Single-Phase Power vs Three-Phase Power

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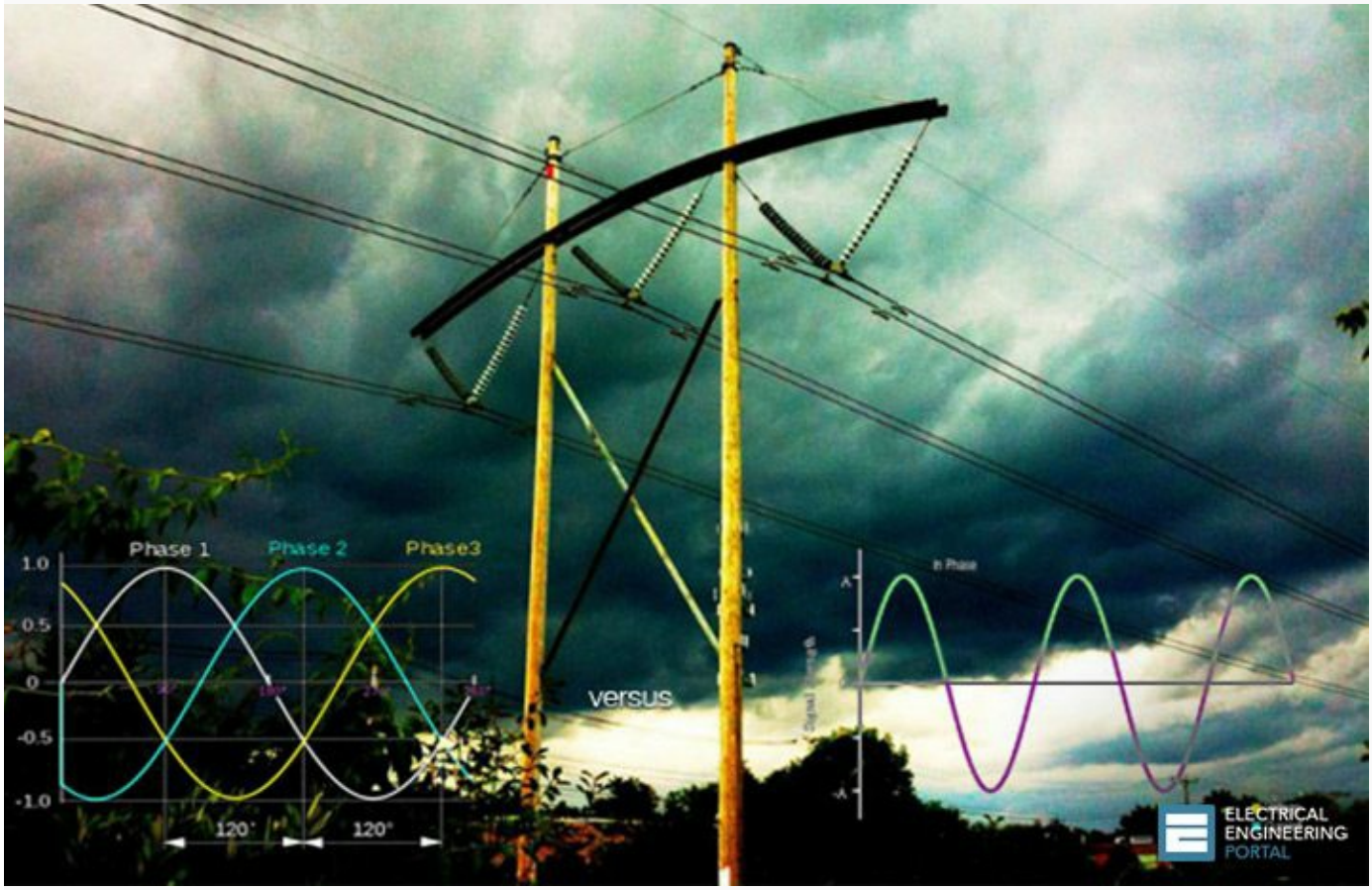

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Electric Power System

The principal elements of an electric power system are the generating stations, the transmission lines, the substations, and the distribution networks. The generators produce the electricity, the transmission lines move it to regions where it is consumed, and the substations transform it for industrial, commercial, and residential use.

Finally, the distribution networks carry the electricity to the customers.

Most AC power is generated as **three-phase power**.

Both three-phase and single-phase devices can be powered from a three-phase supply. A three-phase circuit is a combination of three single-phase circuits. The current, voltage, and power relations of balanced three-phase AC circuits can be studied by applying the rules that apply to single-phase circuits.

The sine waves of three-phase voltage are separated by ***120 electrical degree*** because they are generated by three separate sets of armature coils in an **AC generator**. These three sets of coils are mounted 120 electrical degrees apart on the generator's armature. The coil ends could all be brought out of the generator to form three separate single-phase circuits, but they are conventionally interconnected so that only three or four wires are actually brought out of the generator.

> *Single-phase AC voltage with zero power factor has both voltage and current sine waves in phase, so they cross the zero line together twice in each cycle.*

Similarly, a plot of three-phase voltage sine waves, also with zero power factors as shown in ***Fig. 1***, has all three voltage and current waves crossing the zero line twice each cycle together. Each of its three phases, **V1**, **V2**, and **V3**, is separated by 120 electrical degrees.

Power supplied to each of the three phases of a three-phase circuit also has a sinusoidal waveform, and the total three-phase power supplied to a balanced three-phase circuit remains constant.

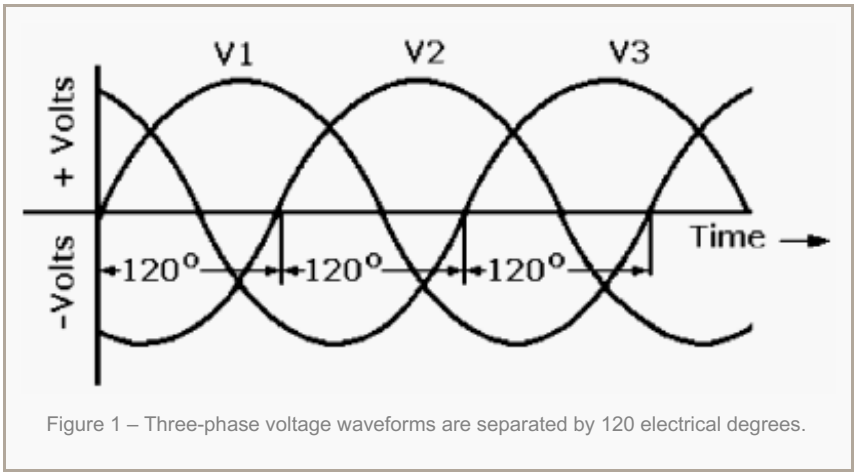

Figure 1 – Three-phase voltage waveforms are separated by 120 electrical degrees.

Ok, let's conclude something…

As a result, there are two practical reasons why three-phase power is superior to single-phase power for many applications:

1st reason – Three-phase machines and controls can be smaller, lighter in weight, and more efficient than comparable single-phase equipment. More power is supplied to them in the same period than can be supplied by a single-phase power circuit.

However, the trade-off for this advantage is that three-phase machines and controls are more complex and expensive.

2nd reason – Only about 75 percent as much copper wire is required for distributing three-phase power as is required for distributing the same amount of single-phase power.

Resources: *N. Sclater, J. E. Traister – Handbook of electrical design*