Development of Power Market in India

Subrata Mukhopadhyay, Senior Member, IEEE, Sudhindra K. Dube, and Sushil K. Soonee, Senior Member, IEEE

Abstract—This paper presents the status of development of power market in India with the creation of opportunities consequent to restructuring of the sector through unbundling, opening up for private sector participation, positioning of regulatory mechanism through commissions at state and central level and appellate tribunal, allowing open access, etc. Starting with the background, it aims at giving a clear picture of achievement till to date and issues to be resolved to reach the goal. In this context opportunities that exist for power and energy trading with neighboring countries too are highlighted.

Index Terms — open access, power market, power exchange, inter-state generating station, free governing mode operation, unscheduled interchange, regional energy accounting, environment impact assessment.

I. INTRODUCTION

At the time of independence in 1947, Indian power sector was merely concentrated in and around few towns and urban areas to meet the need. In the following decade it saw development of massive river-valley projects that lead to some form of limited interconnected system to provide power to population along particular belts as side by side benefit to the effort made for irrigation for the agricultural need and flood control. However, sixties gave proper status to the development of power sector both in terms of generating unit sizes, transmission voltage due to the requirement of rapid industrial development, calling for integration and evolution of state grids. Attempt to join these grids to form the five regional grids, however, became successful by seventies and eighties with unit sizes going from 210 to 500 MW and transmission voltage from 220 to 400 kV as a consequence of haulage of large amount of power from coal pit-head (mine-mouth) thermal power stations to urban conglomeration. Subsequent scenario of power sector in nineties and beyond of course has been quite bright from the point of view of development of HVDC systems, incorporated both for bulk power supply over a large distance as high as about 1370 km, be it within a large state or region or for inter-regional transfer of power, and also for inter-regional back-to-back connection for limited transfer of power. Side by side to this, sector was unbundled with the recognition of generation, transmission and distribution as separate and distinct activities so far as power supply system is concerned. Both at state level and central level regulatory commissions were gradually formed to decide tariff, grid code, etc. With the opening up, sector experienced participation of private sector entities, mainly in generation and then in distribution to some extent. Transmission still remains monopoly with public holding terming it as State Transmission Utility (STU) or Central Transmission Utility (CTU) depending upon whether it belongs to any state or center. With Central Electricity Regulation Commission (CERC) permitting open access to inter-state transmission facility from November 2003 [1], opened vistas of power trading by state-owned Companies or private traders or joint sector venture. It was an important step after the promulgation of Electricity Act 2003 [2]. Activities that followed and aimed at, influencing scheduling and real time grid operation with pseudo Power Exchange [3] in place definitely gave the way for healthy trading in power that unlike other commodities in market cannot be stored in its form and hence calling for supply-demand matching at every instant of time. As it proceeds paper gives the status of such trading prevalent in India considering the market related to energy, generation capacity, transmission capacity and ancillary services one by one. Also, with the development in neighboring countries, possibility of power and energy trading is explored.

II. ENERGY MARKET

For the Indian power sector bilateral energy market may be on the basis of long term, short-term, day-ahead or intra-day commitments. With measurements logged at 15-minute intervals weekly cycle of settlement of energy is carried out. This is based on before the fact commitments at mutually agreed terms, but taking into care deviations settled at frequency actuated dynamic rate known as Unscheduled Interchange (UI) rate [3]. However, the process has excessive reliance on UI mechanism, though the rate is restricted by regulatory caps. The trend of course is encouraging with consensus being built for an organized market in this respect in the form of Power Exchange (PEX).

III. GENERATION CAPACITY MARKET

As one goes back to history, typically under Central Government regional power stations, may be termed as

---

Subrata Mukhopadhyay is with Central Electricity, Sewa Bhavan, R. K. Puram, New Delhi – 110060, India (e-mail: subratasoe@go.org).
Sudhindra K. Dube is with the Power Trading Corporation Ltd., NHC, Tower, Bhikaji Cama Place, New Delhi, India (email: dube@ptcindia.com).
Sushil K. Soonee is with the Northern Regional Load Dispatch Center, Power Grid Corporation of India Ltd., SJSS Marg, Katwaria Sarai, New Delhi – 110016, India (e-mail: ssksoonee@gmail.com).
Inter-State Generating Stations (ISGS) (be it thermal – fossil fired or gas-based, hydro or nuclear) established at different times have a common basis of sharing of power amongst the beneficiary states of the concerned region. Totally an allocation of 85% is made of the installed capacity of the state by that procedure. Hence the capacity may be thought of as locked up in long-term bilateral contract between the producer and consuming states. Remaining 15% floating capacity is highly sought after during peak demand season and it keeps changing hands subject to negotiating skill and political networking of the beneficiary causing considerable amount of heartburning for the losers. What started as a flexibility margin to accommodate seasonal demand pattern has degenerated into a discretionary instrument.

On the other hand, lackluster participation of private players in capacity addition (generation & transmission) could be attributed to lack of an organized capacity market. However, rays of hope exist due to stray examples of capacity trade. One such case is with Power Trading Corporation (PTC) brokering the sale of royalty share of Himachal Pradesh State Electricity Board (HPSEB) in Nathpa-Jhakri Hydro-Electric Project to Punjab State Electricity Board (PSEB) for the summer months.

IV. TRANSMISSION CAPACITY MARKET

Perspective planning as a whole is carried out by the Central Electricity Authority, an apex technical body of Government of India in power sector. With the data collected through load survey by its regional units in collaboration with the state electric utilities, long term load forecasting is done. Based on the same matching generation is formulated through integrated resource planning approach identifying generation location and possible corridor for transmission of power from source to load. Thereafter studies are carried out to configure in details the network for evacuation of power from generating stations and consequent strengthening of existing network, if required, with level of voltage chosen with a view to have adequate margin for future expansion. Transmission capacity expansion so planned is then deliberated in the Standing Committees region-wise through a consultative procedure to identify utilities to build, own and operate the relevant expansions.

Accordingly with transmission system still being totally need-based and enjoying natural monopoly, has the pricing tightly aligned to long-term capacity allocations. Though open access is in vogue, in reality it has not been segregated yet as an independent facility under the fear of jeopardizing the existing setup. On the other hand lack of addition may result in congestion sometime at some pockets during grid operation. Consequently its management is totally based on discretion of concerned Regional Load Dispatching Center (RLDC).

The long-term transactions have a priority over short-term transactions. The RLDCs have discretionary powers over interstate dispatch and load regulation. Inter-regional (Pool to Pool) unscheduled interchange transactions are then used for easing congestion.

V. ANCILLARY SERVICES MARKET

Ancillary Services are defined as those services that are necessary to maintain reliable operation of the interconnected / integrated transmission system. These services are required to effect a transaction. It includes reactive power and voltage control, loss compensation, scheduling, dispatch and settlement, load following, system protection, energy imbalance and black start facilities. In India a lot of work needs to be done in this area till now as described below.

A. Load Following-Primary Response
- Free Governing Mode Operation (FGMO) is mandatory as per grid code.
- Issue is diluted / scuttled under the garb of technical jargon / issues put forth by generators.
- Services are basically not priced and implicitly paid through capacity charges. Therefore, there is no incentive for Independent Power Producers (IPP).
- Frequency linked dispatch guidelines are for secondary response.

B. Voltage Control
- Reactive drawl and injection at interstate exchange points are priced.
- It is a simple mechanism. Issues in treatment are virtually of residual amount.
- Generators are not paid and very often they take refuge under a conservative machine capability curve.

C. Loss Apportionment
- Losses are shared by long-term customers in ratio of their subscriptions in ISGS.
- All energy transactions are discounted by estimated losses during scheduling.
- There is regulatory intent of moving towards the concept of incremental losses.

D. Scheduling and Dispatch
- RLDC coordinates as well as implements inter-utility contracts.
- Decentralized resource scheduling is in vogue with state load serving utilities having full operation autonomy of dispatching their generation resources.
- Though as per grid code there is a provision for 5% spinning reserve, due to perpetual shortage in reality this has not been possible yet.
• Well-defined timeline exists for declaration of availability and requisitioning of energy up to capacity subscriptions of the shareholders.
• Expenses clubbed under RLDC Operation and Maintenance (O&M) head are paid by long term constituents only.
• At present a sum of Indian Rupees (INR) 3,000 / day/ transaction is charged for scheduling open access transactions.
• Inter utility settlement statement (Regional Energy Accounting taking care of U1 and Reactive Accounting) is issued by Central Pool Administrator. Capacity and energy charges are settled mutually while the unscheduled and reactive energy settlement is routed through a pool.

E. System Protection
• Equipment protection coordination is decided at the regional level by Protection Coordination Committee (PCC).
• System monitoring and supervision is carried out by RLDC.

F. Energy Imbalance
• It is addressed through unscheduled interchange mechanism.
• Weekly settlement cycle based on above is in vogue.
• It is the discretion of concerned RLDCs for arbitrage across asynchronous (HVDC) links.

G. Black Start
• It is purely voluntary.
• It is well-documented under Regional Black Start Procedures.
• UI mechanism is suspended during period of disturbance and actual transaction is treated as schedule.

VI. POSSIBLE POWER AND ENERGY TRADING WITH NEIGHBORING COUNTRIES

India surrounded by countries of Nepal, Bhutan, Bangladesh, Sri Lanka, Pakistan creates major prospect in South Asia for trading in power and energy due to disposition of natural resources of different kinds for mutual benefits of all. Nepal and Bhutan are rich in Hydro resources, Bangladesh is rich in gas reserves and India is rich in coal resources, thus providing promising option for cooperation among countries. India can emerge as the main potential power / gas export market for the neighboring countries. Generation can be at source and trading through electrical interconnection. India can supply coal to the neighboring countries and can import gas from Bangladesh.

Issues to be addressed in the process of development are investment capabilities, lack of market information, viability of buyers, inadequacies in institutional mechanism, environment and social concerns. Cross border trading in electricity has technical considerations as well as political and economic ones. Pricing should be such that both sides benefit. For example, if one party has a lot of inexpensive hydro power, during monsoon seasons then it may benefit from selling it at lower price to a neighbor rather than having the water spill. There is necessity of larger perspective while planning, obviously through integrated approach for the entire SAARC (South Asian Association for Regional Cooperation) region. Both Generation capacity and Transmission interconnection capacity are to be enhanced. To be adopted is common principle / methodology for tariff determination, operational protocol, security / reliability and regulation. To be evolved also is the Contractual Agreement that addresses principal obligations that are equitable, risk sharing, issues related to financial and payment, commercial and legal, dispute resolution and arbitration.

Therefore, prerequisites for Regional Power Pool (RPP) may be summarized as

• Technical solutions not difficult but Political will of the member countries important
• A cooperative mindset
  - Willingness to reconnect the subcontinent
  - Efforts to build trust / sensitize
  - Greater sensitivities to issues
• A commitment from the member countries for
  - Resources / manpower
  - Reciprocal measures
• Success of Bilateral exchange will create the ground for multi-lateral exchange
• Regional economic prosperity should take precedence over political compulsion

VII. CONCLUSIONS

Though it is in the nascent stage, there are lot of promises in power trading in India with the participation of a number of players from public or private or joint holding companies. Permission for open access really has created opportunities for improving supply system through competition in terms of overall economy as well as ultimate efficiency. With the typical characteristic of the commodity (power) in the market that in its normal form cannot be stored and at every instant supply-demand matching is called for, inherent risk dictates necessity of well-laid principles of practices to be followed for short-term, mid-term and long-term contracts.

So far as power and energy trading with neighboring countries is concerned presently power trading is based on bilateral agreements and although Energy Ring is high in SAARC agenda, the progress has remained slow. The
strategies for promotion of trading can be through carrying out sector reforms, setting up suitable institutional arrangements, joint investment in project including Environment Impact Assessment (EIA), private sector participation, long term transmission planning and free exchange of information.

VIII. ACKNOWLEDGEMENT

The authors are indebted to their respective organizations, Central Electricity Authority, Power Trading Corporation of India and Power Grid Corporation of India of Ministry of Power, Government of India for making valuable inputs in the form of published documents. However, the opinions expressed in the text of paper are no way concerned with the views of the concerned organizations or the Government. The authors gratefully acknowledge also contribution of their co-professionals in these organizations during the preparation of this presentation.

IX. REFERENCES


X. BIOGRAPHIES

Subrata Mukhopadhyay (S'70, M'70, SM'80) was born in Assam, India in 1947. He graduated in Electrical Engineering from Jadavpur University, Calcutta in 1968 and had his Master's and Doctorate Degrees from Indian Institute of Technology, Kharagpur and Roorkee in 1970 and 1979 respectively. His employment experience of 35 years includes teaching and research in Roorkee and power system planning, design and operation with the Central Electricity Authority of Government of India. He has authored two books and twenty-eight papers, won IEEE Third Millennium Medal in 2000, PES Delhi Chapter Outstanding Engineer Award & PES Asia-Pacific Regional Outstanding Engineer Award for 2001, RAB Leadership & Achievement Awards in 2002 and 2004 respectively. He is also a Fellow of the Institution of Engineers (India) and the Institution of Electronics and Telecommunication Engineers, India.

Sudhindra K. Dube is presently working for PTC India Ltd. (PTC) as Director (Operations) since December, 2002. Prior to joining PTC he was working as Executive Director (Northern Region) in POWERGRID. He is a Graduate in Electrical Engineering (1969) from Jadavpur University, Calcutta. Before joining PTC he served SAIL, MECON, NTPC and POWERGRID in various capacities. He served also Private Sector for over six years out of his total about 36 years of experience in industry covering the area of Design, Project Management, O&M, Commercial, Power Trading and Regulatory Issues. During his tenure in NTPC he made significant contribution in the commissioning of 200 MW and 500 MW units of Farakka Super Thermal Power Project. In POWERGRID he handled very crucial assignments like Erection and Commissioning of 400 KV URI- Transmission system in Kashmir Valley, the first 300 KV Kishenpore-Moga Transmission System in India and development of O&M manuals of Transmission equipment. In his current assignment in PTC he is responsible for Marketing, Operation and Commercial activities, formulation of Power Purchase Agreements with domestic / foreign Developers of Power Projects and Cross-Border transactions with Bhutan and Nepal. He has also extensive experience in Tariff mechanism and Regulatory issues. Dube has presented number of papers in the International conferences, particularly in the areas of Condition Monitoring of EHV equipment and trading mechanisms. He has also travelled widely abroad as part of his assignment. He visited Pakistan as a member in the Indian delegation for Power purchase negotiations. He is a Fellow of the Institution of Engineers (India) and Member, CIGRE.

Sushil K. Soome (M'99, SM'01) born in 1946 and currently heading Northern Regional Load Dispatching Center of Power Grid Corporation of India Ltd. as Executive Director, had his graduation in Electrical Engineering from the Indian Institute of Technology (IIT), Kharagpur, India in 1977. After a brief stint in private sector joined Central Electricity Authority and worked extensively in integration of State Grid to form a Regional Grid in Eastern and North-Eastern Region, carried out Research and Literature Survey in Power System Operation and Control at IIT Kharagpur in 1981, traveled extensively Europe, USA and SAARC countries. He had first hand experience of Power System Operation of Eastern, Southern and Northern Grids, and also Commercial, Settlement, Restoration and entire gamut of Power Pooling and System. Frequency maintenance within permissible limits, voltage control etc. achieved to a great extent during his tenure in Southern Region. Persuaded constituents to rejuvenate Inter-State Transmission lines, hitherto dormant. Worked for implementation of Availability Based Tariff (ABT) and on implementation, the scheme is recognized not only in India but worldwide. At present implementing the Intra-State ABT scheme also, and Free Governor Mode of Operation. Streamlined Open Access in Inter-State Transmission System. Authored 24 technical articles and presented in various forums, chaired many technical sessions in seminars / workshops, acted as Member of various committees for Regional Power System on disturbance and restoration. He is a Fellow of the Institution of Engineers (India) also.