Electrical energy is transferred at high potential differences to minimize energy loss

When transporting electrical energy by power lines, such as those shown in **Figure 16,** power companies want to minimize the I^2R loss and maximize the energy delivered to a consumer. This can be done by decreasing either current or resistance. Although wires have little resistance, recall that resistance is proportional to length. Hence, resistance becomes a factor when power is transported over long distances. Even though power lines are designed to minimize resistance, some energy will be lost due to the length of the power lines.

As expressed by the equation $P = I^2R$, energy loss is proportional to the *square* of the current in the wire. For this reason, decreasing current is even more important than decreasing resistance. Because $P = I\Delta V$, the same amount of power can be transported either at high currents and low potential differences or at low currents and high potential differences. Thus, transferring electrical energy at low currents, thereby minimizing the I^2R loss, requires that electrical energy be transported at very high potential differences. Power plants transport electrical energy at potential differences of up to 765 000 V. Locally, this potential difference is reduced by a transformer to about 4000 V. At your home, this potential difference is reduced again to about 120 V by another transformer.

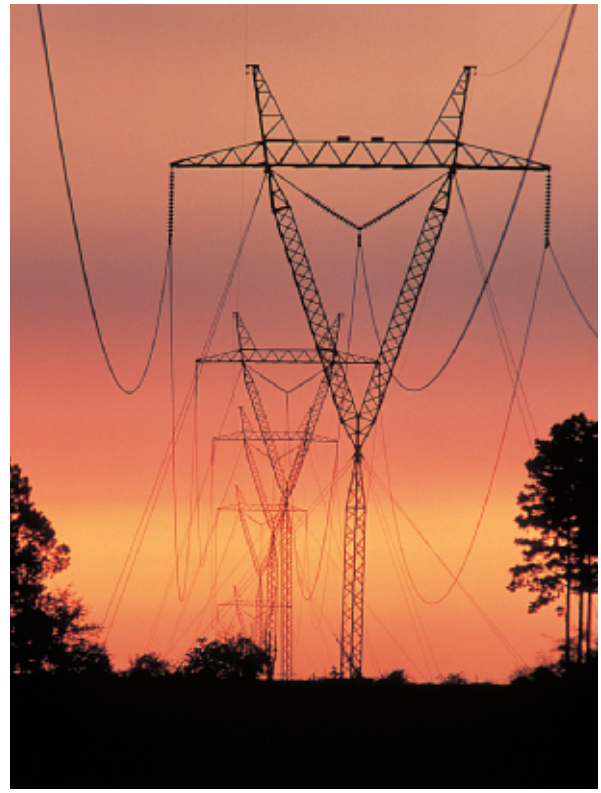

Figure 16
Power companies transfer electrical energy at high potential differences in order to minimize the I^2R loss.

SECTION REVIEW

1. What does the power rating on a light bulb describe?
2. If the resistance of a light bulb is increased, how will the electrical energy used by the light bulb over the same time period change?
3. The potential difference across a resting neuron in the human body is about 70 mV, and the current in it is approximately 200 μA. How much power does the neuron release?
4. How much does it cost to watch an entire World Series (21 h) on a 90.0 W black-and-white television set? Assume that electrical energy costs \$0.070/kW•h.
5. Explain why it is more efficient to transport electrical energy at high potential differences and low currents rather than at low potential differences and high currents.