ALCAP GROUP

ALCAP EDUCATIONAL DOCUMENT | POWER QUALITY

Power Factor Correction

What power factor means, when correction saves money, and why proper measurement and design matter

Poor power factor makes an electrical system carry more current and apparent power than required for the same useful real power. Correctly designed correction can release capacity and reduce applicable charges, but it must suit the load and harmonic environment.

WHAT YOU WILL LEARN

- The relationship between kW, kVA, kVAR, and power factor
- How poor power factor affects current, capacity, and some tariffs
- Where capacitor banks and other solutions fit
- Why harmonics, load variation, and control steps must be studied

PRACTICAL. INDEPENDENT. DECISION-FOCUSED.
Written for South African commercial and industrial energy users. Prepared July 2026 | Version 1.0

01 | THE ESSENTIALS

Build the right mental model

AC loads may require both real power and reactive power. Real power performs useful work. Reactive power supports electric and magnetic fields. Apparent power represents the combined burden carried by the supply.

Power factor

For a balanced fundamental-frequency view, PF is commonly expressed as real power divided by apparent power: kW/kVA. A value closer to 1 means less apparent power for the same kW.

Why it matters

At lower PF, more current is needed for the same kW. This can increase losses and voltage drop, use transformer and cable capacity, and increase charges where the tariff bills kVA or reactive energy.

Correction

Capacitors can supply reactive power locally for inductive loads. Automatic banks add or remove steps as the load changes. Dynamic solutions may suit rapid variation or mixed power-quality needs.

USEFUL RELATIONSHIPS

Power factor = kW / kVA and **kVA = kW / PF**.

At 500 kW, PF 0.80 implies 625 kVA. At PF 0.96, the same 500 kW implies about 521 kVA, before considering harmonics and other site conditions.

A QUICK REFERENCE

Question	Evidence needed	Design implication
Is there a cost?	Tariff, bills, interval kW/kVA/kVAR	Value the avoidable charge
How variable is PF?	Logged profile by operating state	Fixed vs automatic/dynamic
Are harmonics present?	Spectrum, THD, load inventory	Detuning or filtering study
Where to correct?	Single-line, load location, capacity	Central, group, or local

02 | PUT IT TO WORK

Turn understanding into action

A good project starts with an interval power-quality study and a tariff model. Sizing from a single bill value or nameplate list can cause under-correction, over-correction, or resonance risk.

1. **Confirm the commercial driver**
   Identify the exact demand, reactive, capacity, or network charge that correction can influence.
2. **Measure operating profiles**
   Log kW, kVA, kVAR, PF, voltage, current, and harmonic distortion through representative cycles.
3. **Model the target**
   Choose a controlled target with operating margin; do not pursue unity PF without justification.
4. **Engineer the solution**
   Select steps, switching, ventilation, protection, detuning, fault rating, and connection point.
5. **Verify and maintain**
   Commission across load states, trend performance, and inspect capacitors, contactors, fuses, and reactors.

ILLUSTRATIVE EXAMPLE: CAPACITY RELEASE

A 400 kW load at PF 0.80 draws 500 kVA. At PF 0.95 it draws about 421 kVA. The theoretical reduction is 79 kVA. Financial savings depend entirely on the applicable tariff, coincident peak, correction availability, and operating profile.

A GOOD DECISION LOOKS LIKE

- The business case separates demand savings from small loss reductions.
- The design accounts for harmonic resonance and future PV or drive additions.
- Control steps avoid leading PF during light load or generator operation.

03 | CHECKLIST AND NEXT STEPS

Use this before you proceed

[ ]	Obtain the current tariff and at least 12 months of bills.
[ ]	Log kW, kVA, kVAR, PF, and harmonics at the intended connection point.
[ ]	Review the single-line diagram and short-circuit level.
[ ]	Inventory VSDs, UPSs, inverters, welders, and other non-linear loads.
[ ]	Specify detuning/filtering only from a proper study.
[ ]	Include commissioning tests and a recurring maintenance plan.

RED FLAGS

- A savings promise based only on kWh
- Sizing from one instantaneous reading
- Capacitors added without a harmonic assessment
- No control strategy for light load, PV export, or generator modes

PLAIN-LANGUAGE GLOSSARY

kVAR	Reactive power associated with electric or magnetic field energy.
kVA	Apparent power carried by the electrical system.
PF	Ratio or broader measure describing useful power relative to apparent power.
Detuned bank	Capacitor-reactor arrangement designed to avoid selected resonance conditions.
Leading PF	Condition where capacitive reactive power exceeds the inductive requirement.

SOURCES AND FURTHER READING

- Eskom - Power factor overview
- Eskom - Power factor sizing guide
- U.S. DOE - Solar inverters and grid services

IMPORTANT NOTE

This document is for general education only. It is not a substitute for a site assessment, electrical design, tariff review, safety study, or professional advice. Use the latest applicable standards, utility rules, municipal requirements, and manufacturer instructions. Work on electrical systems must be performed by suitably qualified and authorised persons.

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