

POWER FACTOR

IMPACT OF POWER FACTOR

Power factor can impact your business without you even knowing about it. In many cases, SRP customers are unaware of the operational and financial impacts that poor power factor can have on a business. This is because power factor is often misunderstood and overlooked.

In your facility, poor power factor may unnecessarily reduce your electrical system's capacity. It can produce excessive voltage drops and increase your electrical distribution system's heat loss. It can also add additional costs to your monthly electric bill due to power factor adjustments.

Poor power factor also creates challenges for SRP, as it places additional strain on electric generation and distribution resources throughout our electrical system. These strains require SRP to add additional distribution facilities which in turn increases costs to all of our customers.

By addressing these problems within your facility, the performance of your electric systems can improve. Together, we can avoid the undue costs associated with poor power factor.

The following information is intended to serve as a starting point to help you better understand the topic and to provide general information regarding how you can improve poor power factor.

UNDERSTANDING POWER FACTOR

To understand power factor, it is helpful to first understand the fundamentals of inductive loads and the various measures of electric power and their relationship to power factor.

Inductive Loads

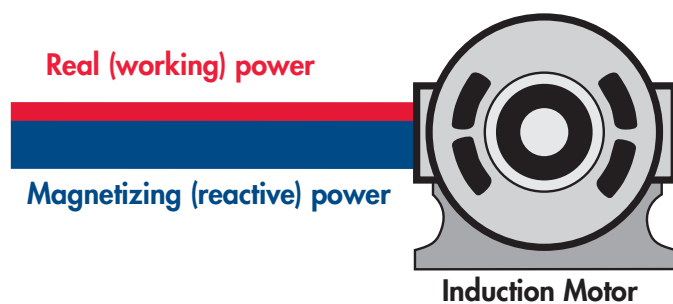
Most commercial and industrial facilities possess inductive electrical loads — devices for which an electromagnetic field must be "induced" and maintained for the equipment to operate properly.

Common inductive loads include motors, transformers, magnetic ballasts within lighting fixtures and inductive furnaces.

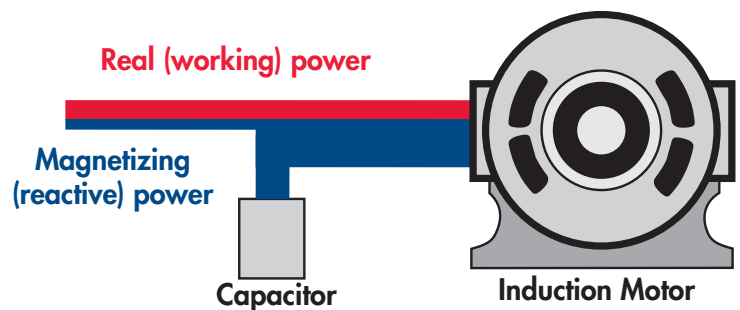
A common trait of inductive loads is that they need two types of power to operate — one to provide real power to do the actual work and one to provide an electromagnetic field to operate. Figure 1 (below) illustrates how two kinds of power are supplied to provide the real power to perform the actual work and the reactive power to magnetize the inductive load.

Figure 1

LIGHT LOAD CONDITION WITHOUT CAPACITOR



LIGHT LOAD CONDITION WITH CAPACITOR



Inductive Motor loads require two kinds of power for operation.

■ Real power (kW) performs the work. ■ Reactive power (kVAR) performs no work but maintains the magnetic field.



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QUESTIONS ABOUT POWER FACTOR?

Contact your SRP Energy Manager or email BizCenter@srpnet.com.

Measures of Electric Power

The electricity that performs the work is measured in kilowatts (kW) and is termed “real power.” This work can include creating heat, light, motion and other mechanical output. The electricity that provides the magnetic field for the motors to operate is called “reactive power.” Reactive power is measured in kilovolt-amperes reactive (kVAR). This type of power places a drain on your electrical distribution system as well as the utility’s distribution system. The final measure of power is called apparent power. Real power (kW) and reactive power (kVAR) together make up apparent power. Apparent power is measured in kilovolt-amperes (kVA) and is the total amount of electricity the utility must generate and deliver to your site to meet your electrical needs.

What Causes Poor Power Factor?

Poor power factor is often caused by equipment (inductive load) that is oversized, lightly loaded or energized but sitting idle. Examples of these operating conditions include oversized pump motors, lightly loaded transformers and chillers that are energized but operating in standby mode. A facility with poor power factor is using more of the reactive power (magnetizing portion of the power) in relation to the real power that performs the actual work. Some industries also are more likely to have a low power factor due to the nature of their business. Manufacturing firms that use cyclical processes where equipment continuously ramps up and then rests idle often have poor power factor. The following industries typically see lower power factors:

NAME OF INDUSTRY	TYPICAL POWER FACTOR WHEN UNCORRECTED
Plastic Extruders	55%–70%
Machine Tools, Stamping	60%–70%
Printing, Tile, Block, Plating	65%–75%
Hospitals, Warehousing	70%–80%
Multi-Tenant High Rise Buildings	80%–85%

DEFINITION OF POWER FACTOR

Power factor is the ratio of real power to apparent power. Power factor essentially measures the percentage of power that is actually doing useful work. It measures how effectively delivered electrical power is being utilized at your facility. A high power factor percentage indicates that power is being used effectively, while a low power factor percentage signals poor utilization of delivered power.

As outlined in our price plans, SRP requires that our commercial customers maintain an average power factor of 85% or greater during each monthly billing cycle. This average is based on energy data that is read throughout this time period. If power factor falls below 85%, an adjustment is assessed.

Power Factor Calculation

Power factor (PF) is determined by dividing real power (kW) by apparent power (kVA). It also can be calculated by dividing kilowatt-hours (kWh) by kilovolt-amperes hours (kVAh).

Here’s an example: A manufacturing company operated their facility with a monthly energy usage of 400,000 kWh and 500,000 kVAh consumed. The monthly power factor is calculated by dividing 400,000 by 500,000, resulting in a power factor of 80%. In this example, the manufacturing company is only effectively utilizing 80% of the total energy supplied by the utility. That means that only 80% of the incoming power is being used to produce useful work.

Power Factor Analogy

An analogy that is often used to illustrate power factor is a horse pulling a railroad car down a railroad track. The horse in Figure 2 (above) is pulling the car from the side of the track and at an angle to the direction of the car's travel. The power required to move the car down the track is the working (real) power. The effort of the horse is the total (apparent) power. Because of the angle of the horse's pull, not all of the horse's effort is used to pull the car down the track. The car will not move sideways; therefore, the sideways pull is wasted effort or nonworking (reactive) power.

Figure 2

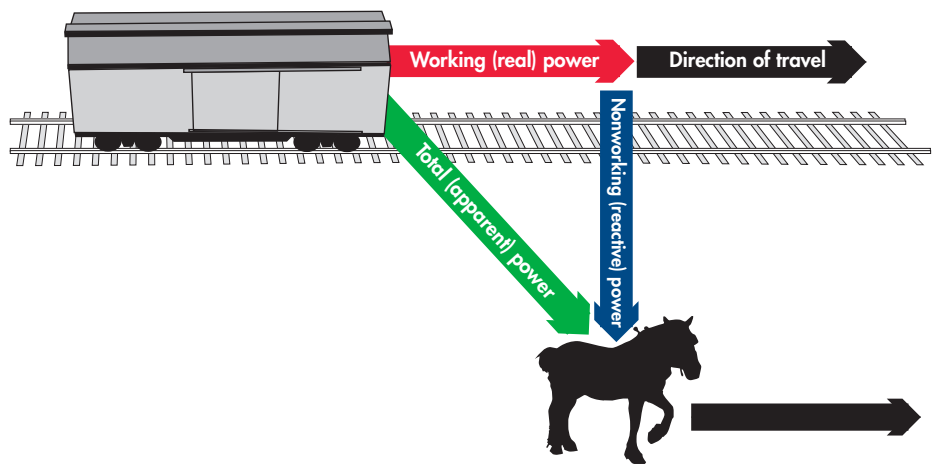


Figure 3

IMPROVING POWER FACTOR

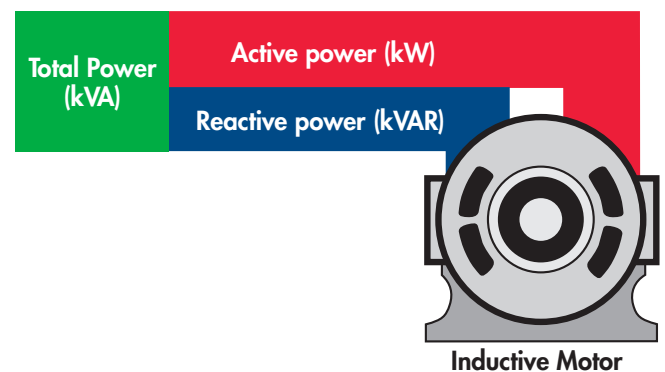
Improving power factor is something that can be accomplished easily during new equipment installations and corrected within existing electrical systems. By installing capacitors, inductive loads are supplied the reactive "magnetizing" power (kVAR) that is required so the electrical system can supply a larger percentage of the real power (kW) to actually perform the work. By properly designing and controlling the portion of kVAR discharged by the capacitor, power factor is improved over SRP's 85% power factor requirement.

Figure 3 (at right) shows how the capacitor bank supplies system kVAR and reduces the Total Power (kVA) within your electrical service.

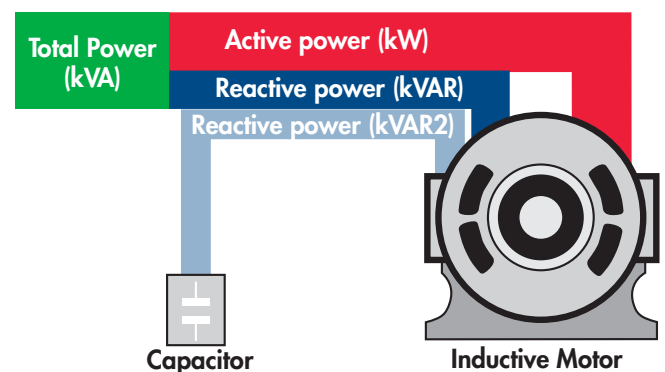
SOLUTIONS TO CONSIDER

For new construction and newly installed systems, it is important to properly size motors and transformers for the loads that they will be carrying. Over-sizing these devices leads to higher initial costs and puts you at risk of incurring adjustments. In addition, consider specifying high-efficiency motors with a high power factor rating. Also, if you know that certain processes within the facility will most likely have a poor power factor, install capacitor banks at the equipment or service panel(s) for those processes to minimize the potential for power factor-related adjustments.

WITHOUT POWER FACTOR CAPACITOR



WITH POWER FACTOR CAPACITOR



Inductive Motor loads require two kinds of power for operation.

- Active power (kW) performs the work.
- Reactive power (kVAR) performs no work but maintains the magnetic field.

In existing facilities that are experiencing poor power factor and monthly adjustments, capacitors can be installed at the equipment level, motor control center and/or at the service entrance section. Although replacing motors, eliminating lightly loaded equipment and making operational adjustments can have an impact on improving power factor, installing capacitors is typically the most cost-effective solution that allows you to maintain your current mode of operation.

A common question asked is, “How do capacitors improve power factor?” Capacitors reduce the phase difference between voltage and current. Since the majority of load is inductive, some amount of reactive power is required to function. This reactive power is provided by the capacitor installed parallel to the load. Therefore, capacitors improve power factor because the effects of capacitance are exactly opposite those of inductance.

POSITIONING OF CAPACITORS

Below are some advantages of installing capacitor banks at various locations within your facility.

At the equipment location:

- › Improves control – limited ability to cause issues elsewhere
- › Eliminates need for separate switching
- › Makes it easier to select the correct size of capacitor
- › Provides greater ability to relocate for facility/production changes
- › Enhances motor performance

At the service entrance section or downstream panel:

- › Improves total facility power factor
- › Reduces cost per kVAR installed
- › Lowers installation costs
- › Provides greater operational flexibility — bank switches automatically to provide exact amount of required kVAR

Capacitor banks are available in a variety of sizes and configurations. Consult a professional electrical engineer to determine the most appropriate technical solution for your facility.

IMPACTS FROM DISTRIBUTED GENERATION

Many businesses are turning to distributed energy resources, such as solar and wind, in combination with energy storage, to offset reliance on traditional electric power. If you are considering installing these types of solutions at your business, it's important to understand how they impact power factor.

When a good portion of your power has been displaced with on-site generation and you have loads with a sizable reactive component, you may see power factor decline after your equipment is connected to the grid. How does that happen? Let's use solar panels as an example: They displace the power you need from the energy grid in the form of “real power.” As a result, the energy grid supplies less real power to your facility but you still receive the same amount of reactive power. This combination may result in a reduced power factor.

Poor power factor places a heavy burden on the energy grid. SRP may require you to take certain corrective measures or make adjustments to your bill if your power factor falls below 85%. See table below for customer examples of changes to power factor before and after solar interconnection.

SOLAR AC SIZE (kW)	SUMMER POWER FACTOR		WINTER POWER FACTOR	
	INTERCONNECTION		INTERCONNECTION	
	BEFORE	AFTER	BEFORE	AFTER
1000	91.10%	86.60%	92.90%	89.80%
766	83.50%	69.30%	83.70%	77.30%
300	95.40%	91.20%	95.30%	93.76%
300	90.60%	84.20%	98.50%	98.03%

Contact SRP before you begin your project

If you are considering installing solar or other forms of distributed energy resources, there are several steps you can take to avoid or minimize power factor impacts. Here are a few tips to keep in mind:

1. Contact your SRP Energy Manager before you begin your project. They can advise you on how to maintain acceptable power factor levels.
2. Speak with a qualified contractor early in the process so they can help you better understand potential impacts to your power factor. The design phase is the ideal time to evaluate solutions.
3. Electrical devices, such as capacitors, have the capability to help ease the impacts to power factor.