



Nursery & Garden Industry  
Queensland

# Understanding and Managing Power Factor

Power factor is the way electricity providers measure how efficiently electricity is used across the electricity network and to customers. This can also be used to measure how efficiently individual equipment uses electricity.

A recent development in the way electricity companies provide power to businesses requires customers to ensure the power factor value at any electrical metering point is within the limits listed in Table 1.

| Supply voltage                  | Power factor range           |
|---------------------------------|------------------------------|
| 50 kV and 250 kV (high voltage) | 0.95 lagging to unity (1.0)  |
| 1 kV < 50 kV (medium voltage)   | 0.90 lagging to 0.90 leading |
| <1 kV (low voltage)             | 0.8 lagging to unity (1.0)   |

Table 1: Supply voltage power factor limits

Understanding power factor requires a knowledge of the terminology used:

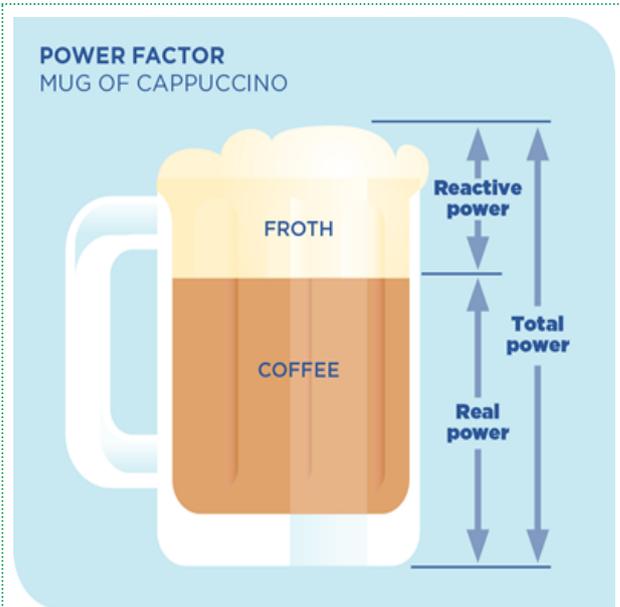
**Total Power = Real power + Reactive power**

**Total power** refers to the total amount of electricity supplied to the meter measured as kVA, this is the sum of:

**Real power**, which is the actual electricity used by equipment to create work, measured in kilowatts (kW), and

**Reactive power**, which is the power required to create and sustain electrical and magnetic fields in equipment such as electric motors. Reactive power doesn't create useful work, but is generated by inductive motors, transformers and solenoids.

**Power factor** is a measure of the ratio of the total power to the real power that is used on the equipment or installation - **Power factor = Real Power ÷ Total Power**. The higher the power factor,



the more efficient the site is at utilising the supplied power.

One of the principles of alternating current (AC) is there is a rapid cycling of electricity coming in from the grid and electricity being fed back to the grid (50 cycles per second or 50 hertz). In this process some electricity is lost through having to maintain fields in electric motors etc. Power factor is a measure of the difference between the amount of electricity being taken from the grid and what is fed back to the grid in this process e.g. a power factor of 0.8 means that 0.2 is lost.

A simple analogy to explain power factor uses a cappuccino. In the diagram the mug must be able to contain both the coffee and the froth. This corresponds to the total power. The froth represents the reactive power and the liquid the real power. Real value only comes from the liquid, which is comparable to the real power used by the equipment. To use an irrigation analogy, power factor is the same as a pumping system losing water through leaks in the system, and fixing the leaks the equivalent of upgrading electrical equipment.

To use a real life example, a large electric motor will typically have a power factor of about 0.85 at full load. If we have a hypothetical electric motor rated at 100 kW, and ignoring the inherent inefficiency of the motor, when running at full load the electricity supplier would have to provide  $100 \div 0.85 = 118\text{kVA}$  to deliver the 100 kW required to run the motor i.e. they would have to deliver 18% more electricity than the equipment uses, resulting in higher capital and operating costs for the supplier. These higher costs usually have to be passed on to all customers in the form of higher tariff rates.

The major sources of large power factors are:

- Inductive loads such as transformers
- AC motors
- Welding equipment
- Arc furnaces and fluorescent lighting.

**Benefits of improving power factor include:**

- Reducing demand on the electricity network, which may lower electricity costs if the business is being charged under a kVA demand tariff.
- Help meet connection requirements outlined within connection agreements.
- Reducing demand on the network may allow additional machinery or equipment to be connected, without the need to upgrade the network.
- The correct voltage being supplied to equipment, which may improve the life of the equipment.
- Reducing the supply of electricity, and so reduce the carbon footprint .

**Steps to identify and implement power factor correction.**

### **1. Identify if there are opportunities to improve power factor.**

There are a variety of ways to measure power factor:

- Logging devices used directly on individual equipment.
- Measurement and logging equipment installed on individual circuits.
- Smart meters can have the ability to display and record power factor for the entire site if it is programmed to do so. The operating manual for the meter will give instructions on how to find power factor information on the meter.

Electricity retailers may also be able to provide this information.

Most nursery businesses don't have the required skills or equipment to assess power factor, and specialists would have to be engaged to identify causes of low power factors, and solutions to improve them. Contact your electricity supplier for a list of companies who may be able to assist.

### **2. Design solutions to improve power factor**

Poor power factors can be addressed in a number of ways. The most common approach is to install power factor correction (PFC) equipment. PFC equipment is a capacitor bank which stores and provides reactive power when required. PFC equipment can be installed on separate pieces of equipment, or installed in bulk on the main switchboard.

A poor power factor can also be corrected by fixing the problem at its source. For example, by ensuring that motors aren't oversized, selecting pumping equipment with electronic variable speed drives (VSDs), retrofitting VSD's where possible, and choosing equipment that has a good power factor.

It should be noted that care needs to be taken when installing PFC equipment, as there are specific requirements that must be met to ensure the equipment doesn't affect VFD's.

After PFC equipment or other changes have been made, it's important to measure and verify the changes in power factor that have been achieved, and compare those to any pre-installation measurements. Installers of PFC equipment should be mindful of ensuring the installation does not impact on the electricity network e.g. affecting audio frequency load control (ripple controllers).

### **3. Maintenance**

Once PFC equipment is installed a maintenance programme will be required. Your supplier should be able to provide advice on the necessary maintenance that needs to be undertaken.

Lex McMullin  
Farm Management Systems Officer  
Nursery & Garden Industry Queensland