Electrical Bloopers: Megawatts, Volts, and All That

Since reporters are seldom trained as electrical engineers, news items about electrical topics often contain errors, as the following examples show.

1. An Associated Press article headlined "Suit Accuses Teacher of Using Electric Shocks", reported that a shop teacher disciplined a student named Justin by forcing him to hold a spark plug in one hand "and a piece of metal connected to an electric current in the other." The lawsuit claims that this "caused three volts of electricity to course through Justin's body."

What's wrong?

"Connected to an electric current" — If Justin touched a metal object in which a current was flowing, then a current would go through Justin only if his body completed a circuit from the piece of metal to the other end of a voltage source connected to the piece of metal. This is why little birds can sit safely on one wire of a power line – their wings or legs don't reach from one wire to the neighboring wire.

"Three volts" — That's only the voltage you get by connecting two 1.5-volt AA batteries end-to-end (in series), with the positive (plus) end of one attached to the minus (negative) of the next. You can't even feel that voltage with your fingers! Don't feel too sorry for Justin.

2. "Vandals Disrupt 500,000 Volts of Power" Source: Bonneville Power Authority (!) Vandals shot at insulators on high-voltage transmission towers and caused this problem.

What's wrong?

"Volts of power" — This article confuses voltage, which is what forces electric current to flow through a circuit, with power, which is a measure of the amount of electric energy that flows every second past a point in a circuit.

Analogy with water flow: Since we have direct experience with water flow, a garden hose analogy might help. Voltage is analogous to the water pressure difference, in pounds per square inch, between the hose faucet and the air just outside the nozzle. Electric current, measured in amperes, is analogous to the water flow rate, which may be measured in gallons or cubic feet per minute.

Analogy with wages: The rate of consumption of electric energy -- measured in watts -- is like the rate at which you get paid -- so many dollars per hour. To find out how much total pay you'll receive, you multiply the rate of pay in dollars per hour times the number of hours you worked. Similarly, when you buy electric energy you are charged for the rate of energy delivery, in kilowatts, times the duration of the delivery, in hours, so the unit for electric energy is the kilowattwatt-hour.

The volt is the unit in which voltage is measured, and the voltage used for transmission from a power plant like the Bonneville hydroelectric plant pictured may be as high as 500,000 volts; transformers are used to step up the output voltage from the actual rotating machines that generate the energy. The unit for electric

power is the watt, which equals the voltage (volts) times the current (amperes) that flows. For example, your 120-volt, 10-ampere hair drier dissipates electric energy at a 1200-watt rate as it converts electric energy to heat. To refer to large amounts of power, people often use the kilowatt (1000 watts) or the megawatt (1 million watts).

Mixing up megawatt-hours and kilowatt-hours was likely behind a newspaper article describing what appeared to be one of the worst business strategies ever. The head of a utility district in Northern California was claimed to be buying electricity at "$100 a megawatt hour … and selling it to customers for an average of 8.5 cents." In fact, the 8.5 cents was probably the cost per *kilowatt*-hour that appeared on customer's utility bills, making the retail rate $85 per megawatt-hour, still not high enough to turn a profit.

Another error that appeared in print was the confusion of megawatts -- a measure of power -- with megahertz -- a measure of frequency. The mayor of a California city commented about a suggestion that electric power be obtained from a local water company that generated only a small amount of power for its own use: "East Bay Municipal District generates [only] about 12 megahertz of energy. That's enough to run 12,000 homes." Wrong, about the megahertz instead of megawatts. It is true, however, that the energy consumption rate of a typical home is about 1000 watts, so 12 megawatts would supply 12,000 homes. Incidentally, if you convert the metabolic rate at which a typical human converts energy from food to do work and produce heat, you'll find that it's approximately 100 watts.

3. The Governor of California, reporting on the power crisis in January 2001 gave the price of electric energy as being "$55 per kilowatt", and in a televised interview even the articulate spokesman for the Independent System Operators organization that has monitored the flow of power in California quoted a cost for electric energy in "dollars per kilowatt".

What's wrong?

The mistake here is that electric energy equals the power multiplied by the length of time that it is being used. The common unit for electrical energy is thus the kilowatt-hour for domestic consumers (or the megawatt-hour for large users or for the companies that generate and sell power). While a megawatt sounds large, if that power only flowed for one millionth of a second, the associated electric energy would be relatively small and very inexpensive.

If you look at your electric meter, you'll probably find that its dials read in kilowatt-hours, as the photo above shows. Whenever you use power, the wheel beneath the dials turns; the dials just indicate the product of the power in kilowatts times the time in hours that the power is being used. The higher the power consumption, the faster the wheel turns and the more rapidly the pointers move.

It's interesting to look at your electricity bill and find out what you pay for electric energy. In a residential bill for October, 2000, before the power crisis in California was in full swing, the following entries appeared:

Electric Energy Charge	$0.07669/Kwh	$13.42
Transmission		0.85
Distribution		6.24

The charge for producing the electric energy (in Kwh, which is the abbreviation that the power company uses for kilowatt-hour) was $13.42. Getting that energy to Berkeley cost 85 cents, and distributing it through the city to the dwelling cost $6.24.

4. The statement, "Solar panels on the roof generate about 700 watts a day" appeared in a January, 2001 newspaper article about an energy efficient house in Arcata, California. A more outrageous solar cell blooper appeared in an article about a solar panel that "generates 100 kilowatts, or about 120,000 volts."

<u>What's wrong</u>?

"700 watts a day" — Similar to giving prices per kilowatt, instead of per kilowatt-hour, we're interested in how much energy the solar panels can deliver in a day, not just in the rate at which they might momentarily deliver energy. Perhaps the reporter meant that the panel of solar cells delivered 700 watt-hours of electric energy per day. Maybe the statement means that power delivery rate was about 700 watts while the sun was shining, for a total of about 5.6 kilowatt-hours for a 9-5 day. We can't tell what was meant.

"120,000 volts" — This makes no sense at all, for several reasons. First, each little solar cell that makes up a solar panel is a piece of semiconductor that generates a voltage of only about one-half a volt. (You can perhaps see the bluish piece of the semiconductor, silicon, inside the plastic solar cell package pictured above.) To get 120,000 volts, you'd need to connect about one-quarter million of those little cells together in series. Second, there's no reason to do this: that voltage is so high that you'd get an arc between the wires coming out of the panel -- suggested above with the help of a litle computer image manipulation. Would you want to have such an enormous voltage around your house?

To learn more, see information about the very readable book, *Electrical Engineering Uncovered, 2nd Ed.*, at the Prentice Hall web site www.prenhall.com