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Rationalizing Power Trading in Economically Backward States in India

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Abstract: Power is a critical input in India's growth story and it is well facilitated by Electricity Act, 2003 through efficient sale and purchase at viable platforms in order to address the surplus and deficit of electricity in various zones. The study elucidates the development of power market in India, avenues for private sector participation, positioning of regulatory mechanism through commissions at state and central level and appellate tribunal, allowing open access at market rates, etc. It also attempts to appraise the price of unconventional call and put options of electricity along with break even prices in economically backward regions (E1) comprising West Bengal, Sikkim, Bihar & Jharkhand using Black Scholes Option Pricing Model (1973). Results are of great importance where various stakeholders viz. power producers and consumers can minimize risk, hedge risk and play a significant role in price discovery mechanism in electricity market.

Keywords: Power, Economically Backward Zone E1, Black and Scholes Option Pricing

INTRODUCTION

Accessibility, availability and acceptability are the three prime objectives of the power sector which in turn depends on quality and efficiency. The demand of power is gradually increasing and it is a major concern for power sector department. Currently power sector faces various problems viz. air pollution due to coal power plants, large transmission and distribution losses, and lack of pooling of power supply at national level in peak and off peak hours. On production front, there are various sources like coal, hydropower, solar, biogas followed by wind power. Electricity sector reforms have facilitated a transition from a vertically integrated private or public-monopoly market structure to one of competitive wholesale and retail mechanism with marketplaces like power exchanges in order to make the power market efficient, competitive and sustainable by discovering the power pricing at different time by different zones.

GLOBAL OVERVIEW OF POWER

Energy plays a vital role in day to day activities of industry, institutions and individual households throughout the world and its consumption is increasing day by day owing to increased use of electrical appliances, development of electrical heating in several developed countries and rural electrification programmes in developing countries. The world net electricity generation is projected to rise from 17.3 trillion kilowatt hours in 2005 to 24.4 trillion kilowatt hours in 2015 and 33.3 trillion kilowatt hours in 2030. The strongest growth in demand is shown by the non OECD countries due to the expansion in their power grid for supporting and maintaining the robust economic growth. There is an average increase of 4% per year from 2005-2030 in the total electricity generation in the non OECD countries whereas in the OECD countries the average increase is 1.3% per year for the electricity generation. The per capita consumption of India is far behind when compared to the world average and very less when compared to other countries. However, Indian Government has also paved the way by various power sector reforms.

INDIAN POWER SECTOR REFORMS

Electricity Act 2003

Government has implemented Electricity Act 2003 and has abolished the monopoly created through the Electricity (Supply) Act, 1948 of the State Electricity Boards. Subsequently it has made the power pricing more competitive through independent regulatory commission at centre and state level to cater to the interests of consumers. This act has given adequate freedom to captive power plant producers and thermal producers with least requirement of clearances. It also ensures pan Indian market and open access subjected to minimum consumption in transmission and distribution with multiplicity of licensing in same area. However the cost of electricity in open access is determined by the market.

National Electricity Policy

National Electricity Policy has mandates to make power available for all households by 2012 and to maintain the spinning reserve of 5% to be available at the national level. It also emphasizes on economically viable quality power supply to households and harnessing the hydro potential fully. It also envisages the development of national grid and the extension of Availability Based Tariff to the state level. Further it also mulls all India transmission tariff sensitive to distance and direction by the Central Electricity Regulatory Commission.

Tariff Policy

National Tariff Policy has made the tariff competitive through competitive bidding among producers and suppliers under the aegis of regulatory commission. It has also ensured that cross subsidy to 20% of the average tariff will be reduced in next five years and it will be also sensitized to distance and direction to achieve the performance standard strictly.

The concept of trading

Power trading is still in nascent stage and is picking up with limited exchanges. And consumers are served by state power departments, private producers or State Electricity Boards (SEB), Independent Power Producers (IPPs) Central Generating Stations (CGS). Each SEB has an allocated share in central sector/ jointly owned projects and is expected to draw its share without any role in the pricing of power. On the other hand, suppliers and consumers of power have inelastic consumers and suppliers respectively and the price is fixed by regulatory commissions. Power generation/transmission is highly capital intensive attributing higher percentage to fixed cost but demand is sensitive to concern, climate, temperature, loads and geography of the place paving the way for adequate trading opportunities in power sector in order to utilize effectively and optimize the cost of production.

The installed power capacity of India has increased from 1362 MW in 1947 to 148265 MW in 2015. Still the energy shortage is pegged at 8.2% of the energy production which is 50% below the installed capacity. This shortage aggravates to 10.5% in the peak hours on aggregate basis.

The installed capacity of the various regions of India is shown with the help of the following table with the ownership sectors as well as the mode wise breakup viz. thermal, nuclear, hydro, and renewable energy sources.

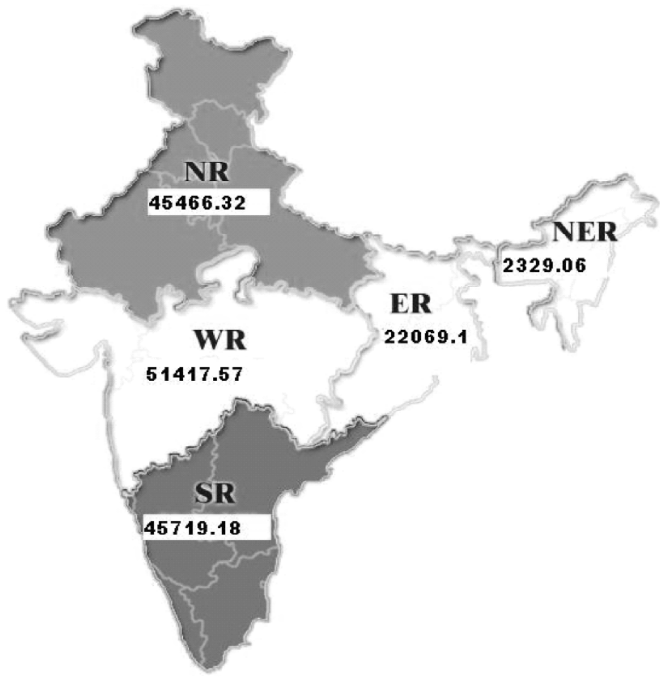

Figure 1: Regional capacity of generation (Source: powermin.nic.in)

THE NECESSITY OF TRADING IN INDIA

India is divided into five different grids and every grid has its own peculiarity. Like, the northern grid is a deficit region which has highly weather sensitive load. It has adverse weather conditions with fog and dust storms. In the North eastern region the load is very low but it has high hydro potential. In the eastern region there is low load but the reserves of coal is very high. It has pit head base load plants. In the western region the load is basically industrial load and agricultural load. In the southern region the load is very high and it is basically dependent on hydro potential. Here, 40% of the load is agricultural load.

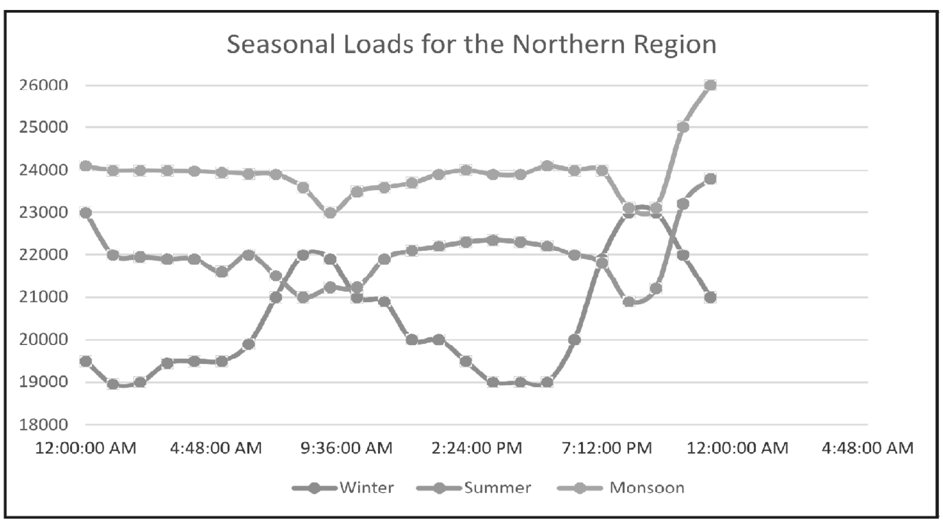

Figure 2: Typical seasonal load curves for the Northern region

In the northern region the load during the summer seasons remains near the 22000 MW mark in the wee hours of the morning. It reduces a little bit during the daytime but it again shoots up at the evening time to around 24000 MW. In the winter season during midnight the load is around 19500 MW. It increases in the morning time and goes to around 22000 MW and again reduces after 11 am. The main peak is reached during the evening time when the demand goes to around 23000 MW.

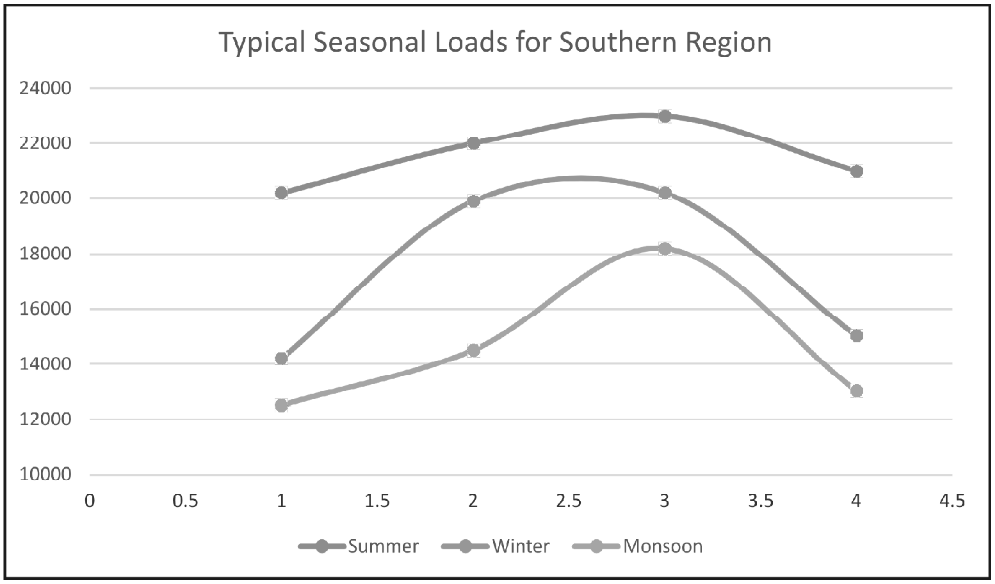

Figure 3: Typical seasonal load curves for the southern region

During the summer time the load is almost same throughout the day with the load increasing a little bit in the evening time. It fluctuates round the 20000 MW mark but during the evening peak it goes to around 23000 MW mark. The winter time witnesses a drastic change in the load curve with the load increasing mostly from 7 o'clock in the morning and reaches the peak at the evening time. At this time the load is around 21000 MW. During the monsoons the load falls further down with the evening peak around 18500 MW.

There is always the existence of shortages in meeting the peak as well as the overall demand.

Although there is an overall shortage, the inherent density in demand of various states and regions in the country results in periods of seasonal surplus in one state or region coinciding with periods of deficit in another region. This coexistence of overall shortages with complementary geographical and temporal surplus-deficits provides substantial opportunities to improve the economic efficiency and the security of supply through trading of power both within as well as across regions. With the trading of power across the regions it has been possible to reduce the demand and supply gap in various states of India.

There is also the need for the availability of adequate transmission capacity and inter regional links for transfer of power from a surplus to a deficit entity and support. This way the full benefits of trading can be realized.

Trading is also required for developing a fully-fledged, efficient and competitive market mechanism for power trading and also to facilitate the development of generation projects including through private investment, both resulting in reliable, economic and quality power in the long term. It also helps in developing a power market for optimum utilization of energy. Optimum utilization of existing resources is possible with the help of power trading. It also aims to catalyze the development of power projects particularly environment friendly hydro projects. It also promotes the exchange of power with the neighboring countries.

Power trading current scenario

The 97% of the supplies are locked up in the long term power purchase agreements (PPA) and the remaining three 3% is fixed by short term trading. Trading is usually done between surplus and deficit regions which help in optimal utilization of resources attributed open access provision in the electricity policy. Normally the trading is skewed to suppliers due to huge demand in the market.

Power exchanges

Power exchange is a platform available for the purchase and sale of power in addition to the bilateral agreements. It operates on a day-ahead basis, functions on all days including bank holidays and Sundays.

Bid Areas

The bid areas are divided into 10 different areas.

N1- North Region- Jammu & Kashmir, Himachal Pradesh, Punjab, Chandigarh and Haryana N2- North Region- Uttar Pradesh, Uttaranchal, Rajasthan, Delhi

E1- East Region- West Bengal, Sikkim, Bihar & Jharkhand

E2- East Region- Orissa

W1- West Region- Madhya Pradesh, Chhattisgarh

W2- West Region- Maharashtra, Gujarat, Goa, Daman and Diu-1,Daman and Diu-2,Dadar and Nagar Haveli, North Goa

S1- South Region- Andhra Pradesh, Karnataka, Pondicherry (Yanam), South Goa

S2- South Region- Tamil Nadu, Kerala, Pondicherry (Puducherry), Pondicherry (Karaikal), Pondicherry (Mahe)

A1- North-East Region- Tripura, Meghalaya, Manipur, Mizoram, Nagaland

A2- North-East Region- Assam, Arunachal Pradesh

OBJECTIVES OF THE STUDY

The specific objectives of the research are as follows.

- To determine the call and put price of electricity derivative in region E1
- To appraise the breakeven bandwidth of call and put price for various stakeholders
- To explore the feasibility of electricity trading in derivative market

METHODOLOGY AND DATA SOURCES

The pricing of electricity derivative is calculated using Black Scholes model based on secondary data collected from different sources. We collect the spot price data for region E1 from official website of Indian Energy Exchange (www.iexindia.com). Data collection is limited to region E1 comprising economically challenged states Bihar, Jharkhand and Eastern Uttar Pradesh from January to March, 2013 and the time period being taken as Peak Power Consumption time, i.e. 18:00 hrs to 23:00 hrs). The selection of sample is judgmental primarily due to huge demand supply gap in electricity production and demand in these states. Thus the concept of minimizing risk and fixing prices of a key parameter is to stabilize the electricity market. The model developed in this research has not been developed earlier and is a novel concept which aims at attaining a bandwidth of economically viable call and put prices for rational trading with standard notations and methodology. The monthly risk free rate is taken as 0.6875 (Annual risk free rate = 8.25%). The monthly volatility of the electricity instruments are calculated as square root of four x Weekly Volatility (which is Annual Volatility x (1/48) ^.5 (%)) and is 113.97%. We have used three levels of expiry for call and put options as one month (T=1), two month (T=2) and three month (T=3).

The Black and Scholes Option Pricing Formula (Fisher Black and Myron Scholes, 1973)

$$C = SN(d1) - N(d2)Ke^{-rt}$$

$$P = Ke^{-rt}N(-d2) - SN(-d1)$$

Where,

$$d1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

$$d2 = \frac{\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

The Variables are:

S= Stock Price

K = Strike Price

T = Time remaining until expiration

R= Current Risk-Free Interest Rate

σ = Volatility Measures by annual Standard Deviation

ln= Natural Logarithm

N(x) = Cumulative Normal Density Function.

RESULTS AND DISCUSSION

Using Black and Scholes Option pricing formula, Table1 (Appendix) presents the prices of call and put options at different level of expiry (T=1, 2, and 3 months). The other parameters like volatility and rate of interest have been adjusted to accommodate monthly values.

Break Even for T=1

The call and put premiums have been calculated for the electricity options for T=1, i.e. time to expiration is one month and it has been observed that for the month of January, 2013, premiums range from 868 INR/MWh to 2000 INR/MWh for call options and 360 INR/MWh to 1800 INR/MWh for put values respectively. The bandwidth of economic breakeven values for T=1 is found out to be in the range of 3000 INR/MWh to 5800 INR/MWh for call options and 830INR/MWh to 2500INR/MWh for put options respectively.

This can form a basis for trading of electricity derivative with shorter expiry period in the Indian Electricity Trading Sector.

Break Even for T=2

The call and put premiums have been calculated for the electricity options for T=2, i.e. time to expiration is two month and it has been observed that for the month of January, 2013 when the premiums range from 1200 INR/MWh to 2700 INR/MWh for Call Options and 562 INR/MWh to 2300 INR/MWh for Put Options respectively. The bandwidth of economic breakeven values for T=2 is found out to be in the range of 3000 INR/MWh to 7300 INR/MWh for call options and 636 INR/MWh to 2000 INR/MWh for put options respectively.

This can form a basis for trading of this derivative in the Indian Electricity Trading Sector.

Break Even for T=3

The call and put premiums have been calculated for the electricity options for T=3, i.e. time to expiration is three month and it has been observed that for the month of January, 2013 when the premiums range from 868 INR/MWh to 3300 INR/MWh for Call Values and 1400 INR/MWh to 2900 INR/MWh for Put Values respectively. The bandwidth of economic breakeven values for T=3 is found out to be in the range of 2600 INR/MWh to 6900 INR/MWh for call options and 800 INR/MWh to 1600 INR/MWh for put options respectively.

CONCLUSIONS

After the enactment of Electricity Act, 2003, Power trading started over the counter but with higher degree of risk which is further resolved by the evolution of power exchanges in 2008 facilitating exchange trading of power among various stakeholders. The trading of power was also prevalent before the existence of the exchanges but the level of risk was more in those agreements. There is no technical barrier as such in making the electricity market more flexible. The baton of price fixing in electricity has shifted from sovereign Governments to regulatory commission. On the other hand, power production entails higher fixed cost and lower operating costs which may fluctuate subjected to season and weather in agrarian economy. There also exists a substantial difference in the demand of power during different hours of the day with variations during peak hours and off peak hours. Further, the geographical spread of India is very large and different parts of the country face different types of climate and different types of loads. Thus having such a diverse context, electricity derivatives play an important role in discovering price signals, hedging risk efficiently, and bridging gap between supply and demand in peak hours. Further it also tailored and structured to achieve price certainty, to hedge risk and to synchronize power generation and transmission.

The demand and supply of power varies across states depending on business requirements, agricultural needs, and temperature variations making the power trading platform inevitable. It also becomes essential due to fluctuations in demand in different hours in different geographical locations. Thus the appraisal of call and put price using Black Scholes Option pricing becomes very important for price discovery in the power market. It is found that the call price varies between Rs 800 to Rs 3300 per MWh for call options and Rs 300 to Rs 2900 per MWh for put options respectively.

The high call and put price in E1 region reflects the higher volatility indicating the high demand supply gap necessitating the need of power trading and efficient utilization of resources. In competitive power market, power quality and demand side management are still challenging issues. Trading arrangements should tackle these concerns and arbitrage issues among competing contracts.

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