

*Electrical energy is generated locally, but the fuels used for generating electrical energy are traded globally. Because global trade applies price pressure to fuels, energy prices continue to rise. While we cannot control the price charged for energy, we can work to control the total cost for the energy used in our facilities. Sound energy management methods can help us manage the total cost for energy consumed in our facilities. This article examines energy management methods and their application.*

**Discover energy savings  
in power-factor control,  
VFDs and lighting**

**Demand Management**

While a facility cannot typically manage demand directly (it must react to its inflow as it occurs), it can enjoy the benefits of demand management through power-factor correction. Power factor is the ratio of real power over apparent power. Penalties on bills are generally a result of differences in apparent power and real power used. Improved power factor results in a reduction in demand, which in turn yields a reduction in total energy costs.

The difference in power represents the variation in phase between the current and the voltage used to energize the magnetic coils in transformers and motors. This results in capacity filled on the system but not used. The most common way to correct for power-factor costs is to utilize capacitors to offset the difference caused by the transformers and motors. This saves some power by reducing the losses from I<sup>2</sup>R losses (heating losses) on the lines. More dramatic savings occur from removing the utility penalty.

Utilities charge for power factor in differing ways. Some utilities bill by kVA, which is commonly called apparent power and includes both real power used and the reactive power on the system. For those, any lagging power factor less than 1 results in a power factor penalty. It is important to be careful that over-correction does not occur; some utilities penalize for leading power factor as well, reasoning that volt-amperes reactive must be wheeled whether positive or negative.

For example, assume a utility bills demand at \$10 per kW (real power). If power factor is corrected to reduce demand billing by 200 kW, the customer's utility bill will be reduced by \$2,000 monthly. Correcting for power factor can yield dramatic savings, and often power factor correction systems pay back installation costs within two years or less.

When designing a new or expanded electrical distribution system, power-factor correction should be designed into the system. That said, power-factor correction can be incorporated into an electrical distribution system at any time, even years after the initial installation.

Users can make a preliminary determination of the efficacy of power-factor correction by consulting the utility's customer service representative (CSR). The CSR is able to advise whether the facility is incurring a power-factor penalty, as well as its magnitude. The CSR can also perform a rapid estimate for the amount of correction required; this information is necessary for the contractor or manufacturer's representative to calculate installation costs. It is important for customers to gather a 12-month bill history to estimate power factor spanning all seasons. Typically, power factor varies throughout the year due to air conditioning or other load variations.

A word of caution is in order when applying power-factor correction capacitors. Today's electrical distribution systems incorporate components that may produce harmonics that flow on power lines. Care should be exercised that significant harmonics are not present. Consult an engineer familiar with harmonics who can perform a system evaluation prior to installing the capacitors.

**Conserving Energy With VFDs**

Various methods are used for controlling the flow of air and water, some more successfully than others. Traditional methods of controlling air and water flow have a variety of drawbacks, whereas variable frequency drives (VFDs) can be effectively employed to save energy and provide a host of additional benefits. VFDs can be added to an existing system. That said, the least costly approach is to design them into a system when it is in the planning stage.



By David Bredhold

# Electric savings



Conventional methods include using motorized dampers to reduce air flow and motorized valves to control water flow. Additional methods include the use of two-speed motors. Although these methods do work to reduce flow, they suffer from various inadequacies.

Motor-operated dampers require materials and labor, and they are expensive to install as a result. Although they reduce air flow, they waste energy; the motor and blower run full speed, while air flow is modulated by the damper. Because the blower's motor is running at full speed, energy is being wasted.

Motor-operated valves are expensive and occupy space. Space costs money. While valves reduce water flow, the motor and pump are running at full speed. Energy is wasted pumping water that is going nowhere. Furthermore, pump impellers suffer undue wear when running at higher speeds.

VFDs can be used effectively in air-handling and fluid-handling systems to control flow while conserving energy. Savings in energy flow directly to the facility's bottom line on its accounting statement.

The speed of alternating-current (AC) motors is dependent on the frequency of the applied AC voltage. An 1,800-rpm motor, having 60-Hz voltage applied, runs at 1,800 rpm. If power with frequency of 30 Hz is applied to the same motor, it will run at 900 rpm. VFDs, as the name implies, operate on the principle of varying (actually, adjusting) frequency. As such, they can be used to adjust the frequency applied to the motor, changing the speed of the motor. When a motor's speed is reduced, its power consumption is reduced.

Beyond saving energy, VFDs result in additional savings from reduced maintenance costs. Air handlers may be belt-driven, and extra wear is imposed on belts when started with a full-voltage (across-the-line) starter. Belt life is reduced from the stretching that occurs when blowers are started across the line. Additional maintenance dollars are expended adjusting and replacing worn and stretched belts. Reduced wear on belts and sheaves translates into maintenance dollars that can be spent elsewhere.

Wear on pump impellers is reduced when pumps are pumping reduced volumes of fluid at lower velocities. Pulling pumps to replace impellers can require significant amounts of time and money.

Replacement impellers are expensive, as is the cost for the labor to replace them. Savings realized from not servicing blowers and pumps can be redirected for other necessary activities.

Although a facility personnel may perform its own maintenance with its personnel, the costs for labor should be recognized as real costs, not sunk costs. Even though maintenance people are paid regardless, labor saved on one task can be allocated to another.

VFDs can also offer a benefit that is sometimes recognized immediately. VFDs rectify AC voltage to pulsating direct current (DC) voltage. Capacitors are used to filter the pulsating DC voltage to provide pure DC voltage. The DC voltage is then inverted to provide varying frequency and voltage to drive a motor at the desired speed. The capacitors in a VFD also serve to correct power factor, even as they filter the DC voltage for use by the VFD. One can look on power-factor correction as a free benefit included in the purchase of the VFD. Again, the savings flow directly toward the facility's bottom line.

### Lighting Management

The old truism about turning off the lights holds especially relevant in large facilities. Lights left on when personnel are gone for the evening waste significant amounts of energy. Although a facility manager can mandate that all lights must be turned off when personnel leave, assuring the job is done is another matter. Conveniently, equipment such as circuit breaker panels and panel boards are available to automatically control a facility's lighting, both indoors and out.

Circuit breaker panels and panel boards are available containing electrically switched circuit breakers. The panel boards have microprocessor-based controllers associated with them; the controller may be contained within the panel board or located outside.

The controller can be programmed to turn interior lights on at the beginning of a shift and extinguish them during the hours when personnel are not occupying the offices. Programming can include weekends, when no one will occupy the office, as well as holiday schedules. The controller is also able to compensate for daylight saving time.

Provisions can be made for varying ambient-light

levels, as facilities may have natural light from a variety of areas. Ambient-light sensors can be incorporated to turn off lights that are not necessary.

Exterior lights can also be incorporated in the system. Some facilities use a photo sensor to turn exterior lights on at sunset and off at sunrise. Others control them by means of a time clock. The controller can accommodate both types of control. The longitude and latitude for the site are input into the controller, and the controller then calculates local sunset and sunrise to adjust for the varying light levels through the year.

Temporary lighting for cleaning crews can be accommodated through use of momentary switches in each room. When the switch is turned on, lights in the room will turn on for a user-defined length of time and then be extinguished.

### Conclusion

Unfortunately, facilities are at the whim of the global markets when it comes to the price of energy. That said, facilities are able to mitigate usage and control energy costs. By actively managing energy costs—through correcting for power factor, utilizing VFDs and managing the usage associated with lighting—facilities are able to make dramatic reductions to overall energy consumption and costs. Typically, the types of investments in equipment analyzed here are recouped within a few years simply by the reduction in energy costs. The savings continue for years to come. **WWD**

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