Understanding electrical power systems short

Understanding electrical power systems short

Electricity is the movement of electrons along electrical conductors (wires) that form a closed circuit. In itself, electricity is not that useful, but it is valuable as a source of energy. It is also easier and more convenient to transport electricity than other energy carriers over long distances and it is versatile in the sense that it is readily convertible into other forms of energy like heat, light and mechanical energy.

Measuring electricity. Since electricity is a form of energy like heat, it can be measured and ex-pressed in similar terms. The conventional unit of measuring any type of energy is joule (J). Related to this is the concept of power, which is the rate at which energy is delivered. Mathematically power is equal to the quantum of energy delivered divided by the time in which it was delivered. Power is measured in watts (W), where one watt is equal to one joule of energy delivered in one second.

Watt-hours. In practice, electrical energy or electricity is often not expressed in joules but rather by referring to power. Conventionally electricity is measured in Watt-hours (Wh) with one watt-hour being equal to the amount of energy delivered by one watt in one hour. But one Wh is an extremely small quantum of energy in practical applications in power systems. Therefore kilowatt-hours (1 kWh = 1000 Wh) or megawatt-hours (1 MWh = 1000 kWh) are used. Very high quantum of electricity is measured in gigawatt-hours (1 GWh = 1000 MWh) and terawatt-hours (1TWh = 1000 GWh).

Electrical circuit. Electricity flows through electrical circuits, usually conductors (wires) made of copper or aluminum. A simple electrical circuit would like one shown in Figure 1 in which a light bulb is connected to a source of electricity through wires. The symbols used in that figure are standardized electric symbols.

Energy loss in electrical circuits. When electricity flows through a substance, including electric wires and cables, some of it is lost (in the form of heat) due to the "resistance" offered by the substance. Think about electric current as water flowing through a pipe and resistance as the friction offered by the pipe to the flowing water. Resistance offered by a conductor is measured in Ohms. Mathematically, the energy loss is roughly proportional to square of the current flow. In other words, by cutting the current by 50%, energy loss can be reduced by 75%.

We saw earlier that, for a given value of power, voltage is inversely proportional to current (power is equal to voltage times current, so for the same value of power current is equal to power divided by voltage). This implies that electrical energy lost in a circuit, for a given power delivered and a given resistance, is inversely proportional to the square of voltage.

Installed capacity. Each generating unit in a power plant has an installed or nameplate capacity, which is its maximum mega-watt (MW) electrical power capacity that the unit can generate. Corresponding to this

generation capacity is the actual electrical generation, which is measured in megawatt hour (MWh). Remember that one MWh is equal to the amount of electricity generated by a generating unit with a capacity of one mega-watt running continuously for one hour.

Where G is generation in mega-watt hours (MWh), C is capacity in mega-watt (MW) and time is hours for which the generating unit is run. Note that, because the year has 8760 hours, a one mega-watt generating unit can generate a maximum of 8760 MWh of electricity during a year. Practically, actual electrical generation from a unit is lower than its installed capacity and is measured by electrical meters. Power stations are explained in more detail in Power plants.

Distribution. The distribution system consists of electric lines, substations and cables reaching all the way to the consumers. Distribution has two distinct functional components - distribution and supply. "Distribution" refers to the physical network through which electricity is transferred from the transmission system to end consumers. "Supply" refers to the commercial activities related to selling power to consumers, including metering, contracting and billing.

Organizing power systems. The institutional relationship between generation, transmission and distribution systems is determined by the market structure of the electricity industry. The legal system also puts restrictions on ownership of the different functions - supply and distribution are jointly operated as a single function in many areas, while that might not be the case in other locations.

The ways the electricity industry is organized varies greatly across the world and has changed over the course of history. To see their differences, it makes sense to think about the industry in terms of different functions of steps in the value chain: generation, transmission, distribution, and retail supply. These can be either provided by one firm or by separate firms; and they can be working under competition or as regulated monopolies.