Management of Uncertainty in Supply Contract Auctions

Contribution to the Panel "Hedging Risk and Uncertainty in Electricity Markets"

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Abstract — **Uncertainty management becomes a key challenge in the restructured electricity industry as the implementation of market processes increases the sources of uncertainty beyond those faced in the former vertically integrated industry. We focus on the assessment and management of uncertainty in the area of contracting for short- and mid-term supply contracts. Such contracts are drawn up with the successful sellers in an auction held to determine the lowest priced supplies to meet the requirements of various classes of load. The primary focus of the analysis is the auction design product definition issues and their impacts on the resulting outcomes. The high prices attained in the 2006 Illinois Electricity Auction reflect the impacts of shifting uncertainty from the distribution companies to the sellers of the needed electricity supply. We assess the impacts and provide the insights we obtain to improve uncertainty management in short- and mid-term contracting for electricity.**

Index Terms — **Electricity markets, electricity auctions, electricity prices, operational planning, power system economics, uncertainty management.**

I. Introduction

The environment arising from the restructuring of the electricity industry brings new challenges for all its constituents. In particular, the trading entities in electricity markets face many sources of uncertainty in addition to those of the earlier vertically integrated industry structure. The advent of market forces and the set up of the market structures and the design of markets result in numerous sources of uncertainty whose management is a key challenge in the restructured environment. One consequence of the numerous sources of uncertainty is that electricity has become one of the most price volatile commodities in any market. Such volatility entails the need for effective financial tools, such as forward contracts and financial derivatives [1], to manage the impacts of uncertainty. As the long-term contracts signed at the onset of restructuring are nearing their end, the acquisition of the new generation of contracts is of much interest to the industry. One approach to select the suppliers for forward contracts is through the deployment of auction mechanisms. Such auctions for contracts have been implemented in countries such as Brazil and Chile [2], and in some states such as New Jersey and Illinois with uneven results. Our focus in this paper is on the use of forward contracts for short- and mid-term supply of electricity to meet the future load demands of certain load classes.

The use of auctions as a market mechanism is encouraged by characteristics such as the independence of the seller's identities, the transparency of the process reflected in an open process and the information available for the players, the speed of the process, the stimulation of competition, and the appropriate price discovery. However, due to the special characteristics of electricity such as the lack of substantial storage capability, the just-in-time manufacturing nature and the many physical and engineering constraints of the system, the *MW* commodity cannot be treated as any ordinary commodity such as farm and mining products. Therefore, the market mechanism must take into account the unique characteristics of electricity and electricity markets.

The work in this paper is motivated by the results of the 2006 Illinois Electricity Auction. We analyze the product definition used in the Auction for the short- and mid-term forward contracts. We focus particularly on the risk and uncertainty issues that arise. We start the discussion by presenting a review of the design and the results of the Auction. We identify the principal design flaws in the product definition which result in unnatural and uncertain products. We also analyze in detail the ramifications of the definition including the uncertainty effects of the products sold and bought in the Auction.

This paper contains three additional sections. We devote section II to the explanation of the main design elements and results of the 2006 Illinois Electricity Auction. We analyze uncertainty management in the Auction process in section III. We present the concluding remarks and future directions for research in section IV.

II. The 2006 Illinois Electricity Auction

The electricity markets in the state of Illinois are facing important challenges in these days. In the year 1997 the restructuring of the Illinois electric industry resulted in that the 2 utilities Exelon and Ameren sold to affiliates or third parties their generating assets. A transition period of 10 years was set in which the residential and small commercial tariffs were artificially frozen and the Illinois utilities met demand using long-term contracts. In the year 2004 the Illinois Commerce Commission started a series of workshops and studies to figure out what to do after the end of the transition

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period. One of the recommendations was the use of auctions as a procurement method for short and mid-term contracts, following the example of others states in the United States such a New Jersey in which an electricity auction was performed in 2002. The year 2006 the Illinois Commerce Commission approved the use of the auction proposed by Exelon and Ameren. In September of 2006 the auction was held and the effect over the tariffs started in January of 2007. After one year of the realization of the auction, the auction was cancelled, and a new mechanism to contract supply for short and mid-term periods is being implemented.

In this section, we present a brief review of the principal characteristics and results of the 2006 Illinois Auction, more details can be found in [3]. The main objective of the Illinois Electricity Auction was to ensure reliable supply for the distribution companies of the state – Ameren and ComEd. Key characteristics of the Illinois Auction are being a multiple products-units auction, using a reverse simultaneous 'clock' auction, having 2 buyers and 21 sellers, and being designed and managed by NERA economic consulting.

The designers of the auction defined attributes to differentiate the products. The products are differentiated in terms of the distribution company, the customer class and the duration of the contract.

There are two customer classes for ComEd – CPP-B and CPP-A – their characteristics are [5]:

- CPP-B or Competitive Procurement Process Blended: residential, designated lighting service and small commercial customers with demand less than 400 *kW*
- CPP-A or Competitive Procurement Process Annual: larger commercial and industrial customers with demand greater than 400 *kW*

In the same way, for the Ameren subsidiaries there are two customer classes – BGS-FP and BGS-LFP – that are characterized by [5]:

- BGS-FP or Basic Generation Service Fixed Pricing: residential and small business customers with demand under 1 *MW*
- BGS-LF*P* or Basic Generation Service Large Customers Fixed Pricing: large commercial and industrial customers with demand greater of equal to 1 *MW*

The set of products with all the characteristics is shown in Fig. 1.

The critical element in the product definition of any auction is the unitary product. In the 2006 Illinois Electricity Auction this unitary product is specified in terms of the so-called tranche. Such a product definition is substantially different from other electricity auctions around the world in which a fixed quantity of either power or energy is auctioned [2].

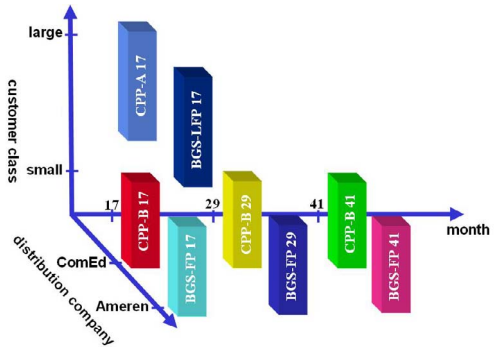

Fig. 1 Set of products in the 2006 Illinois Electricity Auction.

The tranche of the chronological load over a specified period is defined to be a fixed-proportion of the load in each point in time during that period. An illustration for a *10 %* tranche with one, two, three and four units is shown in Fig. 2.

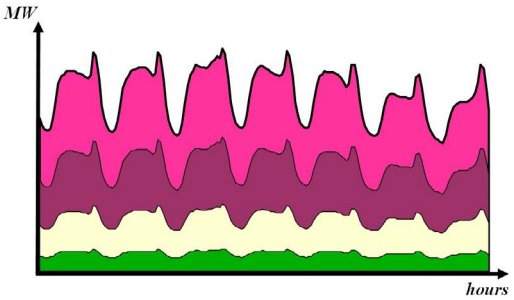

Fig. 2. Decomposition of the total load into 4 groups of 1 to 4 tranches (basic tranche is a 10% of the load).

TABLE 1
INITIAL AND FINAL PRICES COMED PRODUCTS

ComEd				
customer group	small to medium			large
product	CPP-B17	CPP-B29	CPP-B41	CPP-A17
initial price (*$/MWh*)	100	100	100	104
final price (*$/MWh*)	63.96	64.00	63.33	90.12

Each one of the 8 product of the Auction had a target number of tranches. The 8 products were auctioned simultaneously using the reverse auction mechanism [3]. The Auction was performed in rounds in which the Auction Manager set the prices for the 8 products in round 1 and each seller response with their offers. Each seller was allowed to offer one or more tranches of each of the 8 products. A scheme of the players and information flow in the Auction is shown in Fig. 3.

As long as there was an oversupply of any single product, a new round is launched by the Auction Manager with the prices in the new round modified from those in the previous round by non-negative decrements.

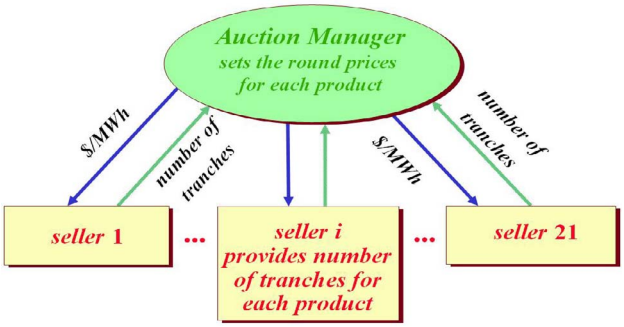

Fig. 3 The players and the information flow in the Auction.

The attainment of the supply – demand in the 8 products signaled the end of the auction. Each seller of a specific product received the identical price for each unit of the product sold. The 2006 Illinois Electricity Auction was completed after 39 rounds. The round prices are plotted in Fig. 3 and the final prices are shown in Tables 1-2.

TABLE 2
INITIAL AND FINAL PRICES AMEREN PRODUCTS

Ameren				
customer group	small to medium			large
product	BGS-FP17	BGS-FP29	BGS-FP41	BGS-LFP17
initial price ($/MWh)	100	100	100	104
final price ($/MWh)	64.77	64.75	66.05	84.95

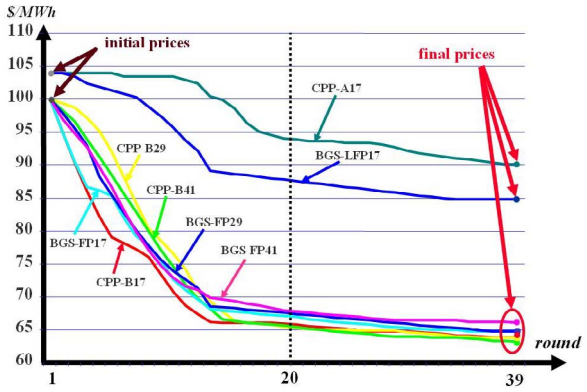

Fig. 4 Round prices in the 2006 Illinois Electricity Auction.

III. UNCERTAINTY ANALYSIS

The uncertainty faced by the parties involved is strongly dependent on the terms and the nature of the short- and mid-term contractual obligations. Such contractual terms are specified totally by the product definition. In this section, we analyze the implications on uncertainty issues of the tranche-based product definition used in the 2006 Illinois Electricity Auction and identify the design flaws, as well as, assess the ramifications on the Auction outcomes.

The tranche-based product introduces considerable uncertainty for the sellers, and virtually removes all the uncertainty for the buyers. The uncertainty is due to the fact that the tranche-based product is directly a function of the yet-to-be-realized loads in the period of interest. Such loads and the resulting load shape are inherently random, as they are dependent on a variety of sources of uncertainty. Consequently, the power and energy associated with a tranche are uncertain over the duration of the period. Each seller has a volumetric and a capacity uncertainty in what he sells. The volumetric uncertainty impacts the expected revenues, and the capacity uncertainty implies an uncertain utilization of the generation resources required to meet the sales obligation. Such capacity and volumetric uncertainty was historically faced by the utility in the deep of the vertically integrated utility structure, as were the sources of uncertainty in generation, such as forced outages, fuel price escalation and the market prices.

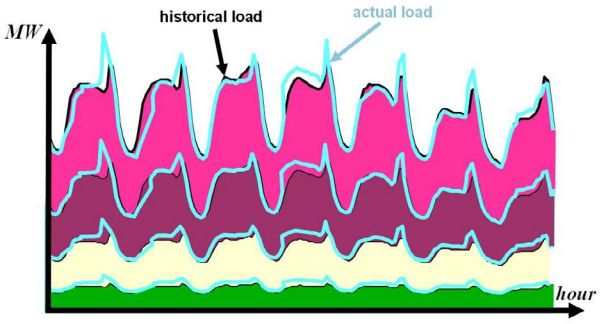

Fig. 5 Impacts in the tranche-based product by the capacity and volumetric uncertainty in the load.

Another characteristic of the tranche-based product is the unnaturalness. Such attribute is reflected by the fact that such a product can only be 'created' by a set of generators for base, cycling and peaking applications. Such a definition requires that each seller become an aggregator of the outputs of several generators. As such, each seller of tranche-based products takes the role of a 'mini-distribution' company serving a scaled replica of the buying entity's load for a particular customer class. Such unnaturalness also brings new uncertainty for the sellers. Since, typically, a seller cannot produce the tranche-based product, he needs to purchase from the markets and is exposed to their volatility. Alternatively, he might need to sign contracts which comes whit their own sources of uncertainty. The uncertainty and unnaturalness of the tranche-based product produce such an artificial product that each seller has to charge enough high prices to cover against all the sources of uncertainty. In this way, the original motivation for using auctions for short- and mid-term contracts is, in effect, negated by the need of the buyers of the supply to pay for the 'insurance premiums' of the sellers to be able to acquire the tranche energy required for the period.

The tranche definition produces an uneven distribution of the uncertainty faced by the players. Such a distribution puts all the uncertainty in the realms of the sellers. Due to the tranche definition, as a proportion of the total load, it is possible to appreciate in Fig. 5 that all the uncertainty in the load is responsibility of the sellers, and the role of the distribution

company is reduced merely to simply being a delivery entity to the end users.

The push of the uncertainty on the shoulders of the suppliers to conform to the product definition impacts substantially the process outcome. We compare the actual market prices at a hub in Illinois in the period January 1 - April 30 of 2007 against those of the auction process. For effectiveness, we plot the market prices in a price-duration curve and observe that more than 90 % of the period, the market prices are below the auction prices. In fact, the auction price of one product in the whole period is above the market price at the chosen hub in Illinois.

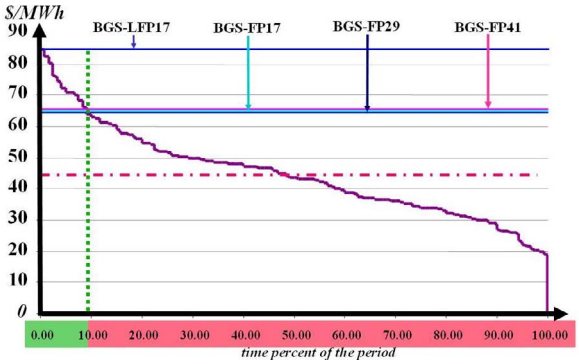

Fig. 6 Price duration curve for the Auction prices and the market prices for the period of January-April 2007.

Looking at the final prices, there is a clear decoupling in the level of prices between small and medium, and large industrial and commercial customers. Even though the prices for the two sets of products started similarly at 100 and 104 *$/MWh,* respectively, the final prices are at the level of 65 *$/MWh* for the small and medium customers, and 87 *$/MWh* for the large industrial and commercial customers. The higher prices of the latter products aimed at the large industrial and commercial customers of Ameren and ComEd can also be interpreted as a consequence of uncertainty issues. These prices reflect the fact that those customers have the greater flexibility in migrating their loads to alternative energy service providers. As such, they represent another source of uncertainty to the sellers. The difference between the prices for these products and those for the medium and small customers represents the premium charged by the sellers to cover this uncertainty.

There is a counter-intuitive outcome in the prices of the ComEd products in that the longer contracts are priced lower than the shorter ones. Since, the longer the period the higher the uncertainty, the rational expectation is that the prices associated with longer-term contracts tend to be higher than those covering a shorter period. The only explanation for this anomalous behavior is the desire of the large amount of nuclear generation in Illinois to find assured markets for longer periods, even if they are at lower prices.

Our analysis indicates that the product definition is one of the key issues in the auction design. An obligation that requires a fixed quantity of energy is vastly different from that requiring a fixed percentage of a given class load, as is the case of the tranche-based product in the 2006 Illinois Electricity Auction. The high prices attained in the 2006 Illinois Electricity Auction are therefore attributable, in part, to the uncertainty and unnaturalness of the product definition used.

IV. Concluding Remarks

In this paper, we present the analysis of uncertainty management in the 2006 Illinois Electricity Auction for short- and mid-term supplies. Our focus on the product definition indicates a major shift from the buyers to the sellers with significant financial impacts from the uncertainty under the Auction. The Auction outcomes are characterized by the uniformly high prices charged by the sellers to carry the uncertainty they face under the product definition. The insights garnered from this analysis provide the basis for improving the product definition in auctions for short- and mid-term supply contracts. The improved product definition based results will be reported in future papers.

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Biographies

George Gross is Professor of Electrical and Computer Engineering and Professor, Institute of Government and Public Affairs, at the University of Illinois at Urbana-Champaign. His current research and teaching activities are in the areas of power system analysis, planning, economics and operations and utility regulatory policy and industry restructuring. His undergraduate work was completed at McGill University, and he earned his graduate degrees from the University of California, Berkeley. He was previously employed by Pacific Gas and Electric Company in various technical, policy and management positions.

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