Some Basics of Electricity

Non-hydrocarbon energy sources include nuclear, biofuels, hydroelectric, wind, solar, and geothermal. Except for biofuels, they are primarily ways of generating electricity. It will be useful, therefore, to digress briefly to understand a few things about electrical energy.

An electrical generator works by moving loops of wire through a magnetic field, which causes electrons to move down the wire. We call the movement of electrons an electrical current, and it is what provides the energy we use to light lamps, heat the oven, and run electrical motors. As soon as the wire is disconnected from the generator (somebody throws the switch), or the generator stops moving, the electrical current dies away.

Electrical energy cannot be stored in large quantities. Batteries are inefficient; they hold quantities of energy that are miniscule compared to the amount we use. The Taum Sauk Hydroelectric Project, which failed so spectacularly a few years ago, was an attempt to store electricity, and will be discussed in a separate white paper. For the most part, electricity can be used only as it is generated.

In Missouri, the big electricity generating stations burn coal or use nuclear power to heat boilers, turning water into steam. The steam turns turbines, which rotate the generators. The boilers are huge, and take many hours, even several days, to heat up and make steam efficiently. The generators are large, high-tech, multi-million dollar pieces of equipment with heavy parts that move at great speed past each other. Great stress is put on them from heat, centrifugal force, and pushing their wires through their magnetic fields. Changing the electrical load (the amount of electricity that must be produced to meet demand) too quickly can cause their internal parts to burn out or to crash into each other, ruining the generator.

Electrical demand fluctuates, however, both on a daily basis (high during the day, lower at night) and during the seasons of the year (high during air conditioning season, lower other times of year). These fluctuations provide a severe challenge to managers of the electrical grid and to electrical generating plants. They can't store electricity, so they have to have enough capacity to meet peak demand, knowing it will not be fully used much of the time. They must also find ways to meet hourly fluctuating demand using equipment that cannot react that quickly. Anything that exacerbates the fluctuations placed on their systems presents a serious management problem.

Hydroelectric power is the one common source of electricity that can be turned on and off whenever wanted, often in a matter of minutes (solar, wind and geothermal power can be connected and disconnected, but the installed base is small, and the power that solar and wind produce fluctuates). Thus, the base electrical load is often met using coal and nuclear generating stations, and hydroelectric power is reserved for peak demand, the marginal amount that fluctuates daily.

Electrical demand is forecast to grow, perhaps doubling by 2030. Meeting such demand would require the construction of thousands of new power plants. How will we be able to do that without devastating the planet?[i]

[i] *International energy outlook, 2006*. (June 2006). Energy Information Administration. Downloaded from www.wia.doe.gov/oiaf/ieo/index.html.