**: Appropriate materials and safeguards to prevent electric shock are important. Look for flame retardant UL-94V0 material to maintain safe operation. And, a power contact interface designed to prevent fingers from touching the power contacts.

For more information on JAE and its product line, including next-generation connectors for commercial energy storage systems, please call 949-753-2646 or visit www.jae.com.

About JAE Electronics

Japan Aviation Electronics Industries, Ltd. (JAE), designs, manufactures and markets electronic components, fiber optic connectors, LCD monitor connectors, waterproof electrical connectors, connectors for commercial energy storage systems, and other digital systems. A global company, JAE is a recognized leader in providing solutions to complex design requirements. By combining divergent technologies from experience gained in the aerospace industry, JAE has been able to transfer these technologies into advanced connector designs. From connectors on Japan's Bullet Train, to the smallest hand-held video camera, JAE continues to meet the most demanding applications in the industry.