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Economical Power Trading in Electricity Market

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ABSTRACT: Power trading in India is in an initial developing stage. It has a high potential for growth and development. Freedom to all the operators, developing a flexible market, removal of cross subsidy, provision of an equal access are some of the ways by which commercialization of the power market can be done in a better way. Charges and priorities should be first channelized according to the demand of the particular area. Electricity market is nowadays facing wide range of challenges because of the fast evolving machinery and power stations. There is a need to reduce the basic cost of electricity. Shifting from sole proprietorship to distributed ownership has shifted the market pressure to different small generating units. This paper we will discuss about different aspects of competitive electricity market, electricity forecasting models and economical factors governing power trading operations among different power stations.

KEYWORDS: Power market, market entities, energy forecasting, time series model, renewable power market, open access, energy updates.

I. INTRODUCTION

Throughout the world the electricity market has long been influenced by independent integrated utilities. It's now evolving as a completely integrated as well as a distributed industry. This shift of individual controlling to distributed controlling has made it possible for different generating units to unite under a common umbrella and provide electricity to even remotest of areas. All over the world electric power industry is undergoing important changes because of deregulation. One major objective is to reduce the customer electricity prices through the introduction of competitive energy markets. Many factors will come into account when we talk about the economical power trading. Both generating side and load side has to be considered when deciding the forecasting model for economic power trading. Proper electricity pricing has become an important issue due to various customer locations and their choices on price and authenticity. Various researches have been done to evaluate and estimate electricity prices [17].

In a competitive environment, the price is determined by appropriate supply and demand functions. This price can change at any point of time. Because of increased volatility, an electricity trader could make trading contracts with other parties to guard possible risks and in turn get better returns. Security of the electricity market is another major factor that governs the electricity cost. The electricity trading is carried out through a highly competitive bidding process controlled by power exchange/market operator, apart from the direct transactions that were carried through bilateral or multilateral negotiations. All Generating companies (Gencos) and Power Purchasing companies bid for the most rewarding transactions resulting in different load dispatch schedules. This may lead to overloading and crowdedness in some transmission corridors which might result in market inefficiency and system insecurity. Hence a concrete and robust power trading system is required for secure and fair transmission. Economical and secure operation of the power market will result into the trimming of the electricity cost. In order to ensure reliable, secure, stable and efficient operation of the power system, load forecasting and knowledge of subsidary services requirements are the major concerns [16]. The load forecasting is widely used for most favourable expedition of generation, assessment of power system security, generation reserve allocation, proper market operation, etc. The much needed balance between

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generation and load is done completely through actions taken from the generation side. Further, it is also observed that the non involvement of active demand-side participation is the main cause of increase in the prices, shortages and exercise of market power. A buyer might feel to reduce its demand during course of high prices. However, the challenge that still remains is how to consolidate these changing demand responses into the market design to accomplish maximum savings and effective and efficient market performance.

II. TYPES OF POWER MARKET

Energy market- The energy market is where the ambitious trading of electricity occurs. The energy market is a centralized market mechanism that promotes energy trading between buyers and sellers. The energy market's prices are reliable prices indexes, not only for market participants but for other financial markets and consumers of electricity as well. The energy market has an indifferent and independent clearing and settlement functions. In general, the ISO or the PX controls the energy market functions and all the other pricing requirements.

Ancillary services market- Ancillary services are needed for the power system to operate reliably. In the regulated industry, ancillary services are chock with energy. In the reconstructed industry, ancillary services are mandated to be unbundled from energy. Ancillary services are procured through the market competitively. In the United States, competitive ancillary services markets are operated in California, New York, and New England.

Transmission market- In a restructured power system, the transmission network is where competition occurs among suppliers in meeting the demands of large users and distribution companies. The non committal traded in the transmission market is a transmission right. This may be the right to transfer power, the right to inject power into the network, or the right to extract power from the network. The frame of a transmission right can either physically exercise the right by transferring power, or be anted financially for transferring the right for using the transmission network to others. The importance of the transmission right is mostly observed when overcrowding occurs in the transmission market. In holding certain transmission rights, participants can fabricate congestion charges through congestion credits.

III. MARKET POWER

Non-competitive practices in the electric power industry, especially in the generation sector, mainly deals with market power. When an owner of a generation facility is able to employ a significant influence on pricing or on the availability of electricity, a market power is incarnate. Market power could prevent the competition and the customer choice in a restructured power system. Market power may be defined as owning the ability by a seller, or a group of sellers, to drive the spot price over a competitive level, control the total output, or exclude competitors from a relevant market for a significant period of time. A market power could hamper the competition in power production, service quality, and technological innovation. The net result of the existence of market power is a transfer of wealth from buyers to sellers through a misallocation of resources.

IV. RENEWABLE POWER MARKET

Renewable power market is the new upcoming efficient formula for the world to survive in this era of shortage of electricity sources. Solar, wind, tidal, and geothermal face different technological challenges. Unlike other usable products, electricity can't be stored and hence very unpredictable in terms of its prices. If we look at the current status of the storage ability of different battery technologies available in market, it is just 4 to 5 hours. Hence renewable energy contribution to market can lead to shifting of pressure from fossil fuels and old famous sources to new upcoming latest ones. Nowadays different smart grid technologies are being implemented to integrate complex scattered power generation system. Different demand side management programs have been started to shift the peak load to off peak timings.

Smart meters are being installed which will provide real time pricing and channel of communication to the central electrical office.

In January 2016, new tariff policy was introduced by cabinet to boost the investment in clean energy. Some major developments were-

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- Power plants with regulated tariff will now be allowed to double their extant capacities at the same sites and hence reduction in the time required for different clearances for green projects.
- Regulators flexibility in finalization process of cross subsidy surcharge.
- More frequent tariff revision by regulators.
- Approval for selling of un-requisitioned capacity of power plants.
- Solar and Wind power are exempted from inter-state transmission charges.

These amendments will lead to balanced mix of renewable energy in the upcoming years.

V. ENERGY FORECASTING

Electricity trading is playing a key role in meeting peak demands and maintaining overall resource balance. Increase in the population, technologically motivated living and economic growth are some of the factors which have increased the level of energy use many folds.

New regulations have been made to govern the use of electricity worldwide. On 31st march, the CERC (Central Electricity Regulatory Commission) has awarded 45 trading licenses. All the large consumers of electricity are majorly served by their respective state electricity boards or local generating stations. Today's scenario is such that the suppliers of electricity have a very little choice about whom to provide with their generated energy and buyers on the other hand have no clue about where to buy their required power from.

Different models have been developed over a period of time which are mainly of two types-

- Time series model
- Simulation based models

VI. TIME SERIES MODEL

A time series can be defined as a set or sequence of data points arranged in sequential order and in equally spaced time intervals. Time series occurs in many fields and the analysis of time series has is widely used in areas like market potential forecasting, process control, area complex development plan, weather hydrology prediction, national economy adjustment and control, and biomedical science. Time series analysis uses standardized means to extract information and understand the properties of a physical system that creates the time series. A number of models have been discussed in this paper to deal with the time series analysis. Time series analysis may result from the varied interests of the analyst. One may be interested in process or quality control; for this purpose a time series that measures the quality of a system or process can be produced. The time series analysis is a technique of establishment of mathematical model with the system observation data and forecast the future trend. In another scenario, if more than one variable is observed then variation in one variable can be used to explain variation in other variable for understanding the nature of relationship between the variables.

Different mathematical models are constructed for an observed time series and consequently these models are used to make time series forecasting. The economic benefits of the nation are deeply affected by the stock price so people pay close attention to it. Time series forecasting is the prediction of future events based on previously occurred events using a suitable model. There are two types of time series model- linear time series models- Linear time series model and Non linear time series model. Accordingly, there are different models using different approaches that can be used for time series forecasting.

In Figure 1- It defines all the parts of linear time series models which is used for the price forecasting in power trading. Many other models are there but majorly time series is used because of its simplicity.

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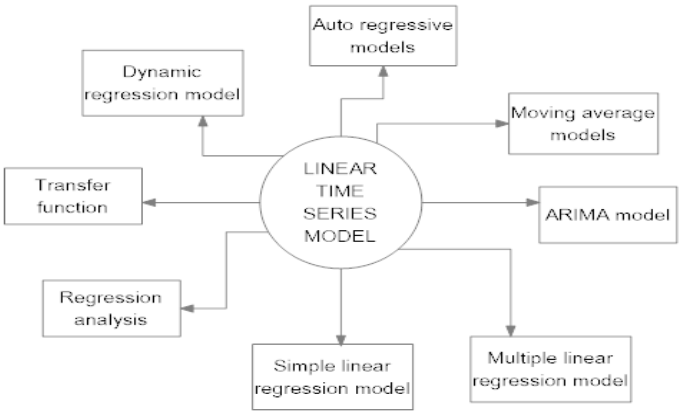

Previously energy pricing has been fixed by the central and state government. But now, it's being done by regulatory commission at the centre. When we talk about energy generation/transmission, it is highly capital intensive. India being an agrarian economy has flexible power demands. Power demands in India are seasonal, weather sensitive and there are frequent fluctuations on hourly basis because of frequent change in load demands. Geographical terrain also influences the energy usage. India is a land with different geographical terrains and fluctuating climatic weather conditions. Hence, energy variations are significant here. Fixed charges make a major part of energy tariff and as a result it affects the cost of energy. Fixed charges need to be balanced and controlled in a way that the requirements of person living in a village can be met with the same efficiency as that of person living in a city. Power demand during the rainy seasons is less in the States of Karnataka and Andhra Pradesh and high in Delhi and Punjab. Whereas many of the States face high demand during evening peak hours, cities like Mumbai face high demand during office hours. It depends on place to place and the type of environment which creates the load. Eastern Region has a significant load peaks round the clock, and even normally power deficit states with very low agricultural loads like Delhi have surpluses at night. This situation indicates enough opportunities and development scope in the field of power trading. This would improve utilization of existing capacities and reduce the average cost of power to power utilities and consumers.

Open access- Allowing non-discriminatory sale/purchase of electric power/energy between two units utilizing the system of an in-between (third unit), and not blocking it on unreasonable grounds.

Major developments-
a) Freedom to buy/sell, and access to market.
b) Adequacy of intervening transmission.
c) Transmission/wheeling charges.
d) Reducing transmission losses.
e) Energy accounting, load scheduling.
f) Smart metering and UI settlement.
Allowing open access to the purchasing units has developed the option of more economical distribution of power. Companies which are purchasing and selling power are earning great profits and thus it is a direct indication of the development in the field of power trading. Transmission charges are now more equally distributed and the losses which have to be minimum in case of long transmitting lines have decreased.

VIII. POWER MARKET UPDATE

1. Low prices, increased trade & enhanced corridor availability characterize spot power market

At average Market Clearing Price (MCP) of Rs 2.56 per unit in December'15, spot power market at IEX saw increased trade along with significant easing of Inter State Transmission System (ISTS) congestion. In December, MCP dipped by 4% over last month. In South, area prices dipped to an extent of 20%, with increase in generation within the region as well as enhanced availability of transmission corridor between rest of India and South. The ER -> SR and WR -> SR corridors were congested 45% of time, whereas, last month corridor was congested 65% of time. Low prices on

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Exchange present immense opportunity to state utilities to optimize their power portfolio and bring down their cost of procurement.

With purchase bids at 3,397 MUs (4,566 MW) and sell bids at 4,981 MUs (6,694 MW) – almost similar to last month, about 2,987 MUs were traded in December, about 9% above the previous month. On an average daily basis, about 96 MUs were traded in December 2015.

With enhanced availability of transmission corridor in December, only 54 MUs were curtailed, almost half of the 116 MUs lost in November. Easing of congestion can be attributed to the Government laying increased emphasis on building transmission, aiming at one nation, one grid and one price. In fact, on 29th December, after several years, the spot market was cleared at a single price of Rs 2.3 per unit across India, a remarkable day in the context of power market.

On an average, 1,042 participants traded in the day ahead spot market on a daily basis in December.

A. Prices (ACP)

The Average Area Clearing Price (ACP) in December across all regions except South was Rs 2.45 per unit, about 4% lower than ACP of Rs 2.54 per unit last month. In South, highest average price was Rs 3.10 per unit, 20% lower than Rs 3.87 per unit in the previous month. In December, price in South dipped as low as Rs 2.24 per unit on 11 December, 2015.

B. A Few Key Power Market Highlights

- Total buy bids – 3.40 BUs
- Total Sell bids – 4.98 BUs
- Total Cleared Volume – 2.99 BUs

C. Participation

1,042 participants traded in the spot market on an average daily basis. The highest participation was on 19 December, 2015 when 1,105 participants traded on the Exchange.

D. Term-Ahead Market

In December, about 25 MUs were transacted, representing just about 1% of volume traded in DAM this month. Trading mainly took place in the Intra-day and Day Ahead Contingency market.

2. Low prices continue- making strong case for distribution companies to replace costlier power

At Rs. 2.52 per unit, the average Market Clearing Price (MCP) for January'16 declined marginally by 2% over last month. Even the Area Clearing Prices (ACP) – price determined post accounting for transmission congestion, dipped across all bid areas. At such prices in the spot market, the State utilities must continuously benchmark the variable cost of their generating stations with price discovered on the power exchange and schedule competitively priced power, thereby optimizing cost of procurement and sharing the benefits with their consumers.

In January, the generators remained enthusiastic about the spot power market as sell bids for the month on aggregated basis were 5,386 MUs (about 7,239 MW on average daily RTC basis), about 8% up over the previous month while demand remained subdued with aggregated purchase bids for the month at 3,449 MUs (about 4,636 MW on average daily RTC basis), up 2% over the previous month. About 94 MUs were traded on a daily average basis with total cleared volume at 2,929 MUs, 2% less over 2,987 MUs traded last month.

About 152 MUs were curtailed in Jan'16, about 3 times the volume curtailed in December (54 MUs), mainly due to constraints in import of power in the Northern region with tripping of one circuit of 400kV Phagi-Bassi and one circuit of 765kV Gwalior-Agra transmission lines due to foggy conditions. The ER-NR and WR-NR interconnections were congested 32% of the time and the ER-SR and WR-SR interconnections were congested 50% of the time during the month respectively. Pertinently, ideal market situation of one grid one price was seen on three instances over the month – on 14th, 30th and 31st January.

A. Participation

1,045 participants traded in the spot market on an average daily basis. The highest participation was on 7 January, 2016 when 1,136 participants traded on the Exchange. The Northern and Southern States were Net Buyers while the Eastern, Western and North-Eastern States were Net Sellers.

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B. ***Term-Ahead Market***

About 13 MUs were scheduled during the month, mainly in the Intra-day and Day Ahead Contingency segments. [2]

IX. RESULT AND DISCUSSION

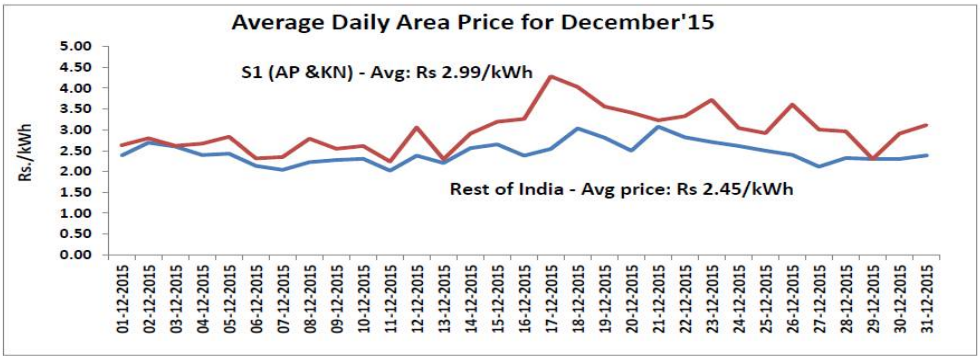

Fig 2: Figure above shows average daily area price for December 15.

In Figure 2- The Northern and Southern States were the Net Buyers.

- Northern States bought – 1,449 MUs, 15% more over the previous month.
- Southern States bought - 413 MUs, 12% more over the previous month.

The Eastern, Western and North-Eastern States were the Net Sellers

- Western States Sold – 1,404 MUs, 20% more over the previous month.
- Eastern States Sold – 824 MUs, 18% more over the previous month.
- The North-Eastern States Sold – 107 MUs, 23% less over the previous month

REGION	BUY (MU)			SELL (MU)			NET
	December'15	November'15	Change (%)	December'15	November'15	Change (%)	
North East	92.43	70.86	↑ 30%	106.90	138.75	↓ -23%	SELL
East	421.86	401.25	↑ 5%	823.85	695.85	↑ 18%	SELL
North	1448.84	1264.72	↑ 15%	328.93	475.26	↓ -31%	BUY
West	611.13	624.36	↓ -2%	1404.30	1174.82	↑ 20%	SELL
South	413.10	367.36	↑ 12%	323.37	243.87	↑ 33%	BUY

Fig 3: Table above gives complete Buy-Sell Picture at regional level for December'15 vis-à-vis November'15.

In Figure 3- BUY SELL (MU) changes are defined, where North and West became major buyers while North East, East and West became sellers.

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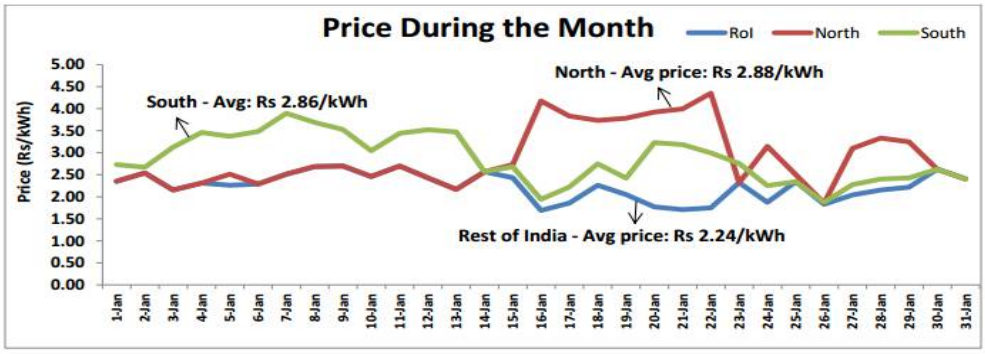

Fig 4: Figure above shows price changes in different regions during the month of January.

In Figure 4- In January, average Area Clearing Price (ACP) dipped across all regions except North.

- In North-East, East and West, ACP was Rs 2.24 per unit, about 10% lower than last month.
- In South, ACP was Rs 2.86 per unit, 4% lower than the previous month.
- In North, ACP was to Rs. 2.88 per unit, 18% up over the previous month.

REGION	BUY (MU)			SELL (MU)			NET
	January'16	December'15	Change (%)	January'16	December'15	Change (%)	
North East	79.94	92.43	↓ -14%	134.48	106.90	↑ 26%	SELL
East	506.30	421.86	↑ 20%	521.06	823.85	↓ -37%	SELL
North	1148.84	1448.84	↓ -21%	461.94	328.93	↑ 40%	BUY
West	745.27	611.13	↑ 22%	1514.01	1404.30	↑ 8%	SELL
South	448.92	413.10	↑ 9%	297.75	323.37	↓ -8%	BUY

Fig 5: Table above shows complete Buy-Sell Picture at regional level for January'16 vis-à-vis December'15.

In Figure 5- Total Sell bids were 5,386 MUs , Total buy bids were 3,449 MUs and Total Cleared Volume were 2,929 MUs .

X. CONCLUSION

The best trading system would be one which will give every customer an independent selecting power that will come irrespective of the competition. Investors and customers both should be given equal importance while deciding any rules and regulations for power transmission. Shortage of anything is a direct indication of mismanagement between two balancing systems. Trading is the solution for those conditions. Rules and regulations are to be formulated for interstate, inter-regional and international transactions which have built-in relaxation that encourages trading and makes transfer of power easier. Bottled-up capacities of the IPPs and Captive Generators as well as underutilized capacities of Utilities need to be tapped urgently through a more commercial approach. Trading of such capacities would mean availability of extra energy at only the variable cost, thus bringing down the average cost of power not only to bulk consumers but also reducing the burden of rate increases on ordinary consumers too. India is already on its way to establishing a power market. Here development in this stage is easy and thus scope is more. This requires considerable and continuous effort ranging from continued strengthening of inter-regional power transmission links, open access to transmission and later to distribution links, releasing the underutilized captive capacities, to the designing of an effective market schemes suited to India's needs. The institutional set-up of the market could make a significant difference to the final market price. In the short term, market rules should promote economic efficiency, so that

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customer loads are served and reliability is maintained at the lowest possible cost. In the long term, the market should produce prices that stimulate appropriate levels of investments in new generation and transmission capacity.

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