POWER EXCHANGE IMPLEMENTATION IN INDIA AND CONGESTION MANAGEMENT IN MULTI EXCHANGE SCENARIO

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ABSTRACT:
In line with the mandate provided by the Indian Electricity Act 2003 and the National Electricity Policy the Central Electricity Regulatory Commission (CERC) has issued a number of Regulations to facilitate trading and introduction of competition in the Electricity Sector in the country. Open Access in inter-state transmission was introduced in May 2004 which facilitated the development of the bilateral market in the country. In order to further streamline the bilateral transactions and to facilitate the implementation of Power Exchange in India, CERC issued the Open Access Regulations 2008. These regulations provided for two categories of Short Term Open Access Transactions namely bilateral and collective (discovered on a power exchange). The paper presents salient features of Power Exchange implementation in India and the experience gained. Indian power grids are well meshed network and congestion occurs in some cases of skewed load generation balance. Congestion management techniques in a single exchange are discussed. Multiple Exchanges have been implemented in the country and sharing of available margins between the Exchanges becomes an issue of crucial importance with reference to achieving overall economy and efficiency. The paper discusses the various possibilities for sharing of the total available margins between the Power Exchanges and the Indian experience in this regard.

KEYWORDS:
Indian Electricity Market, Power Exchange, Open Access, Bilateral, Congestion Management

1.0 INTRODUCTION:

The responsibility for the development of the Electricity Market in the country has been entrusted to the Appropriate Commission as per the Section 66 of the Electricity Act 2003 (EA 2003). Section 5.7 of the National Electricity Policy (NEP) provides for promoting competition in the Electricity Sector with the objective of benefiting the end consumer. The Central Electricity Regulatory Commission (CERC) is responsible for ensuring the development of the Electricity Market at the inter-state level.

The Indian Electricity Grid Code (IEGC) was introduced in Feb 2000 with subsequent revision in April 2006 and the settlement system (Availability Based Tariff or ABT) was introduced in 2002-2003. The ABT mechanism provided the framework for scheduling and handling of imbalances. These two building blocks together provided the basic rules for system operation and the commercial settlement. Thus, out of the four essential pillars of electricity market design [1], i.e., Scheduling and Despatch, mechanism for handling imbalances, Congestion management and ancillary Services, two were in place before the introduction of Open Access.

Open Access in inter-state transmission was introduced in May 2004 and this has been successfully implemented. This facilitated the development of the bilateral market in the country and the results are very encouraging. Open Access regulations provided for electronic bidding for reservation of corridor in case of congestion.

In July 2006, CERC took a giant leap forward in developing the electricity market in the country and floated a discussion paper on "Developing a Common Platform for Electricity Trading". Comments were invited and all the stakeholders were involved in the discussion process, finalization of the framework and rules. CERC issued the Guidelines for Establishment of Power Exchange in February 2007 and in principle approval was granted to the first Power Exchange in August 2007.

2.0 REGULATORY FRAMEWORK FOR POWER EXCHANGE IMPLEMENTATION:

The Open Access in Inter State Transmission Regulations 2004 provided only for the Bilateral Transactions and the transactions discovered through anonymous bidding on a Power Exchange were not envisaged. The system of application of transmission charges was in Rs/MW/Day. A single regional postage stamp was applied in case of

intra-regional transactions for transmission charges and losses. For inter-regional transactions, pancaking occurred. These methodologies for transmission charges & losses were not conducive to the operation of a common platform for electricity trading i.e., Power Exchange operation. Changing the existing Regulations and framework overnight would have had widespread implications. Implementation of the proposed Power Exchange (PX) had to be done seamlessly in the existing scenario. All these factors needed careful consideration and were crucial to the success of the electricity market as a whole.

The Regulations for Open Access in Inter-State Transmission were revised by CERC to include *Collective Transactions Discovered on a Power Exchange*, and the new Regulations became effective 1st April 2008. The Regulator has adopted the approach of light handed regulation while providing an enabling framework for the development of Power Exchange [2]. The objective was to provide operational freedom to the Power Exchange within a given framework and Regulation would be minimal and restricted to requirements essential for preventing derailment of the process. Private entrepreneurship was allowed to play its role so as to facilitate provision of value added and quality service to the customers. The CERC Guidelines for Setting up of Power Exchange, however, clearly provided for a de-mutualised form of Power Exchange implementation where ownership, management and participants were clearly demarcated.

CERC Open Access Regulations, 2008 [3] made the following provisions:

a) Transactions were categorized as Bilateral and Collective (through Power Exchange)
b) Nodal Agency for the two types of transactions was identified. National Load Despatch Center (NLDC) was designated as the nodal agency for Collective Transactions. The Regional Load Despatch Centers (RLDCs) were the designated agencies for the bilateral transactions.
c) Transmission losses were applied at both the points of injection and drawl. The sellers are required to inject more and the buyers draw less than the traded quantum to compensate for the losses.
d) Regulations placed great emphasis on the empowerment of the SLDCs. NOC/Standing Clearance was required to be obtained by State Utilities/Intra-State Entities from the SLDC. The SLDCs are obliged to respond within 3 days to any request for an NOC as per the Regulations. The SLDCs may charge an appropriate fee for such NOC/Standing Clearance (as per SERC or Rs. 5000 if not notified by SERC).
e) The methodology of application of transmission charges moved from "Contract Path" to a methodology closer to the "Point of Connection Charge" for Collective Transaction. A transmission charge of Rs. 30 per MWh was made payable by both the buyers and sellers in the case of Collective transactions.
f) Operating charges for Collective transactions @ Rs. 5000 per day per entity involved were applied. All Buyers within a State are clubbed together into one group and all Sellers within a State are clubbed together into another group by the Power Exchange(s). Each group of buyers and sellers is counted as a separate entity for Scheduling and levy of Operating Charges.

In accordance with the CERC Regulations 2008, the detailed Procedure for Scheduling of Collective Transactions [4] was issued by the CTU. The Procedure covers in detail the aspects related to application for collective transactions, scheduling of collective transactions, treatment of losses, real time congestion management, commercial conditions, defaults, disbursal of payments and indemnification.

3.0 POWER EXCHANGE IMPLEMENTATION IN INDIA:

3.1. Salient Features:

The salient features of the Power Exchange implementation in India are:

a) Voluntary participation
b) Day ahead
c) Energy only
d) Physical delivery only
e) Double sided bidding
f) Hourly bids
g) Uniform pricing
h) Multiple Exchanges envisaged
i) *Congestion Management* by Power Exchange using *Market Splitting*

3.2. Timeline and Available Margins for Collective Transactions vis-à-vis Bilateral Transactions:

The Open Access Regulations provide for a variety of products in the bilateral transactions category which have a pre-defined time line. These are advance, first-come-first-serve, day-ahead and contingency. Collective transactions discovered on a Power Exchange through anonymous bids on a neutral platform result in a transparent price discovery and present a balanced portfolio to the system operator. These transactions are processed before the processing of day-ahead and contingency category bilateral transactions. The total available margins for short term open access are assessed by the RLDCs in advance through simulation studies and made available transparently to the stakeholders through their respective websites. The balance margin after permitting advance and first-come-first-serve bilateral transactions is the margin available for scheduling of collective transactions. The day ahead and contingency transactions are processed after the collective transactions have been scheduled, using the balance available margins, if any.

3.3. Functional Power Exchanges:

Indian Energy Exchange (IEX), the country's first Power Exchange, made an application for grant of permission to setup a Power Exchange in March 2007 and an in-principle approval was accorded by the CERC on 31st August 2007. IEX commenced operations from the 27th June 2008 after the Rules and Bye Laws were approved by CERC and permission was granted to commence operations. The second Power Exchange, Power Exchange of India (PXIL), was granted in-principle approval on 27th May 2008. PXIL went through a process of Regulatory approval similar to that of it's predecessor and it commenced operations on 22nd October 2008.

3.4. Competition amongst Exchanges:

The Regulators have provided for multiple Power Exchanges to exist simultaneously in one physical market. Light handed regulation has been adopted and the Power Exchange(s) have been given full functional autonomy. This allows for competition amongst the existing Power Exchanges and an automatic system of checks and balances. The market participants stand to benefit from the Process of Exchanges vying with each other for providing superior quality of service. Moreover, the charges collected by the Power Exchanges for the services rendered are automatically regulated by the market forces.

3.5. Information Exchange between NLDC and Power Exchange(s):

The exchange of information is fully automated between NLDC and Power Exchanges, NLDC and the Regional Load Despatch Centres (RLDCs). The bidding window for submission of the bids in the Power Exchange(s) is from 1000 Hrs to 1200 Hrs. Information is exchanged between NLDC, Power Exchange(s) and the RLDCs as per a protocol defined in the Procedure for Scheduling of Collective Transactions. A provisional solution is given by the Power Exchanges to the NLDC at 1300 Hrs for checking for congestion if any. In case of congestion, NLDC advises the Power Exchanges about the limits of scheduling. The Power Exchange(s) submit the Application for Scheduling of Collective Transactions by 1500 Hrs and the approval for scheduling is communicated by NLDC by 1730 Hrs.

3.6. Volume of Collective Transactions:

The period considered in this paper is from 28th June 2008 to 31st December 2008. From a trickle in the beginning, the Market Clearing Volume (MCV) for the collective transactions is showing an increasing trend. The average energy traded through both the Exchanges is of the order of 0.5% of the All India energy consumption.

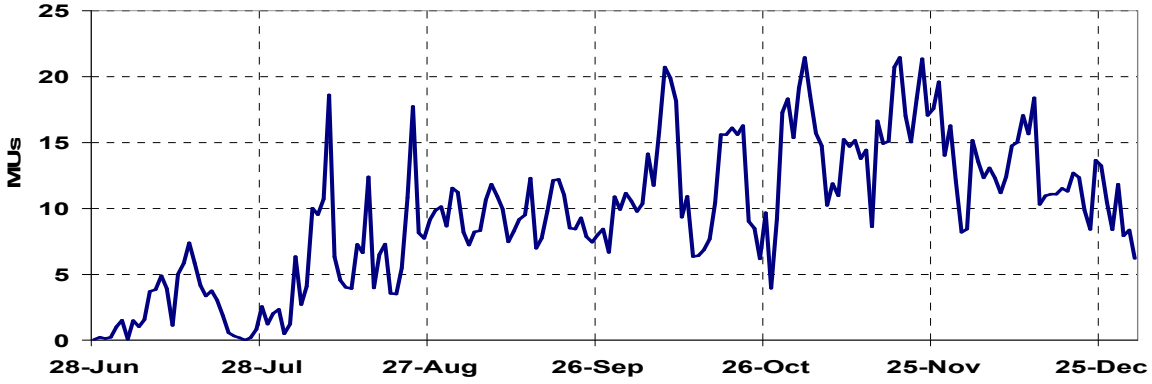

Figure – 1: Daily Energy Traded on the Power Exchange(s)

The maximum volume cleared was 21450 MWh on the 2nd November 2008. A minimum volume of zero (0) was registered for the first time on 25th July 2008 when the market did not clear. The trend of daily volume of collective transactions is shown in Figure – 1.

3.7. Prices discovered in the Power Exchange(s):

It is observed that the quantum of buy bids is much more than the quantum of sell bids [5, 6] reflecting clearly the shortage scenario prevailing most of the time. The maximum Market Clearing Price (MCP) is of the order of Rs. 11.00 per kWh and the average MCP is of the order of Rs. 7.50 per kWh with a standard deviation (daily average) of Rs. 1.17 per kWh[5]. The minimum MCP recorded is Rs. 0.92 per kWh. The bids placed in the Power Exchange(s) are reflective of the UI Price anticipated for the next day. Physically, there are two grids in the country i.e., North-East-West-North East (NEW) Grid and the South Grid. The two grids are interconnected asynchronously through HVDC links and operate at different frequencies, rated frequency being 50 Hz for both the systems. The two grids thus signify two electricity markets having different real time (UI) prices. There exists a possibility of arbitrage between these two markets.

3.8. Groups of Buyers and Sellers:

Some of the regional entities participating in trading through the Power Exchange(s) are (region wise):

a) North: Rajasthan, Delhi, Punjab, Haryana, HP
b) West: Maharashtra, MP, Jindal Power, Gujarat, Goa, Chattisgarh
c) South: AP, Karnataka, Kerela, Tamil Nadu
d) East: Orissa, West Bengal
e) North-East: Tripura, Mizoram, Assam

The first private sector generator to trade through Power Exchange is M/s Jindal Power in the Western Region. Since commencement of the operations, captive generation from the industry has also been able to trade through the Power Exchange. The trend showing the number of groups of buyers and sellers trading through the Power Exchange on a daily basis is shown in Figure – 2.

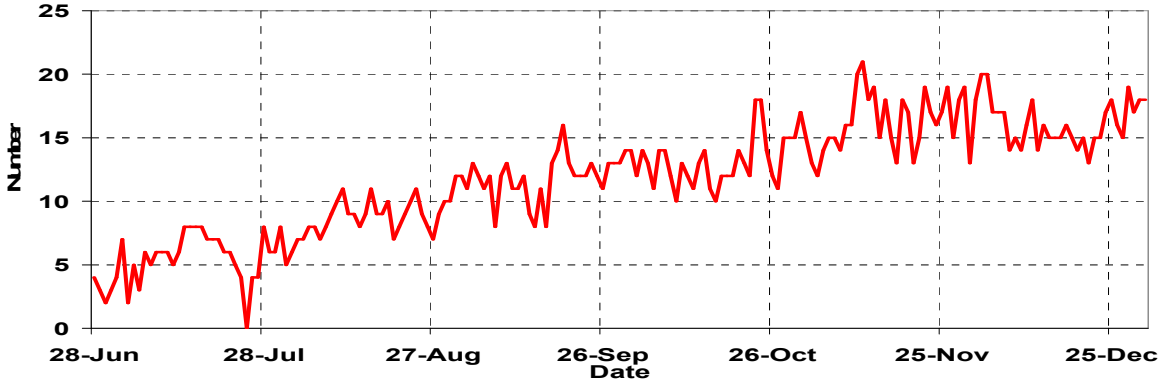

Figure – 2: Groups of Buyers and Sellers

4.0 PECULIARITIES OF THE INDIAN POWER SYSTEM:

The energy resources in the country are not evenly distributed with snow fed hydro resources concentrated in the north, monsoon dependant hydro in the south and coal reserves in central India. As a result, long transmission lines are constructed from the generating stations located close to the energy sources to the load centres and there is long haulage of power. The Indian power grids are also characterized by a well meshed network. Power flow between two areas may not only be direct but there may also be loop flows [7]. A number of flow-gates, which are corridors comprising of a group of trunk lines, have been identified by the system operators for monitoring the power flows (Figure – 3) in addition to the inter-regional links.

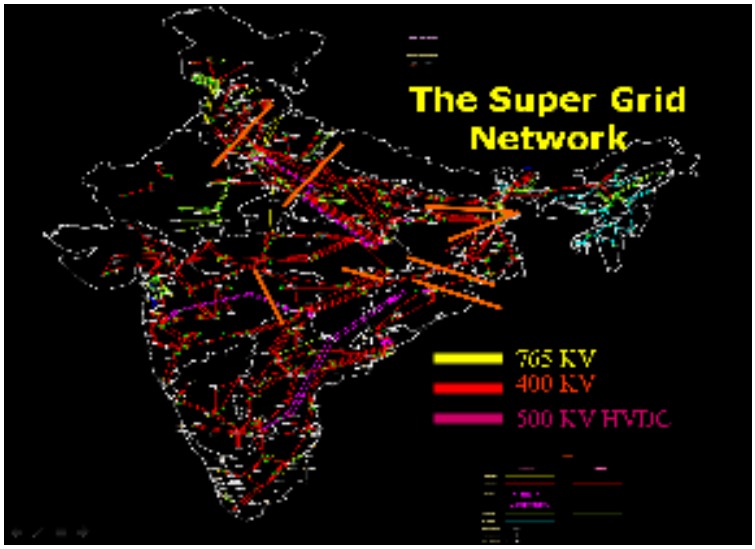

Figure – 3: The Super Grid Network & the Flow-gates

The hydro generation is varying because of seasonal effects. In the Northern Region, it is mostly snow fed run of the river type with a few plants having storage and high silt content sometimes forces outage of these generating stations. In the Southern Region, it is mostly monsoon dependant storage based hydro. The load pattern also varies because of hostile weather conditions, especially in the Northern Region.

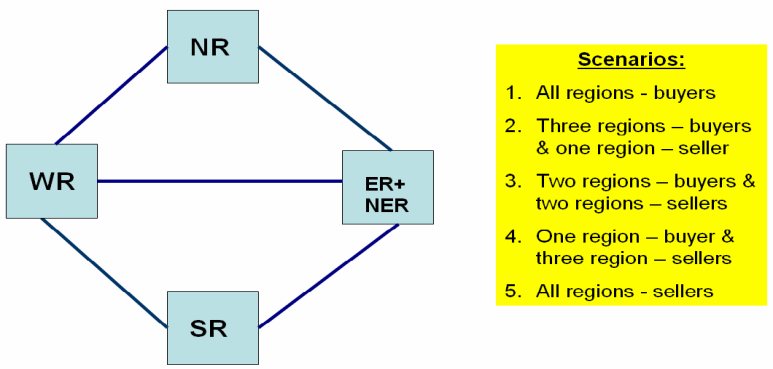

Figure – 4: Skewed Load Generation Scenarios

Congestion is observed sometimes in cases of skewed load generation balance. Figure – 4 shows some of the possible combinations of the location of the buyers and sellers that may lead to skewed load generation balance. CERC has recognized such congestion and issued orders for levy of a congestion charge of Rs. 3 per kWh.

5.0 DEFINITION OF BID AREAS IN THE INDIAN MARKET:

Due to high growth rate of the Indian power sector, high uncertainity, haulage of power over long distances, it is practically very difficult to identify areas where congestion may occur. To start with each region was divided into two bid areas. Ideally, each State may be defined as a Bid Area. Some of the large States like UP and Maharashtra, may have to be sub-divided into 2-3 sub-bid areas. Other criterion for creating/restructuring the bid areas may be based on the past experience of grid operation, pattern of drawal, seasonal variation and degree of participation of the State and intra-State utilities in the short term open access market. The Power Exchanges have also been advised of this possibility and the need for reconfiguration of bid-areas, if need arises. Figure – 5 below shows the list of ten bid areas presently being used.

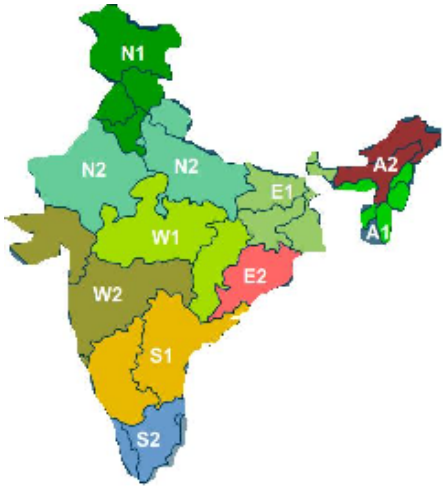

Figure – 5: Bid Areas

6.0 TRANSMISSION CONGESTION MANAGEMENT METHODS:

Some of the commonly used methods for congestion management are:

6.1. Explicit Auction:

An auction of the available inter-connector capacity is carried out and the capacity reservation is done on the basis of the highest bids received. Energy charges are decoupled from the capacity charges.

6.2. Implicit Auction:

This method does not separate energy charges and transmission capacity charges and the process is thus simpler for the market participants.

6.3. Market Splitting:

This is a more evolved form of implicit auction and is carried out in a Power Exchange. The market is split along the congested corridor in the Power Exchange. The prices upstream (surplus area) are reduced and the prices downstream (shortage area) are increased so that the flow on the inter-connector is restricted to the available capacity.

6.4. Counter Trade:

In some of the markets, the system operator invites bids for sale and purchase. In case of congestion, the system operator selects bids in merit order and enters into counter trade to relieve congestion. It is normally used as a last minute correction method.

6.5. Re-dispatching:

In this method, the market trades as if there are no barriers. The transmission system operator arranges for despatch of more generation downstream and less generation upstream of the congested corridor. The cost of congestion is borne by the system operator. This method places the onus for capacity expansion on the transmission system operator and does not provide any signal to the market participants.

The first three congestion management methods may be classified as congestion pricing based methods and the last two as remedial methods [7]. In the Indian scenario, both the Power Exchanges use market splitting for congestion management.

7.0 CONGESTION MANAGEMENT IN MULTI-EXCHANGE SCENARIO:

Multiple Exchanges are operating in the same physical delivery market in India. Different Power Exchanges arrive at solutions based on their own philosophy and algorithms. Scheduling of the trades is possible in case there is no congestion. In the event of congestion, allocation of available transfer margins between multiple Exchanges becomes an issue of prime importance. This would influence the overall economy in the grid and may also trigger realignment of the strategies adopted by the various stakeholders. Therefore, an objective method for allocation of

transfer margins between multiple Power Exchanges has to be adopted. Some of the possible criteria that may be considered for sharing of available margins are:

7.1. Priority based rules:

Pre-defined rules may be agreed upon based on lowest market clearing price (MCP), highest market clearing volume (MCV), highest MCP X MCV, maximisation of social welfare, consumer surplus, etc. Priority based rules may not lead to overall economy. For example, in a surplus scenario, lower MCP may be desirable and in a deficit scenario, higher MCV may be desirable.

7.2. Explicit auctioning amongst the Exchanges:

Considering the fact that inter-dependencies exist in the Indian scenario, implementation of explicit auctioning would be difficult. The ultimate objective of achieving economy may be defeated in circumstances where one of the Exchanges bids aggressively to reserve the capacity.

7.3. Merging the bids obtained by each Power Exchanges:

One of the Exchanges can be designated as a lead exchange and it may be asked to find the solution by merging bids received on all the Exchanges. Alternatively, all the Exchanges may be asked to work out a solution. The merging of bids can be carried out using suitable coding methodology, in order to take care of the confidentiality requirements. The solution which gives a higher MCV may be accepted for scheduling in case the solution worked out by the exchange(s) after merging the bids is different (either MCP or MCV or both). The criterion of higher MCV may be justified keeping in view the prevailing deficit scenario in India. This would effectively be as if the system operator has to deal with only one exchange in the case of congestion.

7.4. Pro-Rata rationing of the available margins:

Sharing of capacity on pro-rata basis is simple to implement. However, it is a sub-optimal method for congestion management. Pro-rata has many disadvantages [8]. This method provides neither the system users nor the system operator with any incentive for efficient use of the grid. It is likely to induce unwanted behaviour by market participants, such as gaming. With advance knowledge that congestion is likely to occur, the market players may overestimate their capacity needs and by doing so secure the quantity requested. Regulatory intervention and anti-gaming measures such as obligation to use the designated capacity would become necessary. In the case of Multiple Exchanges in the Indian Scenario, another factor which further complicates the issue is the inter-dependencies and the fact that alleviating congestion in one corridor may lead to congestion in another.

Worldwide, only one Power Exchange dealing with physical delivery operates in one market. This is a model where the system operator interfaces with only one exchange. Market design in India is a complex one which provides for multiple Power Exchanges handling physical trade. As per the Final Report on Co-ordinated Use of Power Exchanges for Congestion Management by the European Transmission System Operators (ETSO), April 2001 [9], in such a design, there must be a strong co-ordination between Power Exchanges. Other methods such as flow based market coupling, open market coupling, and similar price differential between Exchanges are also being explored.

Extensive debate is being carried out for arriving at an optimal solution for sharing of available margins between Power Exchanges. As an interim arrangement, pro-rata based on respective requisitions has been adopted for sharing of available margins between the Power Exchanges. Pro-rata is applied on cleared trade volumes on each Area and each corridor based on the requisitions by each Exchange. Since commencement of operation of both the Power Exchanges, no congestion was experience till the onset of severe winter in December, 2008. Occasional congestion was experienced after 12th December 2008 in the total import to the Southern Grid. This was because of unprecedented foggy conditions in the Talcher area in Orissa during early morning hours leading to reduced voltage operation of the HVDC Talcher-Kolar inter-connector between the NEW Grid and the South Grid.

8.0 CASE STUDY OF CONGESTION EXPERIENCED ON 12TH DECEMBER 2008:

Due to early morning fog, Talcher-Kolar HVDC had to be operated in reduced voltage mode resulting in a reduction of the total transfer capability to 3600 MW from 4000 MW between 0400 Hrs to 0900 Hrs of 12-Dec-2008. After accounting for reliability margin, long term transactions and already approved bilateral transactions, available margin on ER-SR path was 617 MW and on WR-SR path, available margin was about 490 MW during this period.

Based on the provisional solution received from the Power Exchanges for the period 0500 Hrs to 0600 Hrs, it was observed that the total requirement of both Exchanges was more than total import margin of Southern Grid. Accordingly available margin for each Exchange was calculated on pro-rata basis. The market was split in both the Power Exchanges and the flow was restricted to the available capacity in the final solution. As against a total provisional requisition of 1430 MW for import to Southern Grid, 1091 MW was cleared in the final solution.

9.0 DEVELOPMENT OF DERIVATIVE MARKETS IN ELECTRICITY:

A Power Exchange for physical delivery provides a basis for the development of derivative markets and Futures in Electricity (weekly & monthly contracts) have been introduced by the Multi Commodity Exchange (MCX) from 9th January 2009.

10.0CONCLUSION

Development of the Indian Electricity Grid Code, scheduling procedures, settlement system (ABT) provided a sound basis for the introduction and implementation of Power Exchange in India. A unique and distinguishing feature of this implementation is the existence of multiple Exchanges in a single physical delivery market. Light handed regulation has allowed functional autonomy to the Power Exchanges and at the same time, competition amongst the Exchanges has ensured a system of automatic checks and balances and maximum benefit to the market participants.

Price discovery algorithm of the Power Exchanges aim at social welfare maximization. The prices discovered on the Power Exchanges, which are transparent and neutral platform, through an anonymous competitive bidding, provides a price signal for investment. The Power Exchanges provide an alternate for sale and purchase of power. Implementation of Power Exchange(s) in India has provided comfort to the investors, financial institutions and has facilitated captive and merchant power plants.

The subject of congestion management is still in its infancy. Individual Power Exchanges in India use market splitting for congestion management and this provides a price discovery for transmission congestion. Sharing of available margins between Exchanges is being done on a pro-rata basis as an interim measure and debate is on for a more optimal solution.

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