POWER FACTOR

Power factor (PF) represents the relationship of current and voltage in AC electrical distribution systems. In these systems power is used most efficiently when the current is completely aligned with the voltage, which would be a PF of 1.0. In systems delivering electricity to inductive motors, such as business facilities, PFs are typically below 1.0.

Systems supplying induction motors that are oversized and under-loaded tend to have a low PF. Low PF causes heavier current to flow in power distribution lines in order to deliver a given number of kW to an electrical load, which requires the utility to generate more than the minimum power necessary to supply the real power and consequently increases generation and transmission costs.

Details

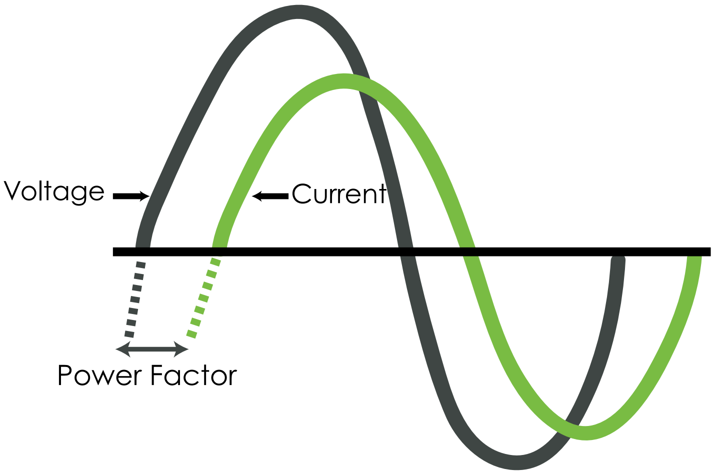
Terminology

Real power (kW) — The work-producing power used to operate equipment.

Reactive power (kVAr) — The non-work-producing power needed to magnetize and start equipment, measured in kilovars (reactive volt-amperes).

Apparent power (kVA) — The combination of real power and reactive power, measured in kilovolt amperes.

What is Power Factor?



How Does Power Factor Affect My Facility?

Like many utilities, NV Energy requires large users to either keep their PF above a certain ratio (0.9 is NV Energy's minimum) or pay a penalty. For large buildings, it may be worth it to correct low PF to either reduce the penalty charges or to restore capacity of overloaded feeders within the building or building complex. Understanding how low PF is calculated and what methods are available for correcting can help inform operations management and technology investment decisions.

PF is the ratio of real power divided by apparent power.

$$\frac{kW}{\sqrt{(kW)^2 + (kVAr)^2}}$$

For example, if:

- Maximum real power for billing period = 500 kW
- Reactive power at the time of maximum kW demand = 375 kVAr

Theoretically, capacitors could provide 100% of needed reactive power. In real world applications, however, PF of at least 90% provides maximum benefit. In the example, the PF is 0.8, so more reactive power of capacitance would be required to increase the PF.

$$\text{Apparent power} = \sqrt{[(500\ kW)^2 + (375\ kVAr)^2]} = 625\ kV$$

$$\text{Power factor} = \frac{500\ kW}{625\ kVA} = 0.80 = 80\%$$

Methods for Correcting Low Power Factor

- Operate a motor near its rated capacity to realize the benefits of a high PF design.
- Avoid operating equipment above its rated voltage.
- Minimize use of lightly loaded or idling motors.
- As standard motors burn out, install energy-efficient options.
- Install capacitors in the AC circuit to decrease the magnitude of reactive power. Capacitors provide the reactive power needed to start up and magnetize the motor instead of getting it from the grid.

Capacitor Banks

The KVAr rating of a capacitor shows how much reactive power it will supply. Each KVAr of capacitance decreases the net reactive power demand by the same amount. So, for example, a 20 kVAr capacitor will cancel out 20 kVA of inductive reactive power. Capacitors can be installed at any point in the electrical system and improve the PF between the point of application and the power source. However, the PF between the load and the capacitor will be unchanged. Capacitors are typically added at each piece of equipment ahead of groups of motors (motor control centers or distribution panels) or at main services.

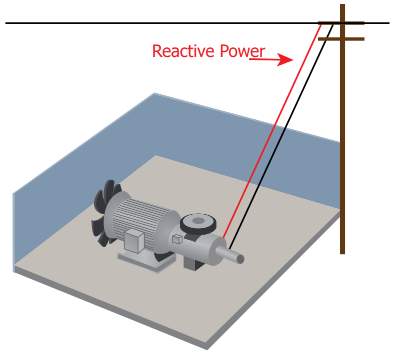
Switched Capacitors

Industrial facilities equipped with very large, intermittent inductive loads—such as big motors and compressors—may require switched capacitors, which are connected to individual motors or groups of motors and only operate when the motor is turned on. Or, capacitors can be switched on and off at the substation, depending on measured PF. Switching is only required if the capacitors needed are so large that they cause an undesirable PF during times when the large motors are turned off. Switched capacitors may cause problems for sensitive electrical equipment such as computers; consult an electrical contractor.

Does Power Factor Affect Energy Savings?

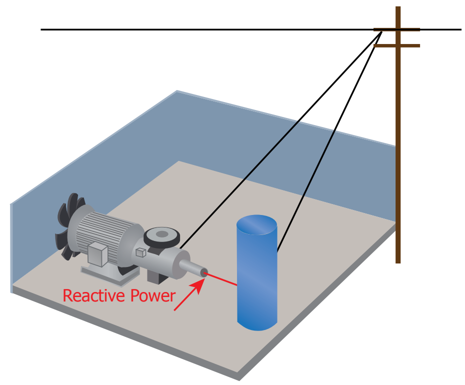
A higher power factor doesn't translate to greater energy savings and a reduced bill due to less consumption. Most energy efficiency programs are based on reductions in real power; PF improvements only reduce the apparent power. Any technologies that claim to reduce your energy consumption are only saving energy on system losses.

Motor Operating Without a Capacitor



A motor not outfitted with a capacitor pulls reactive power from the electric grid. The greater distance this power travels to reach the motor, the more it gets wasted along the way. This distance ultimately results in a lower PF.

Motor Operating With a Capacitor



A capacitor eliminates the need to get reactive power from the grid by providing the amount needed to start up and magnetize the motor. Using less electricity from the grid results in a higher PF.

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