Backup Power Solutions

Santee Cooper® POWER

When power to your facility is interrupted, it can result in significant expenses, including lost product, restart costs for certain equipment, the cost of extended downtime, and lost production. These costs can be avoided with proper planning and the installation of appropriate backup power and ride-through systems for your critical loads.

What Causes Interruptions?

Power interruptions can last anywhere from less than a second up to several minutes or more. Power interruptions that last between two seconds and two minutes are usually the result of a nearby short circuit, which can be caused, for example, by wet insulators or minor accidents to the distribution system. Sustained interruptions of more than two minutes in duration are usually caused by events such as major storms, faults on buried distribution circuits due to road construction, failures on high-voltage transmission lines, and power plant outages. Your risk of power interruptions can depend on the location of your facility on the transmission system—how far you are from the nearest substation—and your building's relationship to others that receive power from the same substation. You may want to ask your utility for its statistics on the frequency and duration of interruptions to facilities supplied from your substation over the last several years.

Finding Solutions

Regardless of the specific cause of the interruption, the preventive solutions at the facility level are normally much more cost-effective than the options on the utility's side of the meter, which can include improvements to the distribution system or the addition of dual feeders. The first steps toward developing an appropriate solution is to determine which are the critical loads and to estimate the costs of potential interruptions. Many facilities do not know or have not estimated their potential outage costs: One vendor of ride-through and backup power equipment found that 34 percent of the companies it surveyed did not know their average hourly costs of downtime. A recent E SOURCE survey of U.S. industrial customers showed average estimated costs of about $1,000 for a momentary outage, increasing to more than $18,000 for outages of longer than several hours. (Keep in mind that these are average total outage costs per customer, which vary by industrial sector and by facility.)

There are three types of loads that may warrant backup power protection. The first is life-safety systems, such as emergency lighting, ventilation, or other systems specified in the National Fire Protection Association's codes and standards. The second is systems that monitor plant equipment, such as supervisory control and data acquisition (SCADA) systems.

The third type of system to consider protecting from interruptions is critical process equipment. You should determine whether equipment can be easily restarted after an outage or whether an outage could damage the equipment. Consider whether an outage would cause a loss of materials or product and whether the materials can be salvaged and reused when production resumes. Also estimate the value of reduced output during or after an outage. Considering these types of outage costs should give you some idea of the potential financial impacts of an outage to your production processes.

There are two basic types of backup power systems: uninterruptible power supply (UPS) systems and backup generators. (A third option, dual feeders to the facility that, to be most effective, would originate from separate substations, is too expensive to be cost-effective in most cases and is not discussed here.) UPS systems should be examined first since they are the lowest cost and may be sufficient in many cases. It may be necessary to supplement UPSs with backup generation for certain critical loads.

UPS Systems

UPS systems are adequate by themselves for many applications. There are three ways to install UPS systems, and two main technologies used in UPS systems provide the temporary backup power: batteries and flywheels.

UPS Configurations

UPS units are designed to operate in one of three ways. There are off-line, line-interactive, and on-line systems, which offer different degrees of protection.

Off-line UPS systems are mainly used for individual personal computers or other non-critical, small, isolated loads. Off-line systems are also referred to as passive standby systems; they provide short-term outage protection and may include some surge suppression but are not able to provide power conditioning. When the power is interrupted, a switch turns the battery on and an inverter converts the direct current (DC) from the battery into alternating current (AC).

Line-interactive UPS systems monitor the incoming power and rely on batteries to correct for major voltage sags or surges. However, line-interactive UPSs do not completely isolate the equipment from the incoming power supply and cannot protect against other power quality problems outside of these major voltage swings. These systems are commonly used to protect computer servers at the small business or department level.

On-line UPS systems use the battery (or flywheel) to supply power to the equipment while using incoming power to recharge the battery. An inverter is used to convert the power from the battery to AC output. As long as the inverter and the battery are running properly, the attached equipment is receiving a steady power supply that is filtered of any voltage disturbances or harmonic distortions, even when the incoming power is interrupted. Thus, this type of system provides the best protection and is the most common type used for loads above 10 kilovolt-amperes.

Batteries Versus Flywheels

Batteries, the technology used most commonly in UPS units, are sized to provide between five minutes and one hour of backup power, and average about 15 minutes of protection. Batteries have limited lives, based on the number of discharges and charges, and their installations must comply with local and national health and safety standards. Environmental regulations, which mainly affect larger installations, can include requirements for ventilation, handling, and disposal of batteries. Every 100 kilowatts protected by a battery-powered UPS requires about a ton of batteries, which will occupy a significant amount of floorspace.

Flywheels are an alternative to batteries in UPS units. Usually, flywheels are used with on-line UPS systems and in facilities where the UPS is installed with a backup generator. They are typically designed to carry loads for about 15 seconds—sufficient time for backup generators to come on within their normal startup time of 10 seconds. Flywheels are also being developed with much longer load-carrying capacities.

UPSs with flywheels cost more initially relative to batteries, but have longer lives, lower maintenance, and smaller floorspace requirements (**Table 1**). They are also

Table 1: Comparison of flywheel and battery UPS systems

For a 250-kilowatt uninterruptible power supply (UPS) system with a 10-minute capacity, the flywheel-powered system is much cheaper than the battery system when including the maintenance costs over a 20-year life. Both systems are assumed to also include a backup generator, although the generator costs are not shown in this comparison.

Expense	Flywheel UPS	Battery UPS
Total installed cost (including $7,500 installation cost for both systems)	$57,500	$40,000
Annual maintenance costs (assuming batteries are replaced every four years)	$3,500	$14,500
Present value of maintenance costs over 20-year life (assuming an interest rate of 13 percent)	$24,600	$101,900
Total costs over 20-year life (net present value)	$82,100	$141,900

Source: Platts

considered more reliable than batteries. Flywheels operate at wide temperature ranges, unlike batteries, which require conditioned spaces.

Compared to flywheels, batteries have longer availability and do not necessarily require backup generators. Battery UPS applications are sufficient when all that is needed is 10 to 15 minutes to shut down critical equipment in an orderly fashion and wait until grid power is restored. Batteries account for over 90 percent of the market share in UPS applications.

Backup Generators

Sustained outages of more than a few minutes require emergency or backup generators. Generators should be able to come on and operate up to the full load in about 10 seconds, and they can operate for hours and even days with adequate fueling. Backup generators typically cost approximately $250 to $350 per kilowatt of capacity. Diesel generators are the most common, although natural gas–fired engines or dual-fueled engines are seeing increasing use.

Backup or standby generators have additional requirements, such as transfer switches or the electronics for parallel connection. Compatibility issues between UPS and backup generators can arise with regard to transfer-switch timing, voltage regulation, and the ability to deal with reactive power.

Backup generators also require periodic starting, "exercising" under load, and other maintenance to ensure their reliability in actual emergencies. At a minimum, you should start up your generator at least once a month and let it run for a minimum of one hour. We also recommend that you run and test your generator at least twice a year under full load and for extended periods in order to mimic different blackout scenarios.

In addition to emergency or backup power supply, standby generators may also provide benefits for peak load management. However, to provide for that, the generator's air emissions permit must allow additional hours of operation—ideally 100 to 200 hours per year. In many cases, you will only be able to get the additional permitted hours if the generator can burn natural gas. (Diesel engines can be retrofitted to burn natural gas with a dual-fuel conversion kit.)

For facilities with significant heating (or cooling) loads year-round, a combined heat and power (CHP) or combined cooling, heating, and power (CCHP) system can be installed to provide backup power as well as year-round heat, power, and perhaps cooling as well. The CHP or CCHP system will usually be sized to at least cover the facility's critical loads in this type of application. This would provide the needed backup power during potential outages, while also providing energy cost savings to the facility during year-round operations.

Combined UPS and Backup Generator Case Study

Cabett Subsea Products in Freeport, Texas, builds cables up to 100 miles long. The cables carry electric wiring and power cable, fiber optic cable, and strength elements such as wire or Kevlar ropes, all covered by a polyethelene layer. Cabett's cables are made in a continuous process, and it is essential that no power outages halt the extrusion process, which, depending on the size and length of the cable, can last up to 50 hours. An interruption of power during the process means losing everything that passed through the extrusion machinery up to that point.

Backup power was considered an imperative when Cabett's new plant was built, so the company installed both a standby generation set and an uninterruptible power supply (UPS) system. The standby generator is sized for 1 megawatt at 480 volts, with a 1,200-amp transfer switch. Integrated into the system is a 900-kilovolt-ampere (kVA) flywheel UPS. The UPS is a single 900-kVA unit with three flywheels providing protection.

The backup system's performance has been excellent. In the first eight months, 219 power interruptions were detected, but the system operated as if no interruptions occurred.

Financial Evaluation

The estimated costs of an outage, considering the damage to equipment, lost materials, and lost production, should be compared with the estimated costs of the backup power options being evaluated. These costs should not only comprise purchase and installation costs in backup power systems, including any required air permits, but also testing, maintenance, fuel, and other operating costs over the life of the equipment. The value of space to house the backup systems can also be included. To the extent that growth of critical loads is anticipated, it is worth considering building a modular system to reduce investment costs initially, while allowing the flexibility to add to the system over time.

Conducting these analyses may require facility managers to engage corporate financial analysts, construction project managers, information technology managers, consulting engineers, and manufacturers. Your electric utility may also be able to assist with data on outage probabilities, patterns, and equipment options.