INDIAN ENERGY EXCHANGE DAY AHEAD MARKET: EFFECTS OF VOLATILITY ON PROFITABILITY

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Abstract: ***A resilient trading system is required to induce competition and efficiency in the Indian energy exchange. Electricity, after the introduction of Electricity Act, 2003 is now being considered as a separate commodity with non- storability being its peculiar feature. Also huge amount of losses is being incurred by the power generators as well as distribution companies due to erratic electricity price movements. Hence it is important to study the factors responsible for volatility in the Electricity market thereby mitigating the risk caused by it. This research conducts a study to calculate the losses incurred by the Indian Electricity Exchange for the month of May, 2017 caused due to excessive price movements, despite of Exchange being a better trading platform than other trading methods. Also the factors responsible for volatility are studied to encourage the stakeholders such as generators and distribution companies to further apply forecasting techniques and prepare a risk mitigation model. It has been observed that there is urgent need to apply econometric modelling techniques as large sum is lost due to volatility in the Indian Energy Exchange (IEX) and among the various factors mentioned in the available literature, the major factors which have mostly affected the IEX's day ahead market prices are regulatory, weather changes, transmission congestion, elections, power plant outage, fuel supply and new power plants operational.***

Index Terms – Day-ahead market price, Indian electricity market, factors, volatility, profitability

I.INTRODUCTION

With the deregulation in the electricity markets in the 1990s and the liberalization of electricity trading, electricity trading in short term market has gained its importance. Since, electricity as a commodity (Barouti and Hoang, 2011) has certain peculiar features with non-storability being the most unique one; therefore various measures have to be taken in order to either to store it or to manage it properly. The storage cost of electricity is generally very high, hence an introduction to price modelling and pricing of derivatives in the electricity market is considered to be a better option. Globally the electricity market is very mature (Srivastava et al, 2011). They have provided a platform to mitigate price risk risen due to increased volatility in the electricity markets worldwide and have made power trading a competitive and transparent process. It has been observed that among the mature electricity markets across the globe such as Australia (NEMMCO- The National Electricity Market Management Company Limited) , USA (PJM- Pennsylvania New Jersey Maryland Interconnection LLC), New Zealand (NZEM- New Zealand's electricity market) and Europe (Nordpool) , European electricity market design is a simpler and a progressive market to introduce new products. The voluntary nature of market requires low level of system integration and simplified transmission pricing rules. This makes the European market model, an "easy to adopt" market model for the developing markets. Like European market, Power market in India is also following a voluntary decentralized market model, constituting of the (i) Bilateral markets i.e. long-term, medium term and short-term markets; (ii) Multilateral market i.e., power exchange (IEX) presently covering day-ahead segment and term ahead segment (iii) real-time multilateral balancing market i.e., Deviation Settlement Mechanism (DSM)

The advent of Electricity Act, 2003 have bought revolution in the Indian Electricity market. Earlier the electricity sector had a vertically integrated private or public monopoly market structure, which transformed into a liquid and transparent competitive wholesale and retail mechanism with various reforms in the sector. Electricity reforms have led to an increase in the number of private players and change in the electricity pricing pattern.

In India, there is huge demand supply gap in the electricity market at geographical level i.e. power deficit (Northern, Western and Southern) in certain regions and power surplus in other regions (Eastern and North Eastern). Hence the need of power trading is inevitable. With reforms and advent of Power Trading as a distinct activity, although there is decrease in the power deficit from 7.7% in January, 2006 to 0.9 % in July, 2017 (Monthly report of Central Electric Authority, 2006 & 2017), still the market is not mature enough in comparison with the global electricity markets. Compared with countries in Europe, where volumes traded on short-term markets range from 23 percent to as much as 88 percent as of 2015, short-term power markets in India account for about 10.48 percent of total power consumption in India (only 3.63 percent traded over exchanges, with bilateral contracts and deviation settlement mechanism/UI accounting for five percent and two percent respectively) **(**Sinha and Jain, 2017; Monthly Report on Short-term Transactions of Electricity in India, 2017**)**. Whereas, the total volume traded on the Nord Pool Spot in 2015 was 489 TWh, more than 80% of the total Nordic/Baltic consumption. Hence, adoption of hedging techniques is the need of an hour (Chaubey, 2016).

The current study is divided into five sections. The first section (i.e., Introduction) throws light on the general overview of the Global as well as the Indian Electricity market. Section 2 of the paper reviews the literature related to electricity trading. Section 3 focuses on the research methodology used for analyzing the effect of trading through long term and short term contracts. Section 4 draws the actual reasons behind the

volatility in the electricity prices among the various reasons available in the existing literature and the effect of volatility on the profit/ loss to the IEX while Section 5 concludes the paper.

II. LITERATURE REVIEW

Electricity as a commodity is a peculiar commodity. (Robert, Mount, 1998) stated various characteristics of electricity with qualitatively differentiate it with other commodities such as:

- Lack of storability. Electricity storage is a costly process, leading to higher price volatility (Barz and Johnson, 1998)
- Inelastic demand. Electricity has an inelastic demand i.e. not much effect on the demand patterns with the short term variations in spot prices for electricity (Robert and Mount, 1998)
- Restrictive transportation networks. Transmission network is a huge hurdle not only in India but across the globe, Even if the countries have generation plants but many are lying idle because of lack of proper transmission networks. (Bernard et al., 1998; Rudkevich et al., 1998; Girish and Vijaylakshmi, 2013)
- Kinked supply curve. Existing generation plant produces a supply stack which becomes steeply sloped as maximum generating capacity is approached. When the generators reaches its maximum capacity, due to inelastic demand, this produces large price movements for even a slightest change in demand when system generators approach maximum capacity. (Frank and Patrick, 1997; Mount, 1999)
- Load is highly weather dependent. : Electricity load is dependent on weather, Extreme weather conditions often leads to excessive load. This leads to difficulty in making precise forecasts.

All the above characteristics of electricity make it a volatile commodity and its modelling a tedious task in comparison with other commodities.
Electricity prices generally exhibit seasonality at annual level, monthly level, weekly level, daily level and intra-day level not only in India but across the globe (Bierbrauer et al, 2007; Huisman & Mahieu, 2003; Karakatsani & Bunn, 2008; Girish et al., 2013).Especially if we observe the IEX prices of each region i.e. Northern, Southern, Eastern, Western and North Eastern, each region have displayed uniqueness in its volatility patterns. The seasonal behavior is shown collectively but if we delve deeper into each region, a completely different picture is comes out.
CERC's (Power Market) Regulations, 2010 had laid down certain rules on the basis of which the Electricity trading market functions and have made it mandatory for the exchange to disseminate price sensitive information to the general public so that forecasting of electricity prices is made easier .
Various monthly and daily reports on Electricity market published by The Indian Energy Exchange, Central Electricity Authority (CEA) and Central Electricity Regulatory Commission (CERC) were referred to study the factors leading to abrupt movements in the prices of IEX.

III. RESEARCH METHODOLOGY

The research firstly conducts a comparative analysis of trading power through long term as well as short term contracts. Then among the short term contracts, a comparative analysis is conducted between trading through Exchange and Bilateral contracts. Also a price comparison is done between the prices of IEX and Long term contracts to study the importance of trading through an Exchange. Then the effect of volatility on the profitability of IEX is conducted for the month of May, 2017 and finally the factors affecting the IEX's Day- ahead Market prices are studied.
Long term contracts are bilateral contracts with duration of the contract ranging from 12 years to 25 years, while the duration of short term contracts ranges between 15 minutes to 3 years (Sinha & Mathur, 2016).Over a period of time, it has been observed that the Gencos and Discoms are shifting from Long term contracts to Short term or medium term contracts (7-8 years) (**Kujur, 2017).**
There are various advantages and disadvantages of entering into Long term and Short Term contracts which are shown below (Jog, 2016; Sinha, Jain,2017;Dewan,2016;Sinha, Jain, 2017; CERC Grant of Connectivity, Long-term Access and Medium-term Open Access in inter-State Transmission and related matters Regulations,2009)

Table 1: Advantages and Disadvantages of Long term and Short Term contracts

S. No.	Particulars	Long Term power purchase agreements		Short term power purchase agreements	
		Advantages	Disadvantages	Advantages	Disadvantages
1	Tariff		Higher cost (mentioned in the Table.)	Lower cost	
2	Corridor booking	First preference			Last preference
3	Volatility	No fluctuation in tariff for long period			Governed by market forces(Girish, Vijayalakshmi,2013)
4	Immediate requirement		Not fulfilled	Fulfilled due to presence of various products	
5	Price Analysis		Forecasting of prices difficult for long periods	Easier using volatility and forecasting tools	

The above table illustrates that trading through Short term contracts is better in comparison with the long term contracts.
In short term market, there are various financial risks involved such as: (Insights, 2014)

Market risk

One of the major risk in Electricity market is market/ volatility/price risk leading to massive price movements. This risk needs to be addressed so that the traders can devise profit maximization strategies.

Counterparty Credit risk

Major losses are incurred by the bilateral traders due to default in payment by the parties. In case of Exchange, this risk is borne by the exchange itself therefore trading through exchange is much safer in comparison to short term bilateral trading.

Liquidity risk

If we talk about bilateral trading, huge amount of money is blocked i.e. the transaction cost whereas in case of IEX only the initial margin amount is paid to initiate trading. Hence liquidity risk is less in Exchange as compared to bilateral trading.
From the above, it can thus be concluded that trading through Exchange is better in comparison with Short term bilateral market.(Despite the traded volume in bilateral contracts is more than that of exchange).
India has two power exchanges: Indian Energy Exchange (IEX) and Power Exchange India Limited (PXIL) which got operationalized in 27th June, 2008 and 22nd October, 2008 respectively (IEX and PXIL site). These exchanges cover all the five regions (Northern, Southern, Western, Eastern and North- Eastern) of Indian electricity market offering anonymous and automatic bidding, enabling efficient price-discovery mechanism, risk management strategies and endeavouring to address supply-demand gap. Between the two exchanges, IEX is a dominant player; hence the prices of IEX are taken for analysis.

IEX has divided all the five regions mentioned above into 13 bid areas (Illustrated in Table below)

Table 2: IEX bid areas

S.No.	Bid Area	Region	States
1	E1	Eastern	West Bengal, Sikkim, Bihar, Jharkhand
2	E2	Eastern	Orissa
3	N1	Northern	Jammu and Kashmir, Himachal Pradesh, Chandigarh, Haryana
4	N2	Northern	Uttar Pradesh , Uttaranchal, Rajasthan, Delhi
5	N3	Northern	Punjab
6	A1	North Eastern	Tripura, Manipur, Mizoram, Nagaland
7	A2	North Eastern	Assam, Arunachal Pradesh, Meghalaya
8	W1	Western	Madhya Pradesh
9	W2	Western	Maharashtra, Gujarat, Daman and Diu, Dadar and Nagar Haveli, North Goa
10	W3	Western	Chhattisgarh
11	S1	Southern	Andhra Pradesh, Telangana, Karnataka, Pondicherry (Yanam), South Goa
12	S2	Southern	Tamil Nadu, Pondicherry (Puducherry), Pondicherry (Karaikal), Pondicherry (Mahe)
13	S3	Southern	Kerala

It has been observed that there has been increase in the bid areas; the reason behind it is to invite more number of participants (captive power plants, industrial consumers owning captive power plants, industrial consumers, independent power producers, state utilities and private distribution licensees) from each area to trade in the exchange.
IEX trades in four major products such as Day-Ahead Market(DAM), Term-Ahead Market(TAM), Renewable Energy Certificates (REC) and Energy Saving Certificates (ESCerts).The DAM contract is entered on one day before the actual execution of the contract i.e. price and volume for a contract are determined on Thursday and the contract is delivered on Friday. Since DAM captures the major portion of IEX and trading takes place in 15 minute time blocks in 24 hours of next day starting from midnight, therefore, conducting volatility analysis is easier in comparison with other products.

In IEX Day Ahead Market, there are rapid movements in the prices ranging from as low as -43.5 % in September, 2009 to as high as 78% in March, 2010 (author's own analysis), also there are common occurrences of volatility clustering in the market, hence there is a need to identify the reasons behind this erratic price movement and to study the historical as well as to forecast volatility of the commodity , which further will help the stakeholders to prepare a risk management model to gain maximum profit

IV. DATA ANALYSIS

We have conducted a price analysis of companies trading through long term contracts and Indian Energy Exchange. Table below reflects a comparative Analysis of Discoms (Power distribution companies) long term power purchase cost and IEX's Market clearing price in the year 2016-17 (State Distribution Utilites Fifth Annual Integrated Rating, 2017)

Table 3: Comparative Analysis of Discoms long term power purchase cost and IEX's Market clearing price in 2016-17

Discom	Long term Power Purchase Cost (Rs per KwH)	MCP in IEX (Rs per KwH)	Difference in Prices (Rs per KwH)
Dakshin Haryana Bijli Vitran Nigam Limited	4.57	2.711	1.86
Uttar Haryana Bijli Vitran Nigam Limited	4.65	2.711	1.94
Himachal Pradesh State Electricity Board Limited	3	2.711	0.29
Jodhpur Vidyut Vitran Nigam Limited	4.38	2.711	1.67
Ajmer Vidyut Vitran Nigam Limited	4.38	2.711	1.67
Jaipur Vitran Nigam Limited	4.28	2.711	1.57
Uttarakhand Power Corporation Limited	3.36	2.711	0.65
Meghalaya Power Distribution Corporation Limited	4.99	2.711	2.28
Chhattisgarh State Power Distribution Company Limited	3.89	2.711	1.18
Eastern Power Distribution Company of Andhra Pradesh Limited	4.52	2.711	1.81
Southern Power Distribution Company of Andhra Pradesh Limited	4.76	2.711	2.05
Southern Power Distribution Company of Telangana Limited	4.55	2.711	1.84
Northern Power Distribution Company of Telangana Limited	4.82	2.711	2.11

The comparison states that there is huge difference in the prices of both making trading through IEX a better option than long term contract. If discoms across the country replaced a quantum of the expensive power bought from PPAs with power from the exchange, they could have saved approximately □3200 crore in FY17 (Sinha & Jain, 2017). Also if we study the case of 3 distribution companies such as Uttarakhand Power Corporation Limited (UPCL), Assam Power Distribution Company Limited (APDCL) and West Bengal State Electricity Board (WBSEB), It has been observed that over a period of time with a shift from Long term power purchase agreements to short term agreements, there has been decrease in the AT&C (Aggregate Technical & Commercial) losses in the respective companies. Hence Indian discoms needs to move towards a balanced mix of long-term and short-term contracts with base load to be met by Long term and the surplus by Short term in order to reduce their losses.

A comparative analysis of the prices (bid area wise) of IEX with bilateral contracts was conducted (as shown in the table below), the data of bilateral contract was taken from Form IV of power trading companies with Chandigarh, Delhi, Punjab, Chhattisgarh, Maharashtra, Tamil Nadu & Kerala and Karnataka & Telangana being the delivery point for N1, N2, N3, W3, W2, S2 and S1 respectively. It has been observed that due to volatility if the stakeholders go for trading through IEX they will incur huge losses except in S1, despite exchange being a competitive market in comparison with the bilateral contract.

Table 4: Profit/Loss incurred through IEX (Rs/ Kwh) due to extreme price movements.

Region	Profit/Loss through IEX(Rs/ Kwh)
N1	-0.51
N2	-0.02

N3	-0.49
W3	-0.21
W2	-0.19
S2	-0.16
S1	0.83

In IEX Day Ahead Market, there are rapid movements in the prices ranging from as low as -43.5 % in September, 2009 to as high as 78% in March, 2010 (author's own analysis), also there are common occurrences of volatility clustering in the market, hence there is a need to identify the reasons behind this erratic price movement and to study the historical as well as to forecast volatility of the commodity , which further will help the stakeholders to prepare a risk management model to gain maximum profit

It was concluded that out the various fundamental, operational, strategic and historic factors (Girish & Vijaylakshmi, 2013), there are various factors which have actually led to the volatility in the Day ahead market such as :Regulatory, weather/ seasonal, fuel supply, transmission congestion, power plant outages/new plants operational, frequency and reservoir levels. Hence, the market risk can to be reduced for the smooth functioning of the Electricity market by studying the factors mentioned above.

V. CONCLUSION

Electricity, like any other commodity, can now be bought and sold in the Electricity market. Across the globe, the electricity markets have matured, leading to scope of growth in the Indian Electricity market leading to efficiency and competition. In the current study, we have studied the impact of volatility in the prices of Indian Energy Exchange day ahead market. We have also investigated the factors affecting the electricity prices in competitive power markets. The results of the study shed light that despite Exchange being a transparent and efficient platform to trade electricity, huge losses are incurred by the power traders due to high volatility in the prices. Also among the various factors which have actually led to the volatility in the Day ahead market, Regulatory, weather/ seasonal, fuel supply, transmission congestion, power plant outages/new plants operational, frequency and reservoir levels are the major factors influencing the electricity prices which can be further considered for modeling and forecasting electricity prices and giving a new perspective to the budding entrepreneurs and other power market participants to invest in the power trading sector.

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