GURUKRUPA GROUP

An Insight about Power Factor Improvement

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- What is Power Factor
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What is Power Factor

Power Factor is measure of how effectively your electrical equipment converts electric power(supplied by your power utility) into useful power output

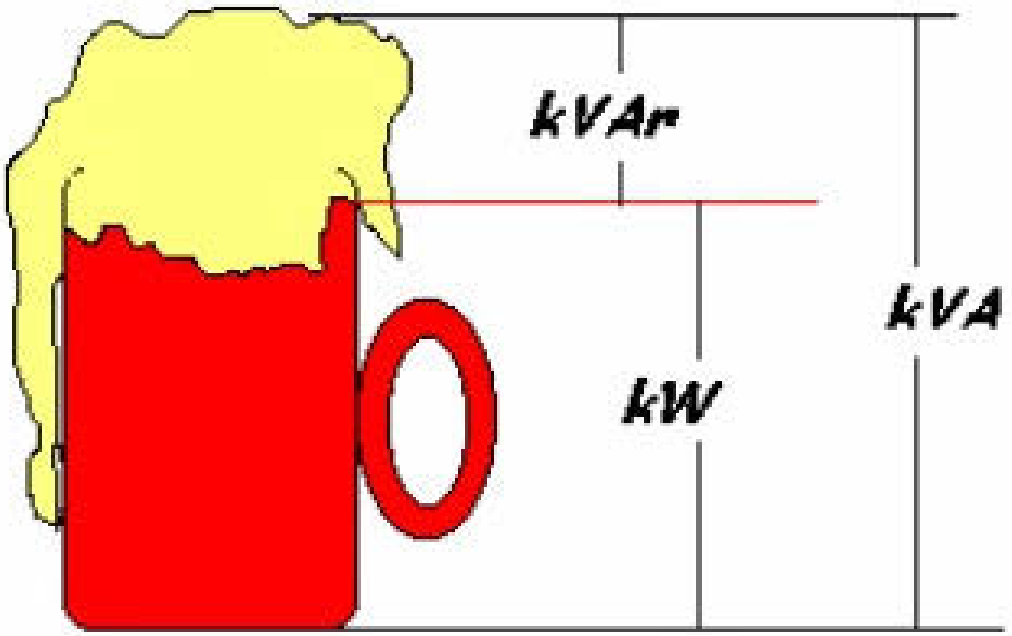
Power Factor is the **ratio of Active Power(kW) to the Apparent Power(kVA)** of an electrical installation

- **KW** is Working Power (also called Actual Power or Active Power or Real Power). It is the power that actually powers the equipment and performs useful work.

- **KVAR** is Reactive Power. It is the power that magnetic equipment (transformer, motor and relay) needs to produce the magnetizing flux.

- **KVA** is Apparent Power. It is the "vectorial summation" of KVAR and KW.

Simple analogy in order to better understand these terms….



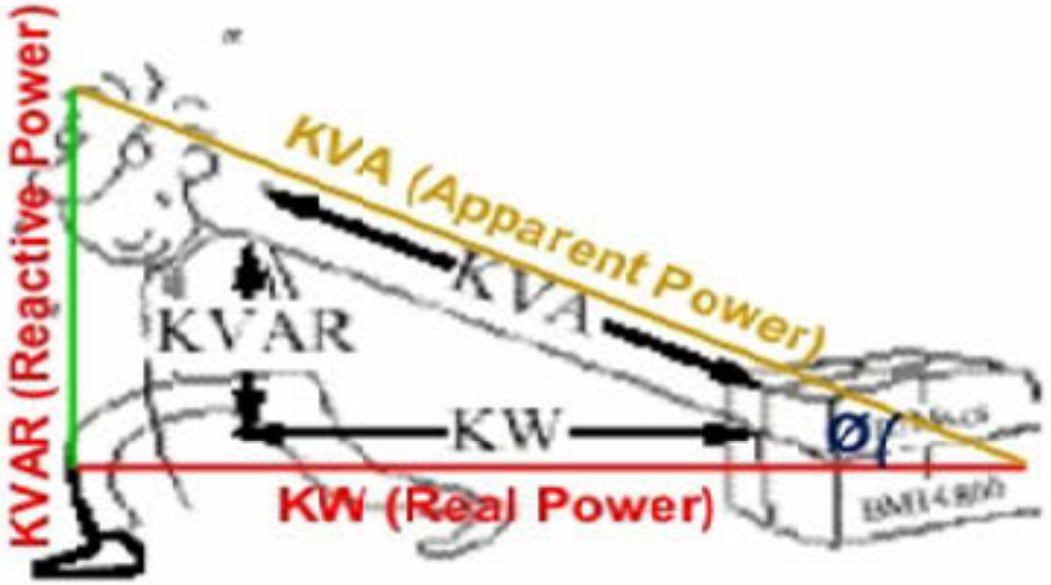
$$P.F. = \frac{KW}{KVA}$$

$$P.F. = \frac{KW}{KW+KVAR}$$

$$P.F. = \frac{Beer}{Beer+Foam}$$

- ✓ The more foam you have (the higher the percentage of KVAR), the lower your ratio of KW (beer) to KVA (beer plus foam). Thus, the lower your power factor.
- ✓ The less foam you have (the lower the percentage of KVAR), the higher your ratio of KW (beer) to KVA (beer plus foam). In fact, as your foam (or KVAR) approaches zero, your power factor approaches 1.0.

Power Traingle .....



$$\text{Power Factor (pf)} = \frac{\text{kW (Real Power)}}{\text{kVA (Total Power)}} = \text{COS } \emptyset$$

Power Factor (COS Ø) should be close to unity

What causes Low Power Factor

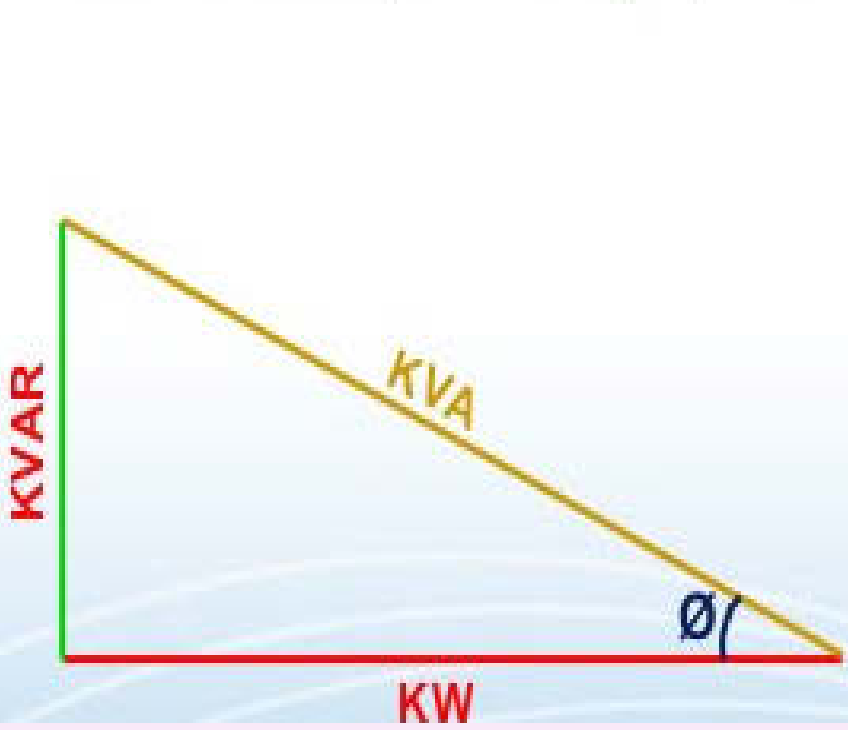
$$\text{Power Factor (pf)} = \frac{\text{kW (Real Power)}}{\text{kVA (Total Power)}}$$

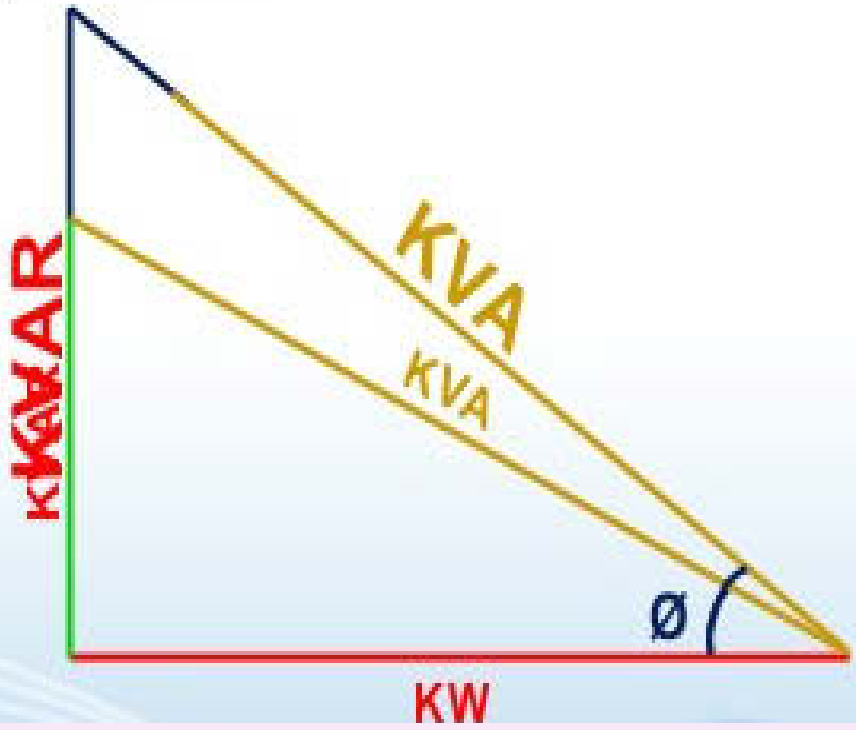
Low power factor results when KW is small in relation to KVA.
Remembering our beer mug analogy, this would occur when KVAR (foam, or Mac's shoulder height) is large.

What causes a large KVAR in a system? The answer is…**inductive loads.**

- **Transformers**
- **Induction motors**
- **Induction generators (wind mill generators)**
- **High intensity discharge (HID) lighting**

- Reactive power (KVAR) required by inductive loads increases the amount of apparent power (KVA) in distribution system.
- This increase in reactive and apparent power results in a larger angle measured between KW and KVA.
- As θ increases, cosine θ (or power factor) decreases.





Why should I improve my Power Factor

- Lower the Utility bill

  inductive loads require reactive power, caused your low power factor. This increase in required reactive power (KVAR) causes an increase in required apparent power (KVA), which is what the utility is supplying.

  So, a facility's low power factor causes the utility to have to increase its generation and transmission capacity in order to handle this extra demand.

  By raising your power factor, you use less KVAR. This results in less KW, which equates to savings from the utility.

- Increased system capacity and reduced system losses

  By adding capacitors (KVAR generators) to the system, the power factor is improved and the KW capacity of the system is increased.

  Reduces I2R losses in conductors

- Increased voltage level and cooler, more efficient motors

As uncorrected power factor causes power losses in distribution system. As power losses increase, you may experience voltage drops. Excessive voltage drops can cause overheating and premature failure of motors and other inductive equipment.

So, by raising power factor, minimizes these voltage drops along feeder cables and avoid related problems. Your motors will run cooler and be more efficient, with a slight increase in capacity and starting torque.

A 10% drop in terminal voltage from the rated,

- ✓ Will reduce the Induction motor torque by approx 19%,
- ✓ Increase full load current by approx 11%,
- ✓ Reduce overload capacity
- ✓ Increase temperature rise by approx 6-7 degrees.

How to correct Power Factor

We have seen that **consumers of Reactive power** (Inductive loads) decrease power factor

Similarly, **Sources of Reactive Power** increase power factor:

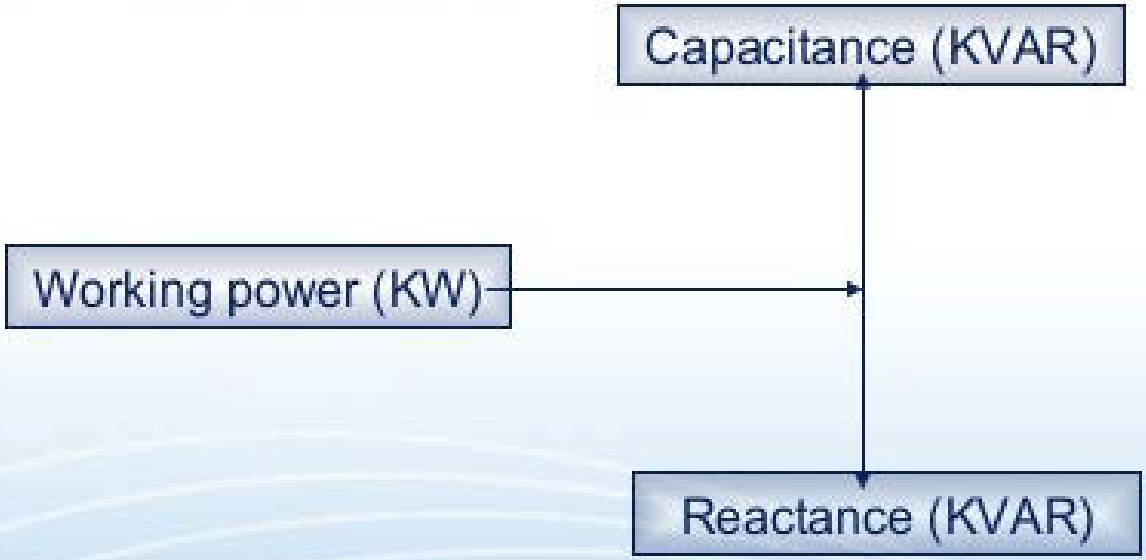
- **Capacitors**
- **Synchronous generators (utility and emergency)**
- **Synchronous motors**

One way to increase power factor is to add capacitors to the system.

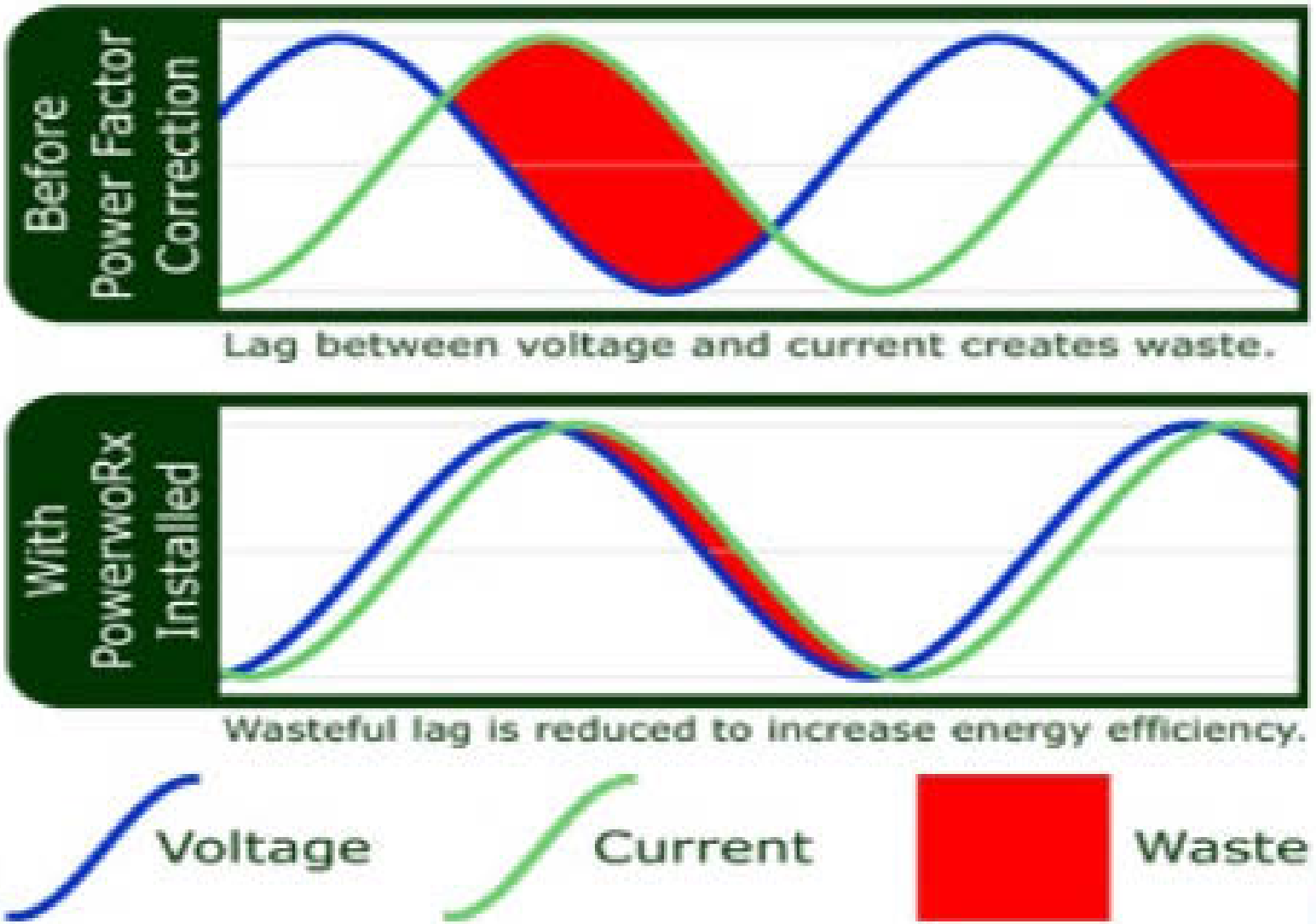
- **Installing capacitors (KVAR Generators)**

Installing capacitors decreases the magnitude of reactive power (KVAR), thus increasing your power factor.

Reactive power (KVARS), caused by inductive loads, always acts at a 90-degree angle to working power (KW).



Capacitors store KVARS and release energy opposing the reactive energy caused by the inductor.

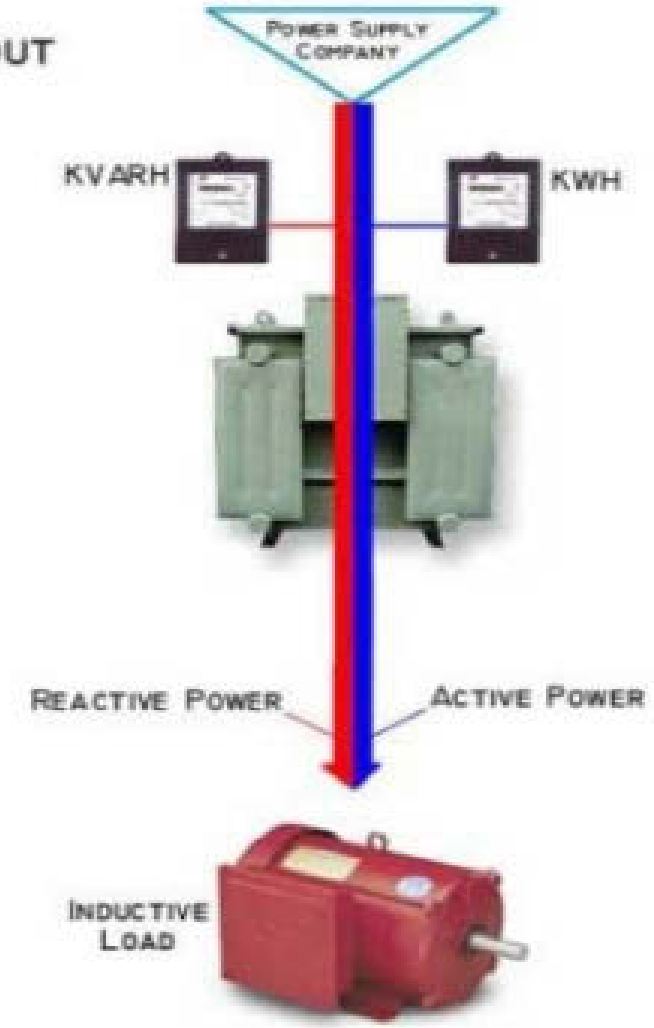

Before Power Factor Correction
Lag between voltage and current creates waste.
With PowerwoRx Installed
Wasteful lag is reduced to increase energy efficiency.
Voltage
Current
Waste

ELECTRICAL NETWORK WITHOUT CAPACITOR BANK

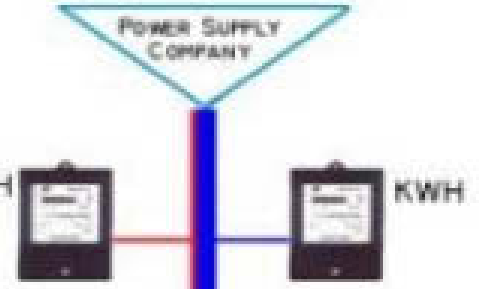
Inductive loads draw both active power and reactive power from power supply company

High transmission losses along cables and transformers

Surcharge maybe imposed by power supply company



Electrical Network with Capacitor Bank

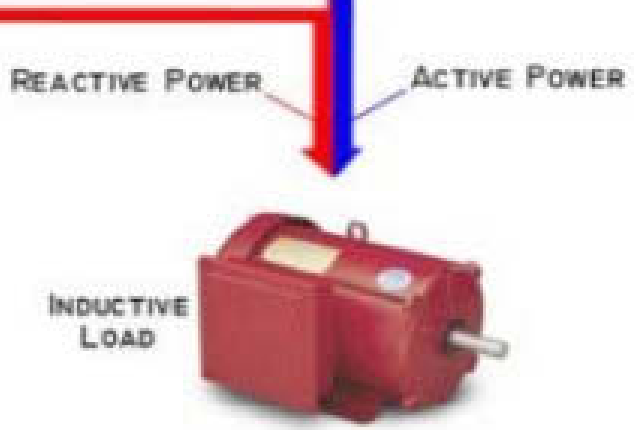


The waste power (reactive) is compensated by the capacitor

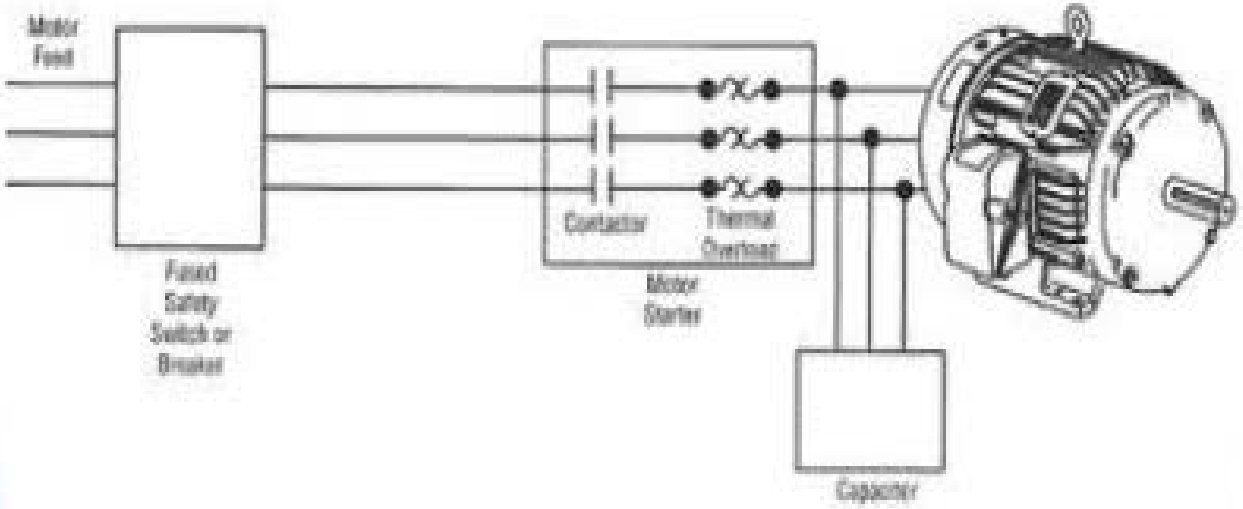
Apparent power or current is reduced

Power factor is improved

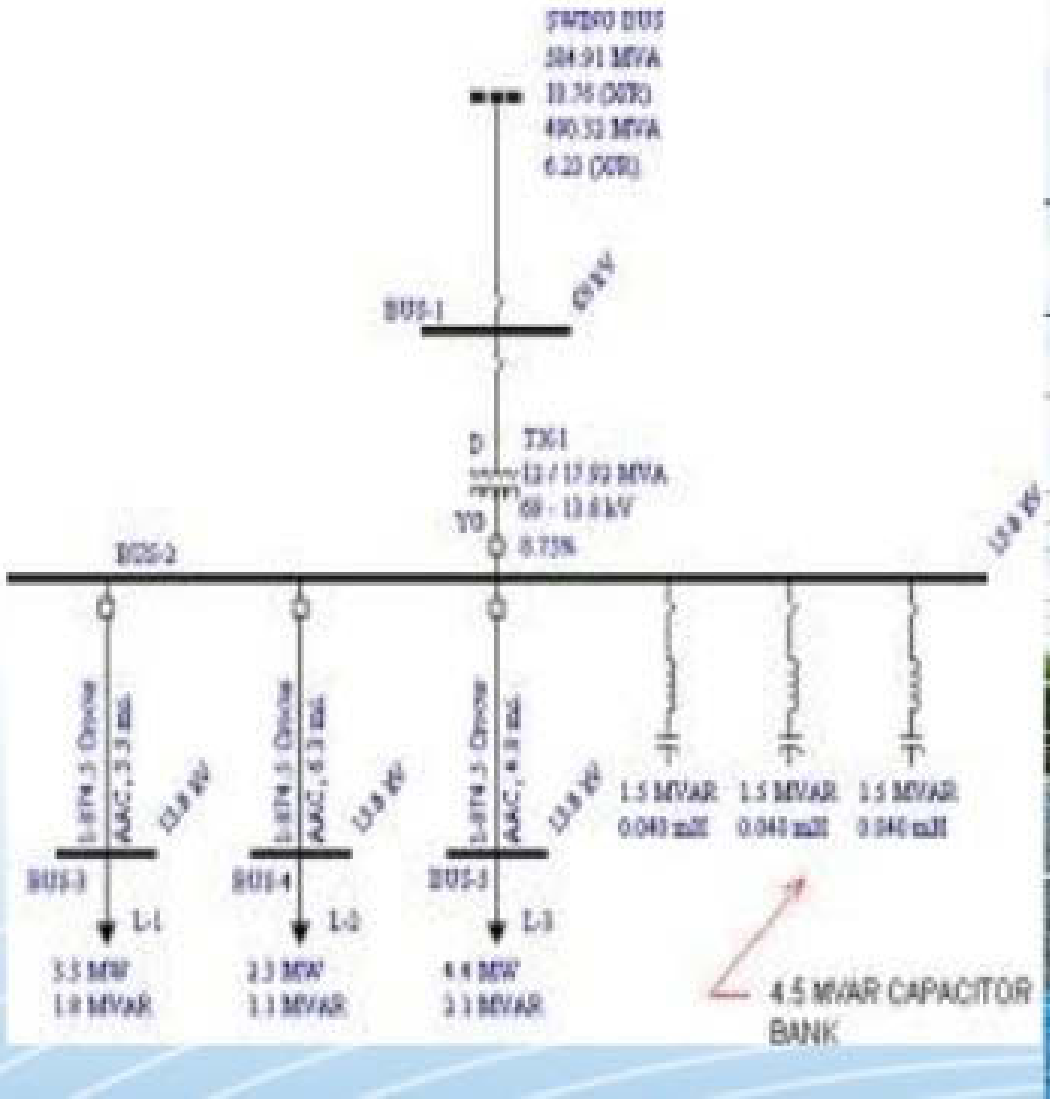
Smaller transmission losses at the transformer



Individual Correction



Group Correction



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