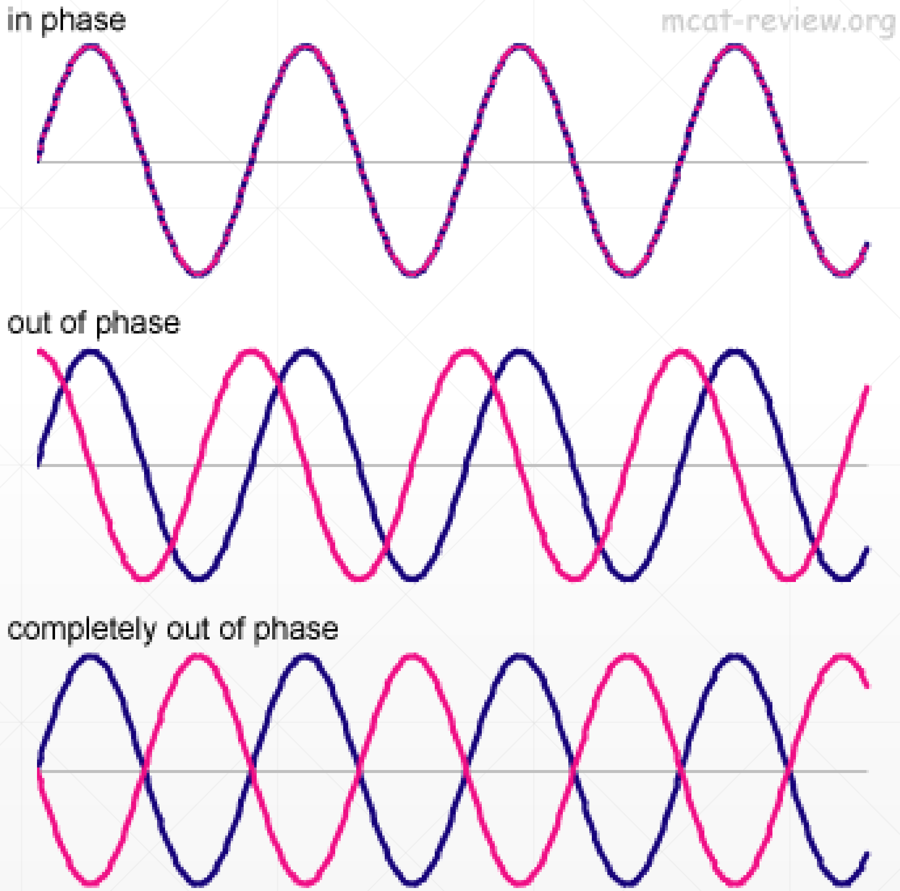
Power Factor and Efficiency

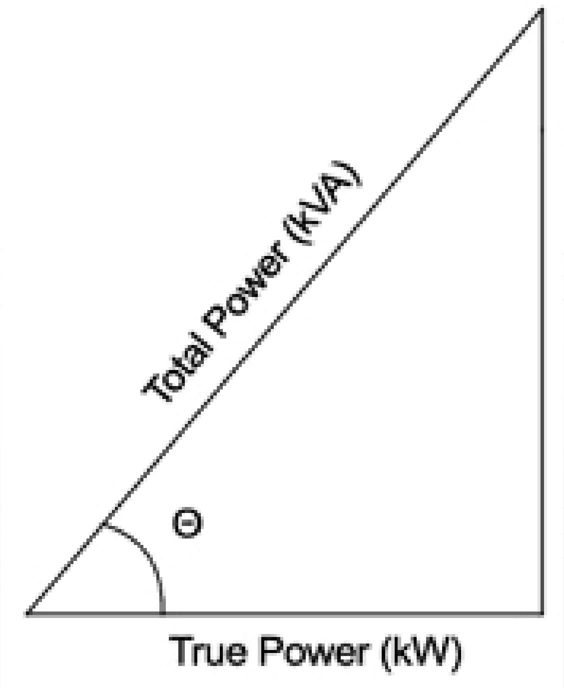
The out of phase relationship between voltage and current in AC circuits often leads to situations where more power in delivered to the load than is actually used.



Apparent Power

- If you measure voltage and current in an inductive or capacitive circuit, and multiply them together, the product is the apparent power supplied to the circuit by the source.
- Apparent power is in units of volts-amperes (VA)

Apparent Power = Volts x Amperes



True Power

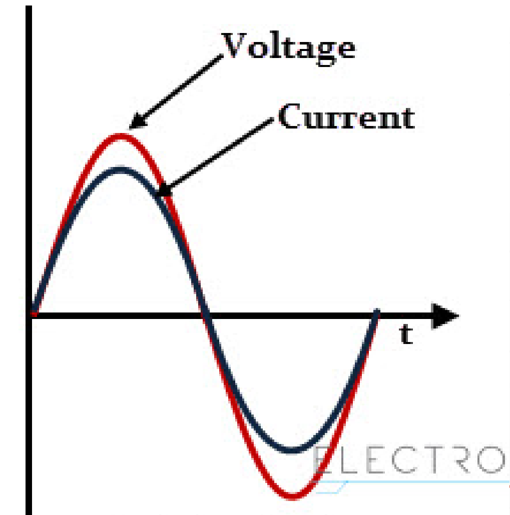
- TRUE POWER is the energy consumed and is expressed in watts.
- To determine the true power (W) consumed by a **DC circuit**: P = V x I
- But in an **AC circuit**, true power is found: P = V x I x PF
- PF = Power Factor. We'll talk about that next.

Power Factor

- As you know, AC inductive or capacitive circuits are out of phase with each other. POWER FACTOR is a measurement of how far the current is out of phase with the voltage.
- Power factor is defined as a ratio of true power (W) to apparent power (VA)
- **PF = W/PF**

Unity Power Factor

- When an AC circuit supplies power to a purely resistive load, the circuit voltage and current are in phase with each other.
- Because the voltage and current reach their zero and peak values at the same time, there is no leading and lagging of the voltage to the current.
- So the power factor is 100 percent (or 1.00). This is known as UNITY POWER FACTOR.

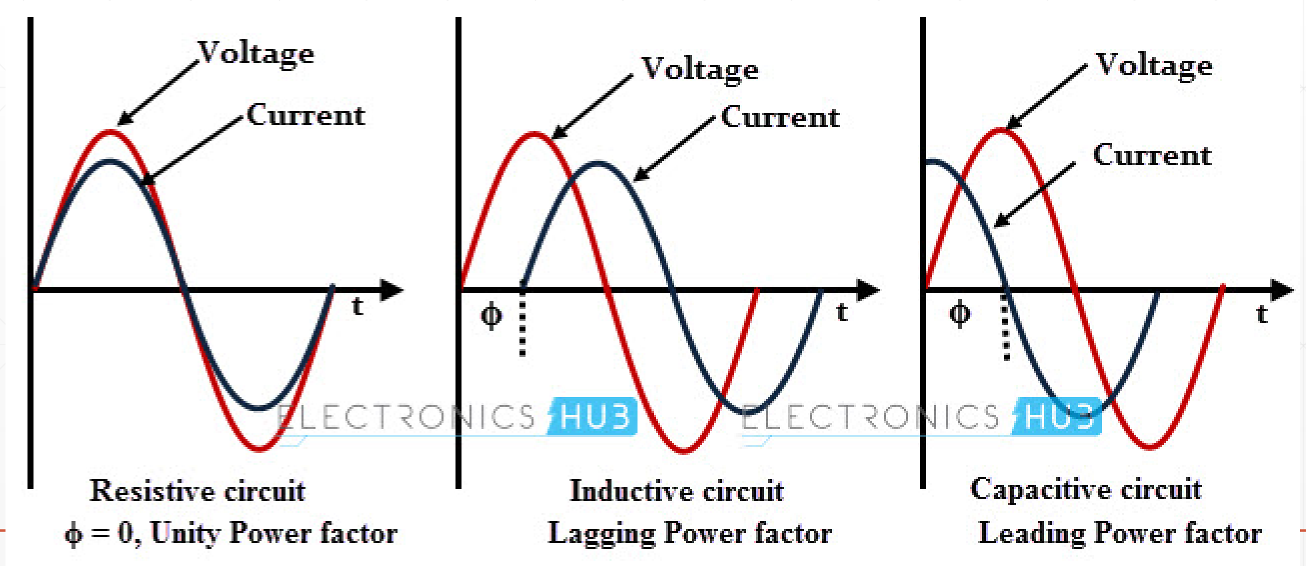


Resistive circuit

$\phi = 0$, Unity Power factor

Power Factor Equations

- Power Factor = True Power / Apparent Power **(PF = W / VA)**
- Apparent Power = True Power / Power Factor **(VA = W / PF)**
- True Power = Apparent Power x Power Factor **(W = VA x PF)**



Cost of True Power

- The cost of electrical power is based on the true power consumed during a month, multiplied by the cost of kWH (1,000W for a period of one hour).
- Because the VA of the load is greater than the watts of the load, fewer loads can be supplied by each branch circuit.
- **More circuits and panels, and larger transformers may be required.**

Efficiency

- Electricity is used to transfer energy to operate motors, light, heat and so forth.
- In this transfer of energy, there are power losses, or waste, in the conductors, the power supply, and the load itself.
- The total amount of power loss in watts is indicated by the term “efficiency.”

Efficiency = how much energy is used for its intended purpose and is expressed as:

the ratio of output true power to input true power

If equipment is rated at 90% efficiency, then 90% of the input power is used for its intended purpose.

10% of the input power is wasted.

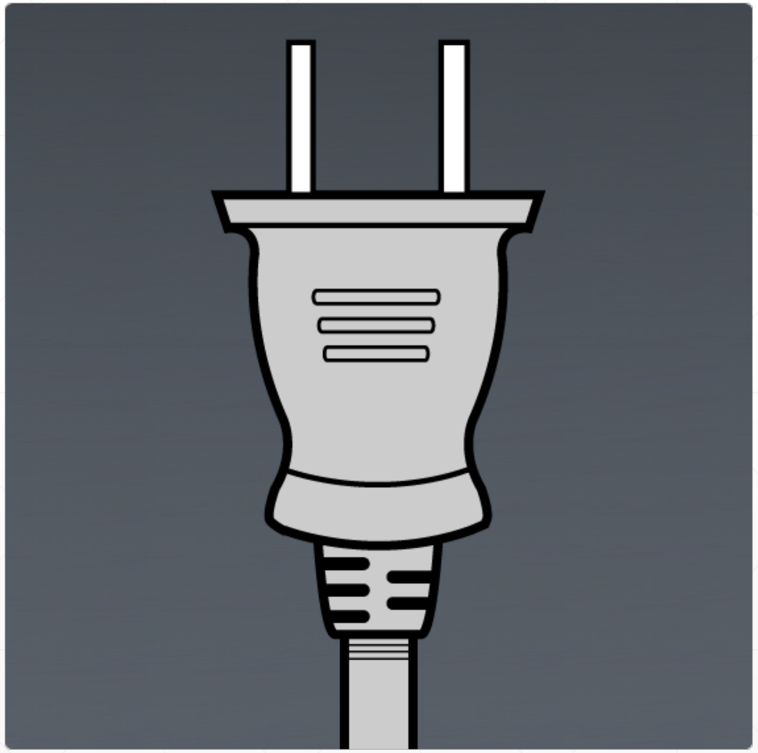
When energy is not used for its intended purpose, it is called “power loss.”

Conductor resistance, mechanical friction, and other factors can contribute to power losses.

Efficiency Formulas

The formulas that are often used with efficiency calculations are:

- Efficiency = Output Watts / Input Watts
- Input Watts = Output Watts / Efficiency
- Output Watts = Input Watts x Efficiency



If the output of a load is 520W and the input is 700W, what is the efficiency of the equipment?

- Efficiency = Output Watts / Input Watts
- 520W / 700W
- Efficiency = 0.74 or 74 %