Ferguson: Energy Matters

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The Flow of Money

It sets my teeth on edge to hear people talk about electricity in terms of "electrons" flowing through power lines like water through a pipe. As a matter of fact, in our alternating current (AC) system the electrons in the wires don't go anywhere—they just jiggle back and forth 60 times every second. It's electric *energy* that flows, not the electrons. In a direct current (DC) system it's true that electrons do move a bit, but they drift along rather slowly. In both systems, it is electric energy that flows, and it does so at almost the speed of light.

Whenever I hear politicians talk about buying electricity as if they were buying "electrons"—or worse yet, "green" electrons—I have the urge to jump up and set the record straight. So far I've managed to bite my tongue and keep quiet.

To make matters even more complicated, the electricity grid is a tremendously complex network of interconnected power lines. When you turn on a light switch in California, the amount of energy flowing in every power line in the West changes slightly and does so almost instantaneously.

So what sense does it make for utility A to say it buys power from generator B? The electric energy that generator B puts into the grid disperses immediately throughout the West; it doesn't all go to utility A. Electric energy follows the laws of physics, not the rules of electricity markets.

Buying electricity is about the flow of money, and secondarily about the flow of electric energy. It's certainly not about the flow of electrons.

What is essential is that the electric energy flowing into the grid from all generators at every instant be precisely equal to the energy flowing out of the grid into air conditioners, lights, motors, and so on. Moreover, this balance must be maintained at every point in the network. The grid operators' job is to ensure that this balance is maintained.

The way this is done is by controlling the flow of money. Every utility or load serving entity in the West is required to have financial arrangements with generators somewhere to put as much energy into the grid as customers are taking out.

It's even more complicated than this, because the amount of energy that can be allowed to flow in any power line is limited. Too much and the line would overheat. Not only must the inputs equal the outputs at every instant, but the collection of generators and loads must not result in excessive energy flows in any power line.

The grid operator in a "control area"—the California Independent System Operator, for example—has the responsibility of seeing that this balance is maintained at all times. Utilities tell the grid operator what their loads will be, which generators they will be sending their money to, and how much power will be put into the grid on their behalf. These schedules are put into a computer and the computer says whether these schedules are "feasible," that is, whether all the region's power lines can accommodate the energy flows. If not, the schedules must be modified.

Unforeseen things happen, so the grid operator also has backup generators on call in real time, some of which must be able to respond instantaneously. The cost of "ancillary services" provided by the backup generators is distributed to those responsible for the imbalance.

For the last several years, I have had a running argument with Pacific Gas & Electric over its refusal to buy wind power from Tehachapi. During some hours of some days, the power lines into PG&E territory from Tehachapi are filled to capacity, mostly with off-peak power being returned to the Northwest. Ergo, says PG&E, they cannot use the lines and therefore cannot buy wind power from Tehachapi.

This is foolishness. PG&E has as much right to use the power lines—Path 15 in this case—as anyone else. There is no reason or rule that prevents PG&E from paying wind generators in Tehachapi to put electric energy into the grid on their behalf. If the sum total of all generators and loads would result in an overload of Path 15, the grid operator has a congestion management process to relieve the overload which might result in a small additional cost to PG&E.

If the small potential cost of congestion management is the real reason PG&E refuses to buy Tehachapi wind power, the utility should say so. Instead, it claims it is impossible. As a substitute, PG&E wants to build an expensive new power line to British Columbia—as if this new line would never be congested.

Politicians and policy people should not be confused by electrical engineering mumbo jumbo. Buying electricity is about the flow of money.

—*Dr. Rich Ferguson, Research Director, CEERT,* rich@ceert.org.