Electric Power Generators: How They Work

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Electricity powers your light switches, computers, phones and more! How do we generate all the electricity used to power are homes? Learn how Electric Power Generators work here.

“Nothing is too wonderful to be true if it be consistent with the laws of nature.”

Michael Faraday

History

The principle of electromagnetic induction is the basis of the generation of electricity.

Discovered in 1830 by Michael Faraday, this later led to the development of the dynamo by Pixie. This started the generation of electricity by converting mechanical energy from steam turbines and hydro turbines. Be it the generation of a few watts of electricity or millions of watts (mega watts) of electricity, the basic principle remains the same.

The Basics of Generators

In its simplest form the electric generator consists of

- A magnet that produces a magnetic field.
- A movable copper conductor placed at right angles to the magnetic field,

When the copper conductor moves, the conductor cuts the magnetic field. This produces an emf (electromotive force) or voltage, which sends an electric current through the copper conductor.

Mechanical energy moves the coil converting it to electrical energy.

Modern Electrical Generators

In real life, the electric generator is slightly different.

- The magnet is an electromagnet and it rotates. This is the 'rotor' or the 'field' and consists of wound conductors on the rotating part of the generator.
- The copper conductor is stationary called the ' stator' or the 'armature'. This consists of high current carrying copper coils wound on the stationary part of the generator.
- The rotor's rotating magnetic field cuts the stationary stator copper conductors to produce the electric current.
- The energy for rotation of the rotor is from a rotating turbine or an Internal Combustion engine.

All generators use this basic principle. Only the primary energy source and prime mover is different. The prime mover can be a steam turbine, a gas turbine, a wind turbine, or a hydro turbine.

One very important factor about electric generators is their synchronised operation.

All the power plant generators connect to the national or the regional transmission grid. The domestic, public, or industrial users get the electricity from this grid. This means all these generators should produce electric power that has the same characteristics.

Three Characteristics

The three important characteristics are

Frequency: The power what we get is an alternating current with 50 Hz, which very simply means the voltage and the directional flow of the electric current changes 50 times a second. In the US, Japan, and some other countries the frequency is 60 Hz. Even though this is something we cannot see or feel this is a very important in the design of and operation of electric generators and appliances.

Voltage: this is the main electromotive force that drives the electric current. Large generators produce electricity at 20,000 volts, smaller generators output at 400 volts or 6000 volts. These voltages are "stepped up or down" as required for transmission and distribution to the user. Transmission of electricity over large distances takes place at very high voltages in the order of 150,000 to 400,000 volts or more. A domestic user needs electricity at 230 volts (120 volts in US). Even though the different types of generators produce voltages at certain standard levels, at the connection point to grid they all have to have the same equivalent voltage.

Phase: Large electric power generators produce 3-phase electric power. Very simply put this means there are three different circuits each generating power at the same voltage and frequency. The only difference is the highs and lows in each circuit takes place at different times in each of the 50 Hz cycle. The advantage is the electric current through each conductor is one third of that of a single phase making it very cost effective in transmission and application. In addition, it is easier to produce a magnetic field required to run an electric motor. Household appliances work only on a single phase, but almost all of industrial application at higher loads use 3-phase.
While connecting a generator to the grid it is very important that these three characteristics match with that of the grid to which it is connected. If not properly done this can disastrously damage the generator. The process of connection is known as synchronisation.

Source:

http://www.brighthubengineering.com/power-plants/45558-electric-power-generators-how-they-work/