Power Risk Management in Liberalized Markets

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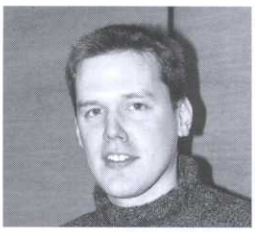

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Firms active in liberalized markets do not only incur risks from their trading operation, but also have certain natural positions. Power generators have long forward positions, because in the future they will own electricity they have to sell in the market. Retailers have short positions because they need the electricity they have to deliver in order to fulfil the contracts with their customers. These contracts can be simple forwards, but very often they have quite complicated option-like features embedded that relate to volume and timing, so that these contracts would be considered quite "exotic" in the terminology of financial derivatives. The main source of financial risk is *price risk*, but there is also *volumetric risk*, the risk that the demand for power and in the case of hydro power also the supply is unusually high or low. A source of risk increasingly important in a liberalized market is *counterparty risk*, the risk that a customer is unable to meet her obligations.

The market offers several financial derivatives that can be used by electricity firms to hedge their exposures. The main contracts are *forwards*, which oblige the owner to buy a certain amount of electricity at a predetermined price for a fixed period of time starting in the future. Other types of contracts are *swaps*, where fixed price electricity is exchanged for floating price electricity, and *options*, giving the owner the right but not the obligation to receive or deliver a certain amount of electricity over some period in the future. Another kind of option which is unique to electricity markets is the *swing option*, which gives the holder the right to choose the amount of electricity received. Due to the volumetric risk mentioned, weather contracts are also important for electricity firms, because electricity demand is highly correlated with weather conditions.

Because of non-storability electricity prices behave significantly different from prices of other commodities

The basis for pricing and risk management of contracts forms a model for the dynamics of the underlying risk factors, the most important one being prices. Electricity prices behave significantly different from prices of other commodities, mainly due to the fact that electricity is not directly storable. Only the primary energy that is converted into electricity can be stored to some extent, like water in a hydro pump facility. Therefore, short-term imbalances in supply and demand cannot be smoothed out using inventories, but production and consumption have to be equal at every moment in time. This means that the fundamental structure of the supply side and the demand side of the electricity market of a particular region have an influence on price changes and should be considered in financial modelling. Important factors of influence are weather conditions, temporary outages of power plants and the so-called *supply stack*, namely production assets that are available and the order in which they are despatched according to the marginal operating cost. The following stylised facts can be observed in time series of electricity prices from various markets.

Electricity prices exhibit a much higher volatility and strong seasonality

Volatility is much higher than in related commodity markets and it is level dependent, that is, when prices are high then volatility is high, too. Time series of electricity prices show temporary marked spikes, which means that prices shoot up and then quickly fall back to long-term means. Also, energy prices are mean reverting, that is usually there is a fairly stable long-term equilibrium price, which is only distorted in the short run. Electricity prices exhibit strong seasonality as well as weekly and daily cycles. In an efficient market of storable assets, seasonality would not occur, because expectations of future prices would be transferred to spot prices. If storage is not feasible, then this important link between expectations and prices does not work. The pricing of electricity contracts is also affected by non-storability. In financial markets, there is a strong link between forward prices and spot prices via the principle of arbitrage. But when it is impossible to take and hold positions in the spot market, arbitrage strategies cannot be carried out and this link is lost. This means that the classical no-arbitrage pricing theory is not valid for electricity derivatives. One way to save pricing results is to model forward prices instead of spot prices as underlyings. If there is an actively traded forward market then those forwards can be used to replicate and thus price and hedge all financial claims. It is necessary to model the dynamics of the forward price curve. One approach is to model forward prices as functions of supply variables, for example the forward price of commodities that are used to produce electricity, like gas or coal, and demand forecasts. The success of these models has, however, yet to be tested empirically.

For risk management purposes, energy firms should be considered as a comprehensive portfolio consisting of production assets, contracts with customers and producers and positions in derivatives. The challenge for electricity firms will be to gain the sophistication needed to design trading and hedging strategies that lead to a full optimisation of their portfolio. ❐