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Power System Trading Analysis II: Market Design Overview

Tina Khandelwal[1], Preet Khandelwal[2]
[1]Assistant Professor, Institute of Co-operative & Corporate Management, Research, and Training, Lucknow, U.P., India

Abstract: **This is second part of 2 paper series on Power trading, in the first part Power System Trading Strategies (TS) is discussed from viewpoint of Power generation company (GENCO) in auction based Electrical Power Markets (EPM) while in second paper market design analysis is done to form competitive EPM. Many challenging issues arise under the newly deregulated competitive electric power markets. This paper proposes a measures and execution condition for making short-term Electrical Power Market (EPM) competitive. The aim is to minimize inefficiencies, monopoly and influence of single GENCO. This paper also shows that, consequences of presence of circuit breaker (CB) in Indian power exchange Market Price (LTP). From these suggested measures, we try to change in market design & formulate necessary and sufficient conditions that characterize competitive EPM. Electricity is a particular type of commodity which does not store in large quantities so whenever it is generated it must be consumed immediately. This has made Electrical power status complicated, for both generation and consumption point of view. The most probable reason for higher LTP is market power and oligopoly, GENCOs having large capacity can impact the LTP by means of their TS. Also, those Market Participants having small generation capacity able to manipulate market price in times of stringent supply function. This paper shows the necessary measure, policy, & execution conditions apply to EPM to make it more competitive.**

Keywords: Electrical power market, Market Design, Trading Strategy, Market Power.

I. INTRODUCTION

This article discusses the design issues of EPM. Design of EPM is discussed so because of manipulation in LTP by GENCOs to maximize their profit. In previous paper of this series TS demonstrates how EPM participants apply the market rules efficiently, and could maximize their own sales revenues by improvising their status in competitive EPM. The power sector is transforming into a more distributed and cut throat competitive area where demand and supply (DS) will determine the market price of electricity and the expected net cost may be lowered with high competition. Power business restructuring has led to the splitting up of its major hubs: Power generation, power transmission, and its distribution. Surprisingly, the most appropriate use of pro forma tariff & trading is the divorce of ownership of transmission from its control. In present scenario EPM comprises a large sub segments like day ahead, hour head, weekly, term ahead market etc types. The growth in power trading is due to the ongoing deregulation policy of the electric power industry. This can cause power production as opened for more competition. Unfortunately, the power trading mechanism is not clearly investigated in the level that we can predict a price change. In this article EPM design is thoroughly analyzed.

Over and above, even tiny GENCOs are capable to use their market power during stringent supply function [1], and GENCOs do not get any lucrative push to make a bid at Marginal Cost (MC) [2]. To surmount these difficulties, few alterations are made effected in the EPM, and unique ways have been deliberated in the research done. We have arrived at crucial solutions. Firstly, for escalating competition, market participants are multiplied by breaking large companies into small entities, or new entrants are waited for coming. [3]. Secondly, to control anyone from wielding market power there could be modification in the organization of auction [4], [5] comparison of both auction structures i.e. Pay As Bid (PAB) & the other uniform-price are done and final conclusion in the favour of PAB can be stated by exhibiting few quantitative plus points over the latter [6]. Lastly, the bringing up of price ceilings will Endeavour to somehow maintain the lower price level.

II. MARKET DESIGN ANALYSIS

It is very well discussed that price manipulation by EPM participant is very easy for market player which have large portfolio of generators. This manipulation in MC is done simply to increase the profit of GENCO. Usually no GENCOs want to sell their electrical power at marginal cost. Hence, by making some rules in the EPM for trading in power, increase in the competitiveness can be achieved. Strategic bidding by GENCO can be minimizes by changing the EPM design. To understand the EPM competence we can compare the actual trade values to ideal trading values to know the current status of profit of a GENCO. Some of the methods to improve the EPM design are discussed in detail:

A. Changing Auction Format to PAB Auctions

In the parlance, it is seen that all EPM participants use the TS for maximizing their profit, therefore resulting LTP becomes high than MC of generator. Also, when there is continuous repetition of power auction happens, LTP becomes higher & higher. This behavior of trading strategy causes increases in forecasted LTP in EPM, which then also cause increase in Optimal Bidding (OB)s on the remaining session of EPM. In other words, LTPs perhaps increases continuously, independent of size & number of EPM participants. The optimal TS for PAB means that their is perfect competition, i.e., no single EPM participant can influence the LTP. Combined effect of increasing LTPs perhaps worsens the EPM, if GENCO's strategy is superimposed on it. PAB is a type auction format in which bids are always above MC in the competitive environment of EPM. It is seen that OB increases with increase in LTP which cause high clearing prices in EPM. Hence, PAB format have possibility of gaming makes inferior to uniform-price auction. Therefore PAB auction format is not optimal for use in EPM design.

B. Increasing the Number of EPM Participants

One another method to improve the competence in the EPM is to increase the number of EPM participants by providing trading license to many GENCO. Increase in EPM participant is done by splitting the existing companies into small entities or reducing the license fee & entry barrier for new GENCOs entering the EPM. This statement does not need any support that, with entry of new participation in the EPM there in increase in the competence. Existing companies having large generation capacity is split down into multiple small capacity companies, this process eliminate the withholding capacity of some generator by GENCOs for raising LTP. It is also foreseen that presence of many EPM participant can decrease MP, there will always remain a significant amount that can't be removed. Hence increasing the number of participant is not good approach.

Among various Commodities, excellent instances under perfect competition are seen in Agriculture products because there is no segmentation in its market. In case of other products, few producer firms and few large consumer influence market share and thus wield dominance in market. They are known as key participants. As it has been past proven; that price manipulation is possible by hoarding or by increasing the selling price.

C. Demand-Side Management

The MP of GENCOs mainly relies on the forecasted value of k as discussed in previous paper, which in turn relies on the slope of DS function. Usually demand of power is inelastic compared to supply in EPM, and therefore big alteration on the demand side will not have very much impact on supply side. Hence, demand-side management worthless idea unless making demand side as elastic as the supply side, i.e., in other words if generation is more than demand the only it is possible, which is not possible in the present scenario.

D. Price Caps (PC)

The slope of DS does not alter with the introduction of PC in from a viewpoint of GENCOs in the EPM. Hence, optimal TS will not alter for bids below the PC. If OB will surpass the PCs, GENCOs mainly have 2 choices, bidding price will be equal to PCs. This TS cause difficulties to system operator (SO) of EPX (electrical Power Exchange) because it cause difficulties in distribution of volume of power at the similar bids to suppliers, at the point when EPM equilibrium reaches the PCs. The 2nd choice for the GENCO is to shorter it's bidding function at the PC. It is not easy to forecast EPM that the demand for power increases the supply but therefore SO will force to remove PCs in order to maintaining Equilibrium, & reliability of power system. Hence, PC perhaps causes the reliability problem [8]. Application of PC California was complete failure in EPM [7]. Introduction of PC is worthless unless the SO cut the limit of power demand which is usually impossible.

III. REGULATORY/POLICY IMPLICATIONS & SUGGESTED MEASURES

A. Imposition of Circuit Breaker (CB) to EPM

The Application of CB restricts the movement in the defined range, either way viz. at 10%, 15% or 20%. These CBs when triggered, bring about a coordinated trading halt in all hourly, daily, weekly, & term ahead market nationwide. The market-wide CBs are triggered by movement of either the IEX or PXIL (Indian Power Exchanges) whichever is breached earlier. These percentages are based on volatility of power price based on market sub segment. Let us consider the case of day ahead market at the end of each day, these price variations of whole day is checked and if any revision in price is required for next day, then this revision CB are apply for the next trading day. The price variations of whole day is checked by Regulatory Authority of respective county (in India CERC is the regulatory authority) at the end of the day. Similarly in all market sub segment hourly, daily, weekly regulatory authority intervene to check market price. The CB rule is implemented to prevent arbitrage market participant from further pushing individual power prices in either rising or declining markets. When violent price movements exceed certain thresholds, the CB rule suspends trading activity. It is believed that suspending trading prevents incipient panics, and gives traders sufficient time to re-evaluate market conditions so that they can bolster their liquidity and credit.

Table 1: Price of Short-term Transactions of Electricity in India (Rupees**/kWh), 2011-12 [9].**

Period	Bilateral through Traders				Power Exchange		UI	
	RTC	Peak	Off-peak	Total	IEX	PXIL	NEW Grid	SR Grid
Apr-11	4.76	5.07	4.72	4.76	3.49	4.00	3.91	6.35
May-11	4.52	5.02	4.22	4.49	2.96	3.03	2.86	3.82
Jun-11	3.81	4.94	3.81	3.82	2.80	2.99	2.96	3.29
Jul-11	3.90	3.95	3.70	3.90	2.97	3.22	3.55	3.42
Aug-11	3.88	4.73	3.61	3.88	2.89	3.01	3.14	2.68
Sep-11	3.95	6.26	4.63	3.95	3.00	3.08	3.81	3.24
Oct-11	4.19	5.16	5.02	4.22	5.40	5.42	6.55	5.52
Nov-11	4.25	6.80	4.75	4.29	4.08	4.09	4.81	4.92
Dec-11	4.12	6.05	4.46	4.17	4.05	4.02	5.40	4.35
Jan-12	4.38	6.10	5.12	4.43	3.29	3.36	3.33	4.36
Feb-12	4.41	5.93	4.70	4.45	3.34	3.50	3.17	5.09
Mar-12	4.37	5.74	4.86	4.43	3.32	3.94	2.96	5.87

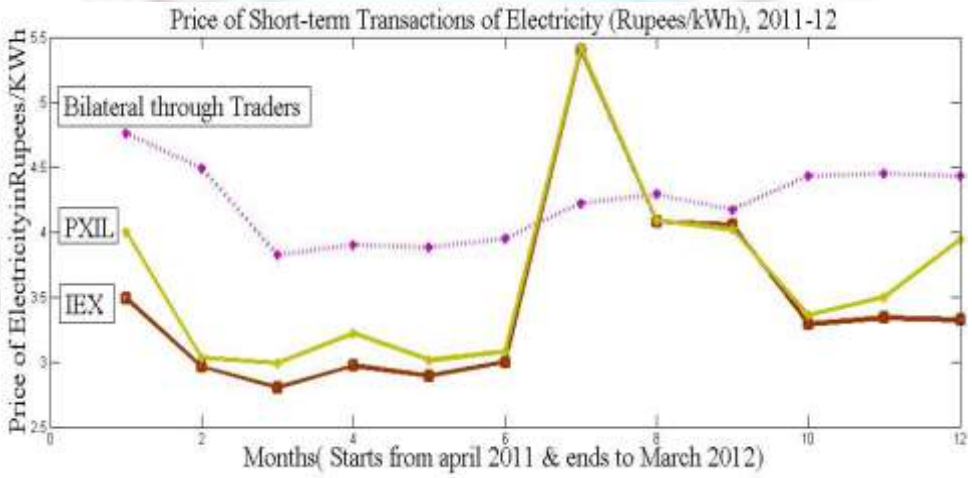

Fig. 1 Price variation in short term EPM of India, 2011 – 12.

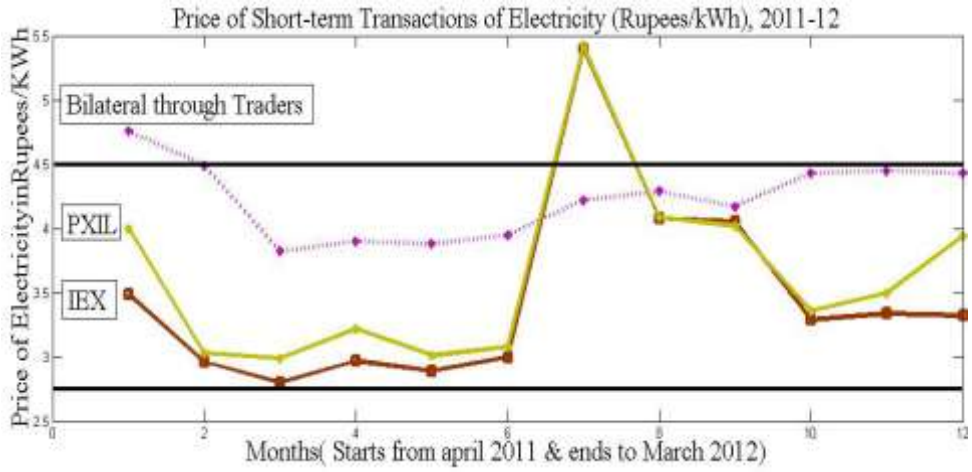

Fig. 2 Price variation in short term EPM of India, 2011 – 12 with implementation of CB.

Above condition shows that implementation of CB can Regulates the market price. In the month of October in Fig. 1 there is spike in price of Power Rs 5.42 in PXIL. If CB is as shown in Fig. 2 then there is no spike in power price. Above (Fig. 2) black line shows the CB barriers for regulation Power Price in EPM. These CB percentage change any time, it depends on Regulatory authority of the Exchange.

B. Increased Trading Margins

Increase in Trading margin is introduced in the power market, it is like security deposits which ensure GENCOs/Market Participant honour their contractual obligations & Speculative trading is reduce to some extent. One contradictory view is increase margin certainty impose higher costs on Market Participants, and reduce trading volume and liquidity.

C. Short Selling (SS) Restrictions

In the parlance, SS usually contributes to market price efficiency and adds liquidity to the EPM, However, during extra ordinary conditions, unrestrained SS cause, and sudden market price declines in power prices that are unrelated to their true price valuation. SSs usually not borrowed power but have plans to buy them back later at a lower market price. This causes increase in Speculative trade in EPM. Actions should be taken by EPM for SS of power to protect the integrity and stability of power prices.

D. Beyond CBs: Shock absorbers, speed bumps, and price-limits

Measures such as "volatility absorbers" or "volatility bumps" will be adopted to slow down but not stop EPM trading. These rules does not stop trading as CB do but impose temporary restriction on maximum & minimum daily price variation limits at levels which are narrower than CBs. This includes Preopening & Pre closing session of EPM. Daily price variation limits can be used to prevent excessive daily price swings. To minimize the effect of volatility in the market or in other words to make market transparent & competitive Regulatory authorities should keep close watch on trades done in the EPM and take corrective measures if any type of unfair activities observe in EPM. Since EPM Sub segment such as term market, day ahead market, hour ahead market constitute one market from an economic point of view. It is believed that the issue with all of these measures is their targeting. A halt caused by CB Perhaps be well intended to check volatility. CB gives time to market participant to take correct decision in the time of volatility.

IV. EXECUTION CONDITIONS

EPM perhaps also facilitate market participants with conditional order specifications. A Purchasing/selling of power is traded according to the type of order conditions applicable with that order. Now these days short term orders are traded mostly through the electronic exchanges. In general, the execution conditions can be applied to hour ahead, week ahead, day ahead and term ahead sub segment EPM. For some conditions, hourly or block bids should have flexible time blocks. Some of the general order trading conditions is given below.

A. Complete or Partial complete: Bid can be partially executed with opposite offer for smaller quantities, while remaining quantity of bid is present in the order book. For e.g., a generator submits a 100 MW bid with Complete or Partial complete execution condition, then the exchange trading method can accept the bid, if matching offer for bid found such as partially (say 60 MW) in one day ahead segment and remaining (40 MW) in other day ahead segment before expiry of the bid can be traded.

B. Only Complete: This condition says Bid can be executed in complete or total, Otherwise it remains in the order book until matching offer does not comes before expiry of bid. For e.g., GENCO submits a 100 MW bid with the Only Complete conditions, then the exchange trading method can accept the bid, if matching offer for bid found for total quantity any time before expiry of the bid can be traded.

C. Fill & Kill: Fill & Kill bid is immediately complete in total or in some part at the defined price otherwise it is expires after defined period of time. Any outstanding quantity is removed from order book after defined period of time as given in execution condition. For e.g., a generator submits a 100 MW bid given execution conditions, then the exchange trading method can accept the bid, if matching offer for bid found then schedule the bid of full or partial quantity in the defined time period only.

D. Fill or Kill: Fill or Kill bid are expired if it immediately not traded for given quantity at the defined limit price i.e., means defined price or more. For e.g., a generator submits a 100 MW bid with the fill or- kill execution conditions, then the exchange trading method can accept the bid , if matching offer for bid found in the specified defined time only be executed.

E. Minimum price and Maximum price Condition: In this type of execution condition GENCOs defines minimum price condition and buyers specify maximum price condition with their orders. The minimum price condition refers to the equation of the number of consecutive hours, & the MWh capacity. A block bid can be matched in case the minimum price is equal to, or greater than, the average price throughout the defined block of hours. A block offer usually be matched for the complete MWh capacity for defined number of hours. Otherwise, it is rejected.

V. CONCLUSION

From the above discussion it is found that EPM is noncompetitive and inefficient. It can be minimized by changing the market design and presence of efficient regulatory authority which can keep close watch on trades done in the short term EPM. It is seen that GENCOs has the ability to alter the LTP through its Strategic bids. This assumption is true until number of GENCOs is not large or in other words less number of market participants with small generator capacity. Usually LTP is set by the interactions of the bidder and auctioneer. An EPM in which all GENECOs & power purchase act as price takers is said to have perfect competition. MC of production is equal to the marginal value of the goods to the consumers is general economic goal to achieve. Such a behavior encourages efficiency on both sides.

The presence of market power shows one assumption of non competitiveness among market participant in EPM. To escalate competition in EPM, market participants are multiplied by breaking large companies into small entities, or reduce barrier for new entrants GENCOs. Also to control anyone from wielding market power there could be modification in the organization of auction comparison of both auction structures PAB & the other uniform-price are done and final conclusion in the favour of PAB can be stated by exhibiting few quantitative plus points over the latter. Lastly, the bringing up of price ceilings will Endeavour to somehow maintain the lower price level. In this paper Regulatory/policy implications & suggested measures are also given such as Imposition of Circuit Breaker in EPM is demonstrated which is effective measure to regulate the Market Price without changes in volume of traded power. Increased Trading Margins reduces speculation in EPM while Short Selling increase liquidity and price control. Restrictions like Shock absorbers, speed bumps, and price-limits also control spikes in the prices. Flexibility of EPM is done by introduction of Bid types execution structure as Complete or Partial complete, only complete, Fill or Kill etc. Final conclusion is that CB is the best measure to regulate EPM and Control of Circuit breaker Should be given to regulatory Authority (in case of India CERC is there) which keep close watch on Electrical trades done in short term electricity market. These CB values vary from time to time & sub segment of the EPM to make market more Competitive.

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