On Value of Flexibility in Energy Risk Management. Concepts, Models, Solutions

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This research project is gratefully supported by the Swiss Innovation Promotion Agency KTI/CTI in collaboration with the industrial partner Nordostschweizerische Kraftwerke AG.

1 New Challenges from Deregulation

Since 90s power markets are being restructured worldwide and nowadays electrical energy is traded as a commodity. Therewith the question how to manage and hedge the financial risks resulting from uncertain electrical power and fuel prices is essential for market participants. There exists a rich literature on risk management in energy markets. Some noteworthy references can be downloaded from our web resources [1] and are reviewed in the cited literature. Let us first investigate the market structure and then discuss two different pricing schemes for risk management in power industries.

Market structure
As a first approximation, the market for electricity is not fundamentally different from any other markets. The price and the quantity of produced and consumed electricity are determined by generators costs and consumers willingness to pay.

A typical agreement traded at electricity markets yields power at constant intensity within a pre-defined time interval. However, electricity trading differs from the usual commodity trading since depending on the maturity time of the supply contract, different market players enter the transactions

- on the *long-term scale* (years to days to delivery), all agents (financial investors, suppliers, retailers, consumers) participate in contract trading
- on the *middle-term* scale (one day to delivery), at least one contract party is involved in physical consumption since positions at the day-ahead market imply physical energy delivery

- on the *short-term scale* (delivery within current day), intraday trading is effected by few agents who are able to adjust their production and demand on hourly basis

The crucial implication from this heterogeneity of the market and its participants is a large diversity with respect to

- risk attitudes (which are obviously different for producers, consumers, banks, and hedge fonds)
- exposure to price risk (by their business, consumers are short, suppliers are long in electricity prices, whereas financial actors consider energy-related investments as a welcome opportunity to diversify their portfolios, or to benefit from alleged price inefficiency)
- strategies to manage the own exposure (suppliers and consumers are able to adjust their production/demand depending on market conditions, whereas financial players apply advanced knowledge in pricing and hedging of financial contracts.)
- information asymmetry (obviously agents involved in production, consumption and transmission of electrical energy benefit from insider information, whereas financial players are better skilled in econometrical techniques)

The above market heterogeneity creates an insisting need for *risk exchange*, which is effected by financial instruments. In electricity markets, we observe

- a significant diversity of contracts, explained by differences in risk profiles of market players
- exotic character of instruments, traced to replication requirement by physical assets

Implications for risk management As an outcome of the deregulation, new challenges are to be faced in energy risk management with focus on the following issues:

- competition is displaced to an intellectually higher level, where mathematically involving methodologies become more and more relevant, which changes traditional business lines
- decision makers should be aware of this development to accrue knowledge form actuarial and financial mathematics
- firm management has to correctly place the own business in the market. In particular, by the choice of a risk philosophy best suited to the business venture and by a consequent implementation of the desired policy, to correctly position the enterprise in the market.

The methodologies to meet those challenges are

1. to realize that the valuation of flexibility is one of the key issues in valuation of all energy-related assets
2. to distinguish the concepts of the individual and global viewpoint on contract valuation
3. to develop own benchmarks for pricing of flexibility
4. to develop and to implement risk-neutral models for energy-related financial contracts
5. to compare the individual and the global concepts considering both as limiting cases, with the realistic situations in between
6. to derive own decisions from this comparison