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How to Lower Your Electrical Bill Without Reducing Energy Usage

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Four Steps to Limit or Remove Electric Company Penalties

Do you know how much you're paying for your electrical power? Or more importantly: Do you know how much you're *overpaying* for your electrical power due to power factor penalties and charges?

In most organizations, one person pays the bills and another is responsible for the budget from which that money comes. As with any raw material, it's often assumed that the only way to lower cost is to limit the usage.

But many companies are paying thousands of dollars a month too much on their power bills due to ineffective management of their power factor. At Eaton, experts have seen small facilities waste hundreds or thousands of dollars a month on power factor correction penalties, with large facilities sometimes losing in excess of $300,000 a year.

Personnel at manufacturing and commercial buildings must monitor this attribute of their electrical power if they're going to keep costs under control and not continually waste money on a monthly basis. Every added fluorescent light, transformer or motor has the potential to change your power factor, and your electric company may be reaping the benefits in extra charges and penalties.

Chances are that if you haven't recently done something to correct the power factor at your facility, you're overpaying for your electrical power.

What is power factor and why should you care?

Within the electrical system that delivers power to your business or plant site, there are two components of current needed to make possible the transfer of energy. The first is the power component, or working portion, of the current, sometimes referred to as active power. This is the component that's converted by your equipment into some useful work, usually in the form of heat, light, torque in rotating machines or the powering of computers, servers and other electronic devices. The unit of measurement for active power is the watt (W) or kilowatt (kW). The second is the reactive component, or nonworking portion, of the current, sometimes referred to as reactive power. This reactive component is very important, in that it's responsible for creating the magnetic flux, which permits transformers and motors to operate. Without it, there would be no transfer of energy into your facility. Think of this reactive component as effectively sloshing back and forth between the electrical utility and the user to create the necessary magnetic fields in transformers and motors. The unit of measurement for reactive power is the volt-ampere-reactive power (var or kvar.)

Using vector math techniques to combine these two components of current and power, the result (see **Figure 1**) is sometimes referred to as apparent power, as the value is based on the "apparent" voltage and current as read from the meters. The unit of measurement for apparent power is the volt-ampere (VA or kVA.)

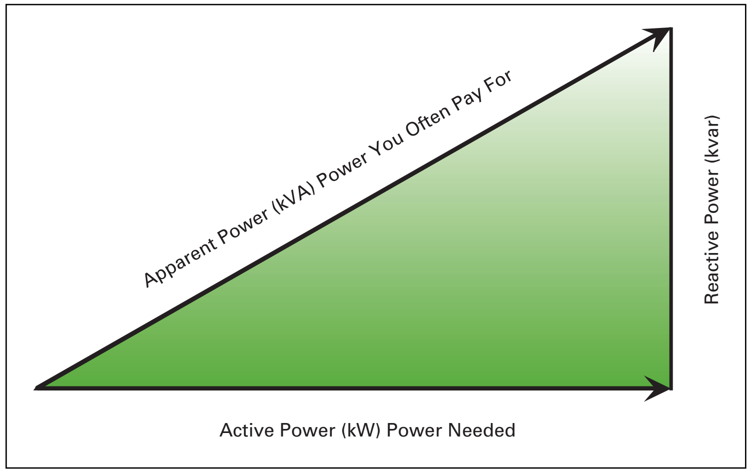

FIGURE 1 Apparent/Active/Reactive Power Schematic

While reactive power typically doesn't register on your conventional kW demand and kWh energy meters (which measure the working portion of the current), the generation, transmission and distribution systems of the utility must be large enough to provide the necessary kvar to your facility.

Power factor is simply the mathematical ratio of the active power to the total power (active and reactive) being supplied to the facility. Low power factor simply means that you're not fully utilizing the electrical power being supplied to you.

A fully corrected power factor value is 1.00, which means all of the current supplied to your facility by the utility is being fully utilized. Typical power factor values range from 0.5 to 0.85. It's usually not economical to improve the value much beyond 0.95. However, this is based solely on your electric utility provider and the way they calculate your electrical bill as you will see below.

Below are the four key steps that should be taken into consideration in understanding and lowering your power factor penalties:

Understand why utilities charge a power factor penalty.

Utilities must design their systems with oversized equipment to accommodate reactive current. In order to pass along the expense of the larger equipment required and the system losses from the flow of the reactive current, many utilities will charge their customers a penalty for low power factor. There are a variety of means in which this penalty is calculated by the utility.

A typical power bill consists of charges for the power demand placed on the system by the customer (measured in kVA, kW or kvar) plus charges for the energy consumed by the customer (measured in kWh). Typical costs for the demand range from $1.00 to $11.00 per kVA, kW or kvar. Typical costs for the energy consumed range from $0.02 to $0.12 per kWh. The power factor penalty is usually applied only against the demand portion of the bill.

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The following three example case studies for power factor penalty calculations are based on a few of the more common ways utilities calculate electrical bills, using the following assumptions. The examples are similar to the usage rates at a medium-sized manufacturing facility or large office building:

- 4,000 kW average monthly demand
- 0.87 Uncorrected Power Factor

Company A
The utility bills Company A for every amp of current (also known as kVA billing). Company A is paying $4.75 per kVA:

The uncorrected original monthly demand billing was 4,598 kVA x $4.75 = $21,840.

Company B
The utility bills Company B for kW demand with power factor adjustments. Company B is paying $4.75 per kW:

The utility charges according to the kW demand and then adds a surcharge adjustment for low power factor or credit for high power factor. In this example, the original monthly demand billing was 4,000 kW x $4.75 = $19,000 per month.

Company C
The utility imposes a direct charge on Company C for the use of magnetizing (reactive) power, usually with a waiver of some percentage of kW demand. Company C is paying $4.75 per kvar.

In this example, the original monthly billing for the reactive demand was 2,268 kvar x $4.75 = $10,773.

Typically, the state public utility commission permits the utility to recoup some of the lost revenue on the wasted energy, as well as their investment for additional required equipment. This often means you can significantly lower your costs by correcting your power factor.

Learn what can be done — what are your options?
Your goal is to improve your power factor. To do so, you have two major options.

- Since motors carrying a light load can cause a low power factor, you can improve your facility power factor by identifying and correcting motor applications that are lightly loaded.

- Power factor can be improved in your facility by adding power factor correction capacitors to your plant distribution system. Rather than requiring the utility to supply the necessary reactive power required by the motors, these capacitors do so. As a result, the utility will in turn reduce or entirely eliminate the penalty for low power factor on your power bill.

Calculate a payback. What is the payback of this type of solution and why?
Let's use the same examples to show how quickly power factor correction capacitors can deliver a payback based on different billing methods of the utilities.

Company A
The utility bills Company A for every amp of current (also known as kVA billing). The company improved its power factor to 0.97, which resulted in a 4,124 kVA demand. The revised monthly demand billing charge was 4,124 kVA x $4.75 = $19,589.

This produced a monthly savings of $2,251 ($21,840 – $19,589), or $27,012 per year. The installed cost for a capacitor sized to bring the power factor up to 0.97 was $24,000, which yields a payback of less than one year.

Company B
The utility bills Company B kW for demand with power factor adjustments. A capacitor was installed to improve the power factor to 0.96. The utility company provided a credit resulting in the revised monthly demand to be effectively reduced to 3,750 kW. The revised monthly demand billing charge was 3,750 x $4.75 = $17,812.

This produced a monthly savings of $1,188 ($19,000 – $17,812), or $14,256 per year. The installed cost for a capacitor sized to bring the power factor up to 0.96 was $20,000, which yields a payback of approximately a year and a half.

Company C
The utility imposes a direct charge on Company C for the use of magnetizing (reactive) power, usually with a waiver of some percentage of kW demand. A capacitor was installed to improve the power factor to 0.95. The revised monthly demand billing charge was 1,316 kvar x $4.75 = $6,251.

This produced a monthly savings of $4,522 ($10,773 – $6,251), or $54,264 per year. The installed cost for a capacitor sized to bring the power factor up to 0.95 was $25,000, which yields a payback of less than six months.

Many users also see a significant payback in increased system capacity. Savings can also be achieved when additional kW capacity is needed at the site. Purchase of a new, larger transformer and switchgear may be avoided by correcting the power factor, which releases the necessary kW to power the additional loads. This can result in a quick payback on the investment in capacitors.

For example, a facility has a 500 kVA transformer operating at near full load. The load draws 480 kVA or 578 amperes at 480 volts. With a load power factor of 0.75 or 75 percent, the actual power available to the load is 360 kW. The company wants to increase production by 25 percent, which means the new load on the transformer would be approximately 450 kW. At a power factor of 0.75, this new 450 kW load translates to a transformer requirement of 600 kVA.

One solution would be to buy a new transformer, with the next standard size being 750 kVA. A much better solution would be to improve the power factor by adding capacitors to provide the necessary reactive power to the load. This approach will release sufficient capacity in the transformer to accommodate the increased load.

To correct the new 450 kW load from the present 75 percent power factor to the new necessary 95 percent power factor will require 250 kvar. The cost will be approximately $3,000, which is much less than a new transformer. Eaton power factor experts can assist in the determination of the required kvar in similar applications.

Take into consideration any harmonic issues.
As power factor correction capacitors are installed, it's critical to take into consideration any harmonic distortion that may be generated from a variety of sources inside or outside of your facility. The presence of harmonics presents a challenge to using only capacitors for power factor correction. In some cases, there are unwanted interactions between the capacitors and the harmonic voltages and currents. Power factor correction at a facility with harmonics requires a more thorough engineering analysis utilizing engineering specialists from companies such as Eaton.

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What should I do next?

The first thing to do is collect 12 months of electrical bills. Review your bills to determine if there are power factor penalty charges on them. If so, go to www.powerfactorsolutions.eaton.com/tools. Here you can view additional information, and use the power factor calculator.

The calculator will calculate engineering data (capacitor size, voltage rise, harmonic resonance, etc.) for your facility. It will also give a first-pass analysis of the payback and return on investment. Since power company billing rates are numerous and diverse, exact returns on investment calculations can only come from examining your utility rate structure in detail. However, the calculator can quickly determine if further analysis is necessary.

Next, if your power bill and the power factor calculator indicate an opportunity for savings, talk to an Eaton power expert, who can help determine exactly what you need and coordinate installation to disrupt your facility as little as possible.

You can also schedule a free site evaluation to review lowering your utility costs or ask a question from a power quality expert at www.powerfactorsolutions.eaton.com/tools.

Author

Wayne Stebbins is a nationally recognized expert in the fields of energy management, metering, ASD systems, power quality issues and electrical safety training. A number of utilities use his services as a resource on a regular basis. Wayne has 15 years experience in various aspects involving the operation and continuous upgrade to a 27 MW co-gen facility at a major fiber producer site in the southeast.

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