

Power Factor

What is Power Factor and What Causes It?

Power factor is a measure of how efficiently you are using electricity. Various types of power are at work to provide us with electrical energy. Here is what each one is doing:

Working Power – The "true" or "real" power used in all electrical appliances to perform the work of heating, lighting, motion, etc. We express this as **kW** or kilowatts and are the consumed element of electrical power.

Apparent Power, which is called **kVA**, (kilovolt-amperes) is the element of electrical power that contains both the kW load as well as a non consumed element known as inductive reactance called kilovolt ampere reactance or, **kVAR**. Every home and business has both resistive and inductive loads. The ratio between these two types of loads becomes important as you add more inductive equipment the power factor may be adversely affected. **Consumed power (kW) and reactive power (kVAR) together equal kVA.**

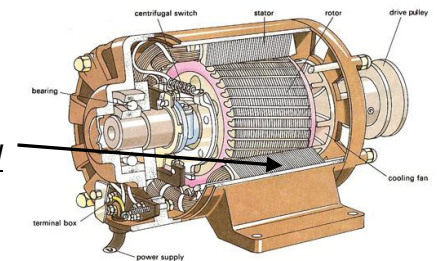
Electricity 101 (laypersons terms)

There are two fundamental electrical load types, **resistive** and **inductive**.



Common types of **resistive** loads are electric heating elements and **incandescent light bulb** which require no inductance or inductive reactance (kVAR) to operate. **Metal**, such as the filament, simply "resists" the flow of electricity and generates heat, light or both.

An **inductive** load, like motors, transformers or lighting ballast, requires a component of power that a resistive load doesn't which is called **Reactive Power** (*inductive reactance*) to generate and sustain a magnetic field in order to operate which is expressed in **kVAR** (*kilovolt ampere-reactance*).



This power (**kVAR**) is not actually consumed but is required for an inductive load to operate. **A good analogy to understand the relationship between kW, kVAR and kVA better is to compare what a bottle is to a bottle of water.** The water, the consumed component (**KW**), and the necessary bottle that is not consumed but is reusable(**kVAR**), together make up the total product that is delivered to you electrically (**kVA**). The manufacturer is not providing the bottle for free and the local electric utility that connects you to "The Grid" may no longer provide the kVAR for free to you.



Going one step further, **Power Factor** (PF) is the ratio of working power to apparent power, **PF = kW / kVA**. A high PF benefits both the customer and utility, while a low PF indicates poor utilization of electrical power. Many electrical utilities charge an additional cost if a PF less than 1.0.

Power Factor

What is Demand/Delivery?

A good representation to help understand the **electrical demand** is the **Speedometer/Odometer** for your car. The **Speed** is relative to the **Demand** and the **Odometer** is relative to the **kWH**. For the same miles traveled, two drivers can demand more or less speed. The higher the speed, the higher the demand is resulting in more fuel consumed and stress to the vehicle for the same distance traveled or kWHs. The higher the electrical demand the higher the cost for the utility to deliver the power. Therefore to fairly assess the cost of delivering power a demand meter will record the peak demand (speed) and charge accordingly so more efficient



customers don't pay for the less efficient customers and **is why most utilities charge for demand/delivery.** kWH's

If I purchase my power from a third party, can my Power Factor effect me?

Because the local utility must **deliver** both the **kW & kVAR** needs for **all its customers**, *regardless of where you buy your power from (kWH's) you still may be assessed a charge. The lower the PF is, the more burden is placed on their distribution grid.* This is why they charge for Power Factor and why purchasing your kWH's from a third party doesn't affect your PF penalty cost.

What is kW and kVA Demand?

The utility needs to **deliver kW** for equipment to perform the work **and kVAR** to magnetize all inductive loads as we discussed in **Electricity 101. The total power delivered is called kVA.** More and more utilities are installing metering to distinguish both kVAR and kW so they can more fairly charge for the kVAR requirement of individual customers.

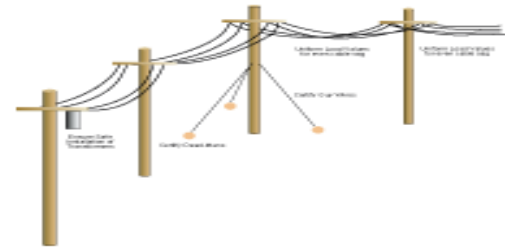
Do all Power Factor Correction opportunities promise savings?

No, if the utility doesn't measure the kVAR, you cannot save appreciable money on your electric demand/delivery charge. **this is important!** There are organizations promoting Power Factor Correction as cost effective for everyone and anyone due to kWH's savings which is untrue. Although in some cases a small amount of kWHs savings is possible it is usually insignificant and will not be enough to justify the cost of improving the PF alone. It's important that this is evaluated carefully and we can do this for you.

Power Factor

Example: A manufacturing operation runs at 100 **kW (Working Power)** and the **(Apparent Power) kVA** meter records 125. To find the PF, **divide 100 kW by 125 kVA to yield a PF of 80%**. This means that only 80% of the incoming current does useful work and 20% is used to provide the magnetizing of the motor stators, transformer core and ballasts' windings.

Power distribution system **transformers** have their capacity labeled in KVA (kilovolt amps), not kW because they require a significant amount of kVAr to magnetize the core. (KVA = VOLTS X AMPS X 1.73 (three phase System) ÷ 1,000) **They will also add to a low power factor especially if lightly loaded.**



With unity power factor (100%), it would take 2,000 kVA of generating and distribution network capacity to deliver 2,000 KW, perfect. If the power factor dropped to 85% however, 2,353 KVA of capacity would be needed for the same working power (kW)

What are kVAr and Reactive Charges

As discussed above the utility is required to deliver kW (working, consumed power) and **kVAr** (reactive unconsumed energy) Low power factor adds load to generating, distribution, and networks with excess kVAr. For this reason more utilities are charging for kVAr, (also call reactive energy) and this is what the charges are for. this can be done in a number of sometime confusing ways. If you feel this is affecting your cost of power you should contact us. **A correctly designed and installed power factor correction system will reduce additional kVA, kVAr and reactive charges** and restore the capacity of possible overloaded feeders and electrical services within the facility.

EPower Factor

What can be done to *improve my Power Factor?*

Power factor correction is achieved most commonly by:

1. **Fixed Capacitor Banks.** (fixed non automatic) The most practical and economical power factor correction device is the fixed PF capacitor. It improves the power factor because the effects of capacitance are exactly opposite those of inductance and is a simple device but its use is limited.

The kVAr rating of a capacitor indicates how much reactive power the capacitor will supply. Since kVAr (reactive power) is not consumed (the bottle) capacitors can be installed at strategic point(s) in the electrical system to supply the kVAr resulting in **reduced kVA, and reactive power (kVAr) delivered by the local utility.** This will improve the power factor between the point of application and the power source of power by storing and supplying this reactive current instead of requiring it continuously from the source. However, the power factor between the load and the capacitor will remain unchanged. Power factor correction systems in a large modern facility are usually installed at main services and/or sub stations at 480 volts to 25 kilovolts. However, fixed capacitors (no-automatic) may be installed directly on some motor loads. ***We can assist on determining if this is appropriate and if so what size is needed.***



2. **Switched Capacitors** (Automatic). Plants equipped with very large, *intermittent* inductive loads, such as large motors, compressors, etc., may require switched capacitors; that is, capacitors are **connected Main Electrical Switchgear** indoors or out. Therefore, they are only in action when the motor loads are operating and are on standby during light load periods.



The automatic switching capacitors systems are commonly required to avoid an undesirable leading power factor during times when facility loads are light.

EPower Factor

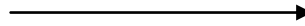
What do Power Factor Corrections Look Like?



This is a **GE Ultravar** 600 kVAr, 480 volt Automatic system with a built in 1200 ampere breaker unit installed outdoors in a NEMA 3R enclosure.



GE Ultravar Pole mounted power factor correction systems are available at all the common distribution voltages.



This is an example of one of our pad mounted 13.8 kV automatic power factor correction units.



These are examples of small and larger fixed **GE Ultravar** units available from 120/ 208 to 600 volts.

