Lesson 10: Cost and Electrical Power Use

Once the electrical system is in place, electrical consumption and the cost of electrical use becomes important. Four factors affect calculations related to electric power: watts, volts, amperes, and resistance. The relationship between these factors was first described in 1826 by a German physicist named Georg Ohm, who devised Ohm's Law for calculating electrical resistance.

The Power Equation and Ohm's Law

The power equation is a mathematical formula that expresses the amount of power used in an electrical circuit or system. It indicates the relationship between wattage (P), amperage (I), and voltage (E).

$$P = I \times E$$

This equation is primarily used to calculate power usage in watts, but the formula can also be used to determine the amperage or voltage of a system if the other two factors are known. These calculations are important when testing an electrical system for efficient operation and for calculating the power use of individual branch circuits or the total system.

Ohm's Law is a mathematical formula that expresses the relationship between electromotive force (E), electric current (I), and resistance (R). Electromotive force, which is measured in volts, is the pressure created by the movement of electrons from one point to another. Electric current is measured in amps. The final factor, which is referred to as resistance in DC circuits, is measured in ohms. The formula for Ohm's Law is as follows.

$$E = I \times R$$

When working with AC circuits, impedance (Z) is used rather than resistance. Impedance describes the counter electromotive force created by the directional change in the AC circuit. The strength of the resistance depends on the rapidity of the directional change. The more frequently the electrical current switches directional flow, the higher the impedance will be.

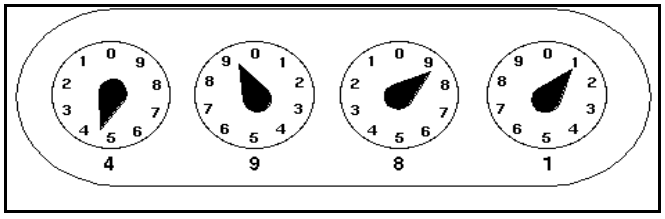
Ohm's Law is used to determine the energy efficiency of an electrical circuit, looking at factors such as voltage drop. It helps electricians determine if changes need to be made in a system, such as using fewer outlets or larger wire sizes. The equation can also help in determining if expanding an existing system is feasible.

To make calculations using the power equation or Ohm's Law, measurements of the electrical system must be made. Handheld electrical meters are available to measure each of the factors used in the equations. An ammeter measures amperage, while a volt meter measures voltage. A watt meter measures wattage, showing how much power is flowing through the system by analyzing both amperage and voltage. An ohmmeter measures resistance in the electrical system. These types of meters are used by electricians to test an electrical system.

Measuring Electricity

To calculate how much electricity is used, being able to read and understand the measurements used to check electrical consumption is necessary. Electrical power is measured by power companies using a watt-hour meter, which measures and instantly records electrical consumption in watts or kilowatts. The watt-hour meter is attached to the electrical system at the meter base, a socket that the meter plugs into. Meters are located at or near the service entrance panel in homes and on individual structures or at the power pole when a number of structures will be operating on the electrical service.

Two types of meters are commonly used. The newer type uses a rotating meter similar to the mileage indicator on a car. This meter is easier to read than the older type, which has several rotating pointers that turn as electricity is used, as shown in Figure 10.1. The following system



is used when reading the pointer-type meter.

- The first dial is read counterclockwise.
- The second dial is read clockwise.
- The third dial is read counterclockwise.
- The fourth dial is read clockwise.

The numbers are written down from left to right. If the pointer is between numbers, the smaller number is read. The numbers give the kilowatt-hour usage for that point in time.

Determining the Cost of Electricity

Electrical bills are calculated on a monthly or bimonthly basis in most areas. The bills are based on a scale set up by the local electric company. Some companies use a sliding scale that decreases price as usage increases. Others use a fixed rate.

Calculating the cost of electricity requires the rate scale from the electric company and the total kilowatt-hours consumed. To determine the total use over a period of time, the previous meter reading is subtracted from the current one. Cost calculations will vary depending on whether a sliding scale or fixed rate is used, but the basic calculation involves multiplying the rates charged by the amount of electricity used.

For example, suppose that last month's meter reading was 2,000 kilowatt-hours. This month's is 3,511 kilowatt-hours. Using the sliding rate scale given below, what would the cost be?

Sliding rate scale:

$ .08 for the first 100 kWh
$ .07 for the next 200 kWh
$ .06 for the next 300 kWh
$ .05 for the next 500 kWh
$ .04 for over 1,100 kWh

Total kilowatt-hours consumed:

3511 kWh - 2000 kWh = 1,511 kWh

Cost:

First 100 kWh × $ .08 = $8.00
Next 200 kWh × $ .07 = $14.00
Next 300 kWh × $ .06 = $18.00
Next 500 kWh × $ .05 = $25.00

1,511 kWh - 1,100 kWh = 411 kWh
411 kWh × $.04 = $16.44

Total cost:

$8.00 + $14.00 + $18.00 + $25.00 + $16.44 = $81.44

Summary

The power equation and Ohm's Law measure the flow of electricity through an electrical system. They make it possible to calculate loads for each structure, check electrical costs, and plan for future expansion to meet electrical needs. When the electrical system is in use, the amount of electricity used can be calculated by reading the watt-hour meter. This information can be used to determine the cost of electricity.

Credits

Holzman, H.N. *Modern Residential Wiring.* South Holland, Ill.: Goodheart-Willcox Company, Inc., 1986.

Richter, H.P., and W. C. Schwann. *Wiring Simplified*. 38th ed. Somerset, Wis.: Park Publishing, Inc., 1996.