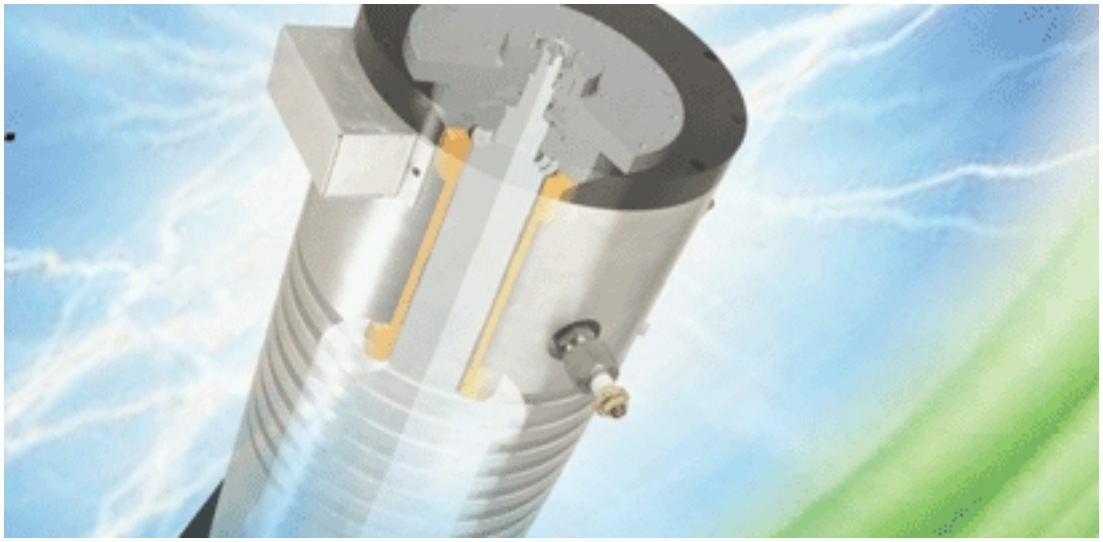
Written by Frank DeLattre, VYCON
Monday, 19 April 2010 10:40



With brownouts and blackouts on the rise, businesses can't afford to gamble on critical power-protection capabilities.

This reliable and cost-effective approach offers a number of advantages for operations that really want to go "green."Power disturbances pose a colossal problem for all businesses. The Electrical Power Research Institute (EPRI) estimates that such disturbances cost U.S. industry as much as $188 billion per year in lost data, material and productivity. Efforts to minimize these losses have taken on their own monumental proportions. According to industry analysts at the Darnell Group, annual spending on backup-power systems exceeds $5 billion worldwide.

Traditional backup-power solutions include uninterruptible power systems (UPSs) with valve-regulated lead acid (VRLA) batteries to provide energy during short-term power disturbances, diesel generators (gensets) for longer-term outages and control electronics to bridge the two. Therein lies a real challenge for businesses that are seriously concerned about matters of sustainability: *It's all those batteries.*

The lead-acid batteries that provide ride-through, or temporary power, for the UPS are commonly viewed as the most unreliable and most costly element of conventional power quality and reliability solutions. In fact, one might be surprised at how many buildings striving to be

green have hundreds or thousands of pounds of toxic lead and gallons of dangerously corrosive sulfuric acid on their premises—*thanks to lead-acid batteries*. It's also rather surprising that the current LEED standards make no allowance for mitigation of these extremely hazardous materials.

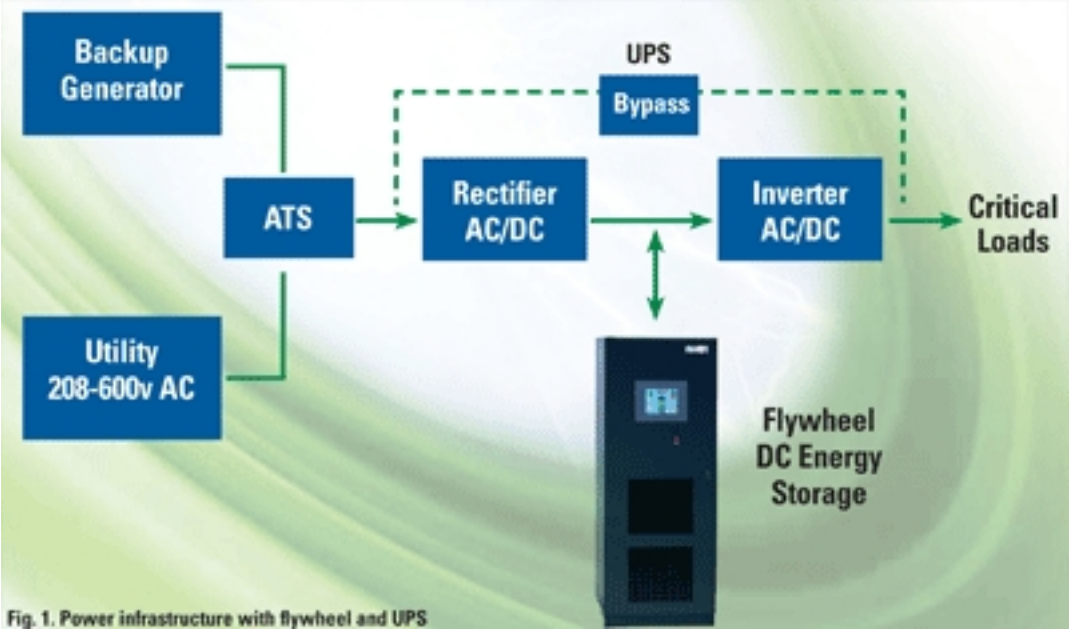


Fig. 1. Power infrastructure with flywheel and UPS

The weakest link

Today's facilities simply can't tolerate an instance of downtime. To ensure that critical processes operate without interruption, large-scale UPS systems continually take the frequent fluctuations and disturbances of utility power and condition the power, delivering clean energy to critical systems.

NFPA 99 regulations for Emergency Power Systems stipulate that gensets must be able to assume the load within 10 seconds. While batteries can perform this function, their reliability is always in question. Are they fully charged? Has a cell gone bad in the battery string? When was the last time they were checked?

Besides being a formidable source of hazardous material, lead-acid batteries are expensive and unreliable. One bad cell in one battery of a chain of four dozen "maintenance-free" lead-acid batteries is enough to bring down the whole set. They also require an excessive amount of testing, monitoring and maintenance to ensure against such occurrences.

Unfortunately, facility and maintenance personnel do not seem to test these batteries as often as they should—*and may not have testing/monitoring systems in place to do so properly.* Ironically, even testing batteries helps to degrade their useful life. Moreover, every four years or so, the batteries have to be hauled away (hopefully to a recycling center) and swapped out with all new, lead-based replacements.

According to EPRI, "Batteries are the primary field-failure problem with UPS systems." Predicting when one battery in a string of dozens will fail is next to impossible, even with regular testing and frequent individual battery replacements. Fortunately, facilities now have a viable alternative to batteries: It's the flywheel energy storage system.

Flywheel basics

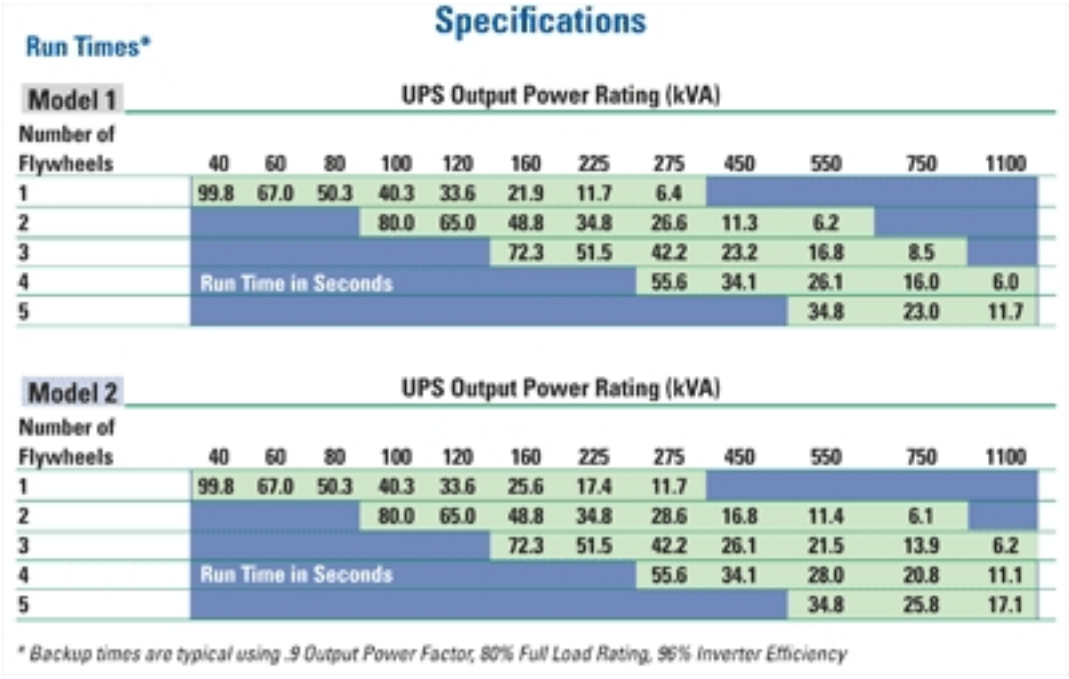
A flywheel system replaces lead-acid batteries and works like a dynamic battery that stores energy kinetically by spinning a mass around an axis. Electrical input spins the flywheel rotor up to speed, and a standby charge keeps it spinning 24/7 until called upon to release the stored energy. The amount of energy available and its duration is proportional to its mass and the square of its revolution speed. In the flywheel world, doubling mass doubles energy capacity, but doubling rotational speed quadruples energy capacity.

During a power event, the flywheel will provide backup power seamlessly and instantaneously (Fig. 1). The nice thing is that it's not an "either/or" situation, as the flywheel can be used with or without batteries. When used with batteries, the flywheel is the first line of defense against damaging power glitches—*protecting against the frequent cycling of the batteries and prolonging their life.*

Since batteries are the weakest link in the power continuity scheme, flywheels with batteries reassure facility managers that their batteries are safeguarded against premature aging and unexpected failures.

When the flywheel is used alone, the system will provide instant power to the connected load as it does with batteries. If, however, the power event is longer than a couple of minutes, the flywheel will gracefully hand off to the facilities' engine-generator. It's important to know that EPRI's research shows that 80% of all utility power anomalies/disturbances last less than two seconds and 98% last less than 10 seconds. In the real world, the flywheel energy storage

system has plenty of time—*up to a couple of minutes*—to gracefully hand-off to the generator.



Specifications

Run Times*

Model 1 — UPS Output Power Rating (kVA)

Number of Flywheels	40	60	80	100	120	160	225	275	450	550	750	1100
1	99.8	67.0	50.3	40.3	33.6	21.9	11.7	6.4				
2				80.0	65.0	48.8	34.8	26.6	11.3	6.2		
3						72.3	51.5	42.2	23.2	16.8	8.5	
4	Run Time in Seconds							55.6	34.1	26.1	16.0	6.0
5										34.8	23.0	11.7

Model 2 — UPS Output Power Rating (kVA)

Number of Flywheels	40	60	80	100	120	160	225	275	450	550	750	1100
1	99.8	67.0	50.3	40.3	33.6	25.6	17.4	11.7				
2				80.0	65.0	48.8	34.8	28.6	16.8	11.4	6.1	
3						72.3	51.5	42.2	26.1	21.5	13.9	6.2
4	Run Time in Seconds							55.6	34.1	28.0	20.8	11.1
5										34.8	25.8	17.1

** Backup times are typical using .9 Output Power Factor, 80% Full Load Rating, 96% Inverter Efficiency*

Fig. 2. In either of these flywheel models, the units exceed the goal of meeting a 20-second run-time requirement as a minimum.

Proper sizing

Normally, the sizing of UPSs and flywheels is done based on actual load. Most engineers size the UPS at 30-40% larger than the actual load to allow for growth. Once the UPS is sized, the flywheel needs to be sized to the UPS. All UPS ratings are based on kVA and kW numbers; the rating used for power applications is the kW rating. When this kW number is established, it will be labeled as the full load kW rating.

For example: A 275kVA UPS rating with a power factor rating of .9 power factor (pf) equates to 248kW of UPS power. Since the majority of loads are sized to UPSs at about an 80% load factor, along with inverter efficiency of 96%, this equates to 207kwb. Consequently, this is the rating used to size the flywheels to assure proper power rating and proper amount of run time requirement. To make it easier to size flywheels, most manufacturers supply customers with run-time charts that match kVA with run time.

As shown in Fig. 2, by using two flywheels, Model 1 will achieve 26.6 seconds of run time, and by using two flywheels, Model 2 will achieve 28.6 seconds of run time. In either case, the flywheels exceed the goal of meeting a 20-second run-time requirement as a minimum. This provides a solution that fits most facilities' needs and ample time to transfer to an engine genset if a longer power outage occurs.

Return on investment

When one compares the life-cycle cost (LCC) of flywheels with the LCC of battery systems (Fig. 3), it's clear which technology has a longer cost savings over the life of the technology. ROI for the flywheel occurs in three to four years—*quicker than that shown for a battery system.* The purchasing decision, though, is not necessarily an "either/or" option. That's because the flywheel can be used with or without batteries.

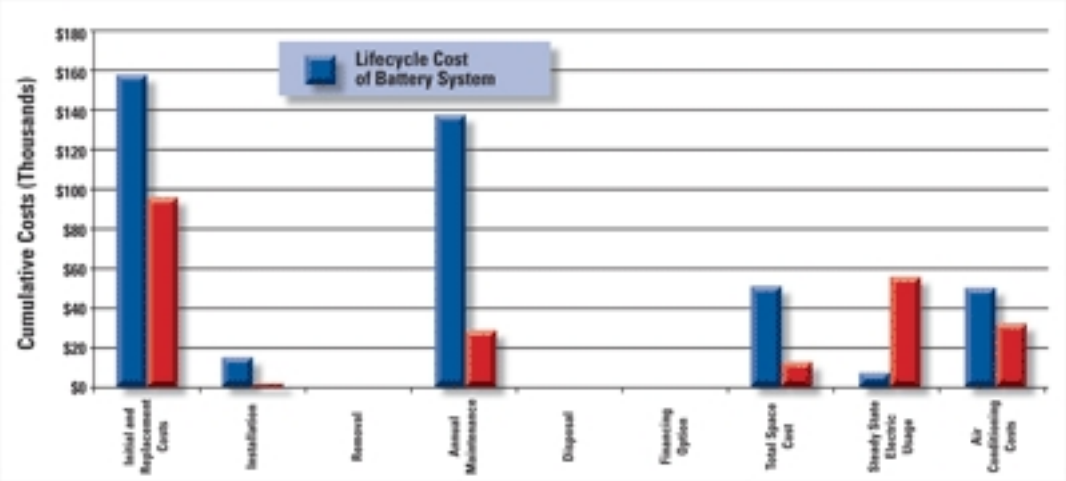


Fig. 3. A 15-year life-cycle-cost (LCC) analysis of battery systems

Assuring power quality

From 40kVA to a megawatt, flywheel systems are increasingly being used to assure the highest level of power quality and reliability in a diverse range of applications. The flexibility of these systems allows a variety of configurations that can be custom-tailored to achieve the exact level of power protection required by the end-user based on budget, space and environmental constraints. In any of these configurations, the user will ultimately benefit from the many unique benefits of flywheel-based systems, including:

- High-power density, small footprint
- Parallel capability that allows for future expansion
- Fast recharge (under 150 seconds)
- No special facility requirements
- No cooling required
- Low maintenance
- 20-year useful life
- Simple installation
- N+1 redundancy options
- Quiet operation
- Wide temperature tolerance

Flywheel implementations comply with the highest international standards for performance and safety, including those from UL and CE. They also incorporate a host of advanced features that users expect to make the systems easy to use.

These days, data centers, broadcasters, hospitals, airports, industrial processes, military facilities and other crucial operations around the world are hardening battery strings—*or even eliminating them altogether*
—by applying clean flywheel energy storage to their UPS systems. This "new kid in town" technology truly offers a green choice in protecting mission-critical applications by finally providing industries everywhere with a truly reliable, long-lasting and virtually maintenance-free DC power solution.
MT

Frank DeLattre is president of VYCON, a company based in Yorba Linda, CA. As noted on www.vyconenergy.com, "VYCON'S mission is to deliver energy storage systems into applications where the need for energy storage has not been met by any existing technology...including other flywheels."