SmartWatt Weekly

Episode 1 - Power Systems and The Electricity Market

As a first step in our study of electricity markets, let's assume that all generators and loads are connected to the same bus or are connected through a lossless network of infinite capacity. Currently storage of large quantities of electrical energy is not economical; consequently, this energy must be produced at the same time as it is consumed.

Trade in electrical energy, always refers to a certain number of megawatt-hours to be delivered over a specified period. The length of this period is typically set at an hour, half an hour or a quarter of an hour depending on the country or region where the market is located. Since electrical energy delivered during one period is not the same commodity as electrical energy delivered during another period, the price will usually be different for each period. Demand does not change neatly at the beginning of each period. Some adjustments in production must be made on a much shorter basis to keep the system in balance. While these adjustments translate into trades of energy, they are best treated as services rather than commodities.

The development of electricity markets is based on the premise that electrical energy can be treated as a commodity. However, there are important differences between electrical energy and other commodities such as bushels of wheat, barrels of oil or even cubic meters of gas. The most fundamental difference is that electrical energy is inextricably linked with a physical system that functions much faster than any market. In this physical power system, supply and demand – generation and load – must be balanced on a second-by-second basis. If this balance is not maintained, the system collapses with catastrophic consequences.

The social and economic consequences of such a system-wide blackout are so severe that maintaining this balance between generation and demand of power is the most fundamental requirement when dispatching generation schedules. The variation of demand throughout the day as well as the likelihood of system-based contingencies that may happen on the grid, are taken into consideration and the required supply reserve, to be available at different time intervals, is always made available on the grid.

Balancing the supply and the demand for electrical energy in the short run is thus a process that cannot be left to a relatively slow-moving and unaccountable entity such as a market. In the short run, this balance must be maintained, at practically any cost, through a mechanism that does not rely on a market to select and dispatch resources.

Another significant difference between electrical energy and other commodities is that the energy produced by one generator cannot be directed to a specific consumer. Conversely, a consumer cannot take energy from only one generator. Instead, the power produced by all generators is pooled on its

way to the loads. This pooling is possible because units of electrical energy produced by different generators are indistinguishable. The demand for electrical energy exhibits predictable daily and weekly cyclical variations, however the accuracy of this prediction is imprecise. The grid must produce electrical energy at the same time as it is consumed. Since the short-run price elasticity of demand is extremely small, matching supply and demand requires production facilities capable of following the large and rapid changes in consumption that take place over the course of a day. It's imperative to highlight that elasticity of demand, thanks to recent advances, can become more elastic, we will discuss these advances in the weeks ahead.

Not all generating units will be producing throughout the day. When the demand is low, only the most efficient units are likely to be competitive and the others will be shut down temporarily. These less efficient units are needed only to supply the peak demand. Since the marginal producer changes as the load increases and decreases, we should expect the marginal cost of producing electrical energy to vary on an hourly basis.

As discussed, a market is an environment designed to help buyers and sellers interact and agree on transactions. These interactions progressively lead to an equilibrium in which the price clears the market, that is, the supply is equal to the demand. If electrical energy is to be traded according to this free-market ideal, the equilibrium between the production and the consumption of electrical energy should be set through the direct interaction of buyers and sellers.

In this ideal market, large consumers and retailers purchase electrical energy from the large producing companies. However, the consumers cannot exactly predict their demand nor can the generating companies exactly predict their ability to supply. These errors and unpredictable events introduce gaps between load and generation that must be bridged quickly and precisely to maintain the integrity of the power system. If these gaps between generation and load were to be treated as imbalances between supply and demand and corrected using an open market mechanism, producers and consumers would have to be kept informed of the state of the market on a second-by-second basis

We can conclude that, while a large proportion of the electrical energy can be traded through a deregulated open market, such a market is unable to maintain the reliability of the power system. A managed spot market that provides a mechanism for balancing load and generation must, therefore, supersede the open energy market as the time of delivery approaches.
The function of the managed spot market is to match residual load and generation by adjusting the production of flexible generators and curtailing the demand of willing consumers. It should also be able to respond to major disruptions caused by the sudden and unforeseen disconnection of large generating units because of unavoidable technical problems. Although the need for managing the spot market stems from technical considerations, this spot market must operate in an economically efficient manner. Being out of balance is avoided at all times to sustain the grid, but this requirement is not cost-free. The grid has to pay to ensure such continuous and secure operation, and traditionally this money is paid to the power generating companies, in the form of the marginal generation cost of purchasing power.