Strays – The electrical grid

When we plug an appliance into the wall outlet, we simply expect electrical power to be available to operate the unit. Most people have little idea where this electrical energy originates; some will say a hydroelectric dam, others might say a coal-burning plant or even a nuclear facility, yet others will say wind turbines or arrays of solar panels, and they're all correct. Rest assured it's not the "power company", but something a little more complex.

Once electrical energy is generated by those sources and more, it's delivered to a huge, nation-wide network of electrical interconnections known as the ***electrical grid*** or ***power grid*** (or simply "the grid"), to be used by any utility that's connected to it. The job of the power company is to establish and maintain their local (state, region, county) stewardship of the grid, devise regulations and policy regarding usage, and to fund all of this by billing consumers.

The grid is made of low-loss, high-voltage, and redundant transmission lines (wires) that carry three-phase AC (alternating current) power to cities throughout the nation. Due to the long distances, the electrical grid carries high voltage and relatively low current to reduce ***I^2R losses***. The energy provided by the grid is then made available to local industries and neighborhoods by an electrical substation (above photo), which transforms the high voltage of the grid to commercial levels. Local transformers then further down-convert the commercial voltages to those expected by residences and businesses within the service vicinity.

Not all electrical power networks are part of the national grid or contribute energy to it. Some municipalities choose to operate autonomously, and will confine their service to a local customer base. Others might operate independently, but contribute to the national grid when their supply exceeds local customer demand.

Many people fear that the grid is exposed to external threats, man-made or otherwise, and that our heavy dependence on electrical power therefore creates an inescapable vulnerability. Events such as terrorist attacks, aging infrastructure, EMP, cyber threats, and even lightning are causes for concern to many who are entrusted with the need for its durability. To be sure, the US government has invested heavily in the protection of our grid by implementing cyber security, infrastructure hardening against weather (especially lightning), network segmentation, and emergency procedures. After all these, our grid is still vulnerable, but utility companies are constantly looking for improved ways of protecting the grid from interruptions.

Still, interruptions will occur for one reason or another. Substations can help protect the grid by large circuit breakers, and can compensate for power factor losses with the use of large capacitors. At times, excessive ***demand*** can bring a portion of the grid to its proverbial knees. Electrical energy demand is heaviest during very cold months and very hot months. Peak demands occur in winter mornings and summer afternoons, when environmental needs are the greatest To accommodate these large demand swings, utility companies have invested in smart grid systems, which implement two-way embedded communication that provides feedback on segment demands and can automatically compensate for some of the demand by releasing more water in a hydroelectric dam, for example.