

## **Advances in Energy-Efficient Power Quality and Energy Storage**

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Large-scale UPS (uninterruptible power supply) systems are ubiquitous in data centers, manufacturing facilities, financial service sites, airports, military buildings, hospitals, broadcast facilities and corporate IT centers virtually everywhere around the globe. World renowned manufacturers of UPS systems have been reporting high double-digit sales growth year over year for several years now. This growth has been particular strong in the highest capacity segment of the industry: 500 kVA and above.

Collectively, these UPS system rely on literally millions of environmentally detrimental lead-acid batteries.

Lead-acid batteries have long been acknowledged as the least reliable, highest cost element of a UPS system intended to operate for more than a decade. The demands of air conditioned space, and plenty of it, combined with frequent maintenance, hazardous materials handling, safety issues and frequent cell/string failures that occur primarily when the stored energy is needed most.

In the 1990s, the first flywheel energy storage systems – essentially hazmat-free kinetic batteries – were introduced. Flywheels have been eliminating the need for chemical batteries, supplying steady-state power to protect critical loads from brief power disturbances and outages. For outages lasting more than a few seconds, these flywheels deliver supporting power to bridge the time to a backup generator hand-off.

These first-generation flywheels deliver a higher energy density/smaller footprint than comparable capacity VRLA batteries, and eliminate the for cooling, explosive gas ventilation, personnel safety systems, sulfuric acid spill containment, hazardous materials disposal and many other downsides of battery usage. Most significantly, end-users didn't need to buy a new one every three or four years and have the old one hauled away to a specialized disposal facility. *And* those first-generation flywheel systems have proven themselves far more reliable and less costly to own and operate than UPS battery strings.

The only con in the list of pros has been the standby energy consumption. The most popular, first-to-market flywheel energy storage systems consume 3.5 kW: many times the float energy of a comparable bank of lead-acid batteries and heat generation more than a thousand percent greater than that of batteries.

While energy inefficient steel flywheel systems are still sold today, a next generation carbon-fiber-based flywheel system was brought to the market nearly five years ago that delivers all the advantages of first-generation flywheels (plus a few new ones) with an energy consumption on par with that of batteries.

Lighter, stronger and ten times more energy efficient than competing products, carbon fiber flywheels aim to eliminate energy waste while also mitigating the environmental damage wrought by lead-acid batteries. Additional advantages of this newer technology is near-zero maintenance needs, significantly lower operating cost and the highest uptime availability of any commercially viable energy storage product.