Challenges Faced and Lessons Learnt in Development of Indian Electricity Markets and Regulations

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SUMMARY

Indian power sector has come a long way starting from a state sponsored monopoly to a vibrant and evolving market. During this journey Electricity Markets in India, faced many challenges, overcame many hurdles finally moving towards an open and matured environment. *National Electricity Policy & Act, Tariff design, CERC regulations and operational feedback from System operator are the four pillars that have contributed in designing of electricity markets in India.* India being geographically and culturally diverse have it's own socio- political challenges and due to this, the journey of per capita electricity consumption i.e. from 16 Kwh (1947) to 1149 (2018) took more than 70 years. In spite of having sufficient installed capacity of approx. 356 GW, target of "Power for all 24x7" has not been achieved due to insufficient evacuation infrastructure. To ascertain the optimum infrastructure for connecting generation to end consumers, an electricity market is necessary. Electricity market in India has followed a natural evolution cycle rather than a simulated or influenced evolution. Similar to global trends, energy sector in India has also traversed through all stages i.e. Govt. Ownership, CPSE model (Cost plus profit), PPPs (Public Private Partnership), ABT (Availability Based Tariff), TBCB (Tariff based Competitive bidding), Open access, Power exchange, etc. and now in process of converging to full-fledged electricity markets.

KEYWORDS

Availability Based Tariff, Electricity Markets, Tariff Based Competitive Bidding

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GENESIS OF ACT AND SEPARATION OF SECTORS

Any act or regulations when introduced seems like the best has been envisaged, but with passage of time, discrepancies starts surfacing, thus forming the basis of upcoming amendment or new act or regulation. Integration of functions at one stage to create a robust infrastructure with government support and disintegration of same at later stage with involvement of private participation to infuse competition has been the idiosyncratic feature of power sector development in India.

During pre-independence era, Indian electricity act 1910 has been the base for development of framework for electric supply industry wherein responsibility was on private parties who got license from state government to carry electricity business. In this era, there was absence of coordinated system, generation was concentrated on most efficient units & bulk supply of energy was centralised under the direction and control of one single authority which impeded the healthy & economical growth of electricity sector in the country. The coordinated development of electricity in India on regional basis was becoming important for post war re-construction and development.

These issues were taken care of by Electricity Supply Act 1948 {E(S) Act'48} that mandated formation of state electricity boards (SEBs) with a vision of extending supply from cities to remote villages. However, desired efficiency & overall development of generation could not be achieved by SEBs as they were being controlled by state governments with region specific socio-political issues.

To overcome these issues, Electricity Act '48 was amended in 1975 which paved the way for Central Generating station(CGS) under the umbrella of Public Sector Units (PSU) like National Thermal Power Corporation (NTPC), National Hydro Power Corporation (NHPC) {in1975}& later Nuclear Power Corporation (NPC){in 1987}. As a result of this, the installed capacity increased from 16.6 GW (1975) to 64 GW (1990), i.e., fivefold increase within a span of 15 years.

Transmission of electricity was owned and operated by Generators and generation being larger part of their revenue, transmission lines planning got neglected. Generators built the evacuating lines just to facilitate their own generation and in this process, development of inter-regional & national corridor took a hit. In-order to build a robust evacuation corridor with broader vision, transmission sector was separated from generation in 1991 and POWERGRID/TSO was formed which revolutionised the transmission sector and line length increased from 44 lac ckt. Kms to 87 lac ckt. kms (almost doubled) within a span of approx. 10 years. Several HVDC & inter regional corridors were built at a very fast pace during this period. POWERGRID thus with dedicated efforts transformed asynchronous Grid (operating at different frequency separated in five different regions) into one synchronous grid operating on single frequency in 2013.

With amendment of 1991 to E(S) Act'48, Government opened generation to private sector to instil competition in the sector and also mandated for formation of Regional Load Despatch Centres (RLDCs) & NLDC (National Load Despatch Centre) to have better control on Grid parameters.

Electricity Regulatory Commission Act 1998 (ERC'98) issued guidelines for setting up of CERC (Central Electricity Regulatory Commission) & SERCs (State Electricity Regulatory Commissions) with powers to determine tariffs and introduce private participation in transmission sector. By this act, Government distanced itself from tariff determination and also ensured competition in transmission sector.

Electricity Act 2003 was real game changer for electricity markets in Indian power sector as it introduced many features, viz., Power trading, Open Access (OA), Appellate tribunal (For dispute resolution), restructuring of SEBs, distancing commissions from determining tariff for TBCBs (Tariff based competitive bidding), etc. to create competition for enhancing quality and reliability of service to consumer.

CHALLENGES AND LEARNING IN TARIFF DESIGN

Balancing of consumer's interests and Investor's confidence in the regulated environment is key to development of any sector. Electricity sector being capital intensive and requiring longer horizons for ROI (Return on Investment) have to be supported by government initially by way of tax holiday, subsidies, guarantee of returns, etc. Generally investors and bankers put their money in safe haven or the sector having government support, but flip side is that if they sense huge returns, large chunk of money is flooded in that sector resulting in over building of the infrastructure. Hence a balanced approach is required in tariff design.

Tariff design in India has been mainly divided into two parts pre-ABT and post ABT regime.

(i) **Pre-ABT regime**: Prior to 1992, single part tariff was in vogue in India for pricing of power. The single part tariff for a station comprised of both the fixed cost and variable (energy) cost at a certain (normative) generation level. Energy production above normative generation level yielded additional revenue and vice versa. To gain higher incentives, generators maximised generation in peak as well as off-peak conditions this was perhaps reasonable in the days of severe power shortage. As the grid became larger, this scheme ceased to be viable as it was neither conducive to economic generation of power as per merit order, nor to smooth operation of the regional grids. Single part tariff is diagrammatically shown in Fig. 1.

In the year 1992, based on the recommendations of K.P. Rao committee "Two part tariff" model along with scheme of incentive/disincentive for better generation/ plant availability came in force. This was adjudged shift from undue emphasis on PLF as measure of performance. As per this model, generators were entitled for full fixed cost as per plant's target availability and variable cost only for the quantum of electricity actually generated. Generators were also imparted incentives for maintaining PLF above normative PLF and dis-incentivise, if unable to maintain normative PLF. Fig. 2 depicts KP Rao Committee recommendations in graphical form.

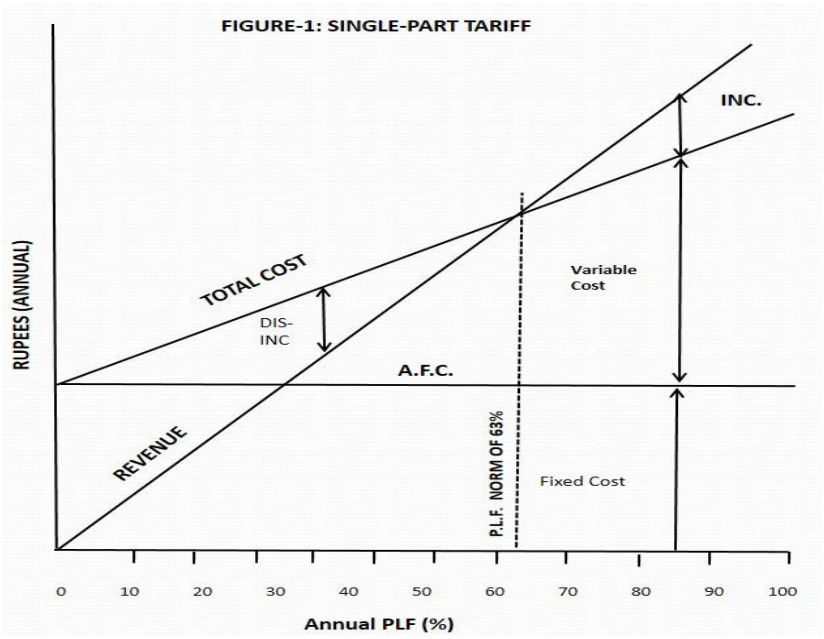
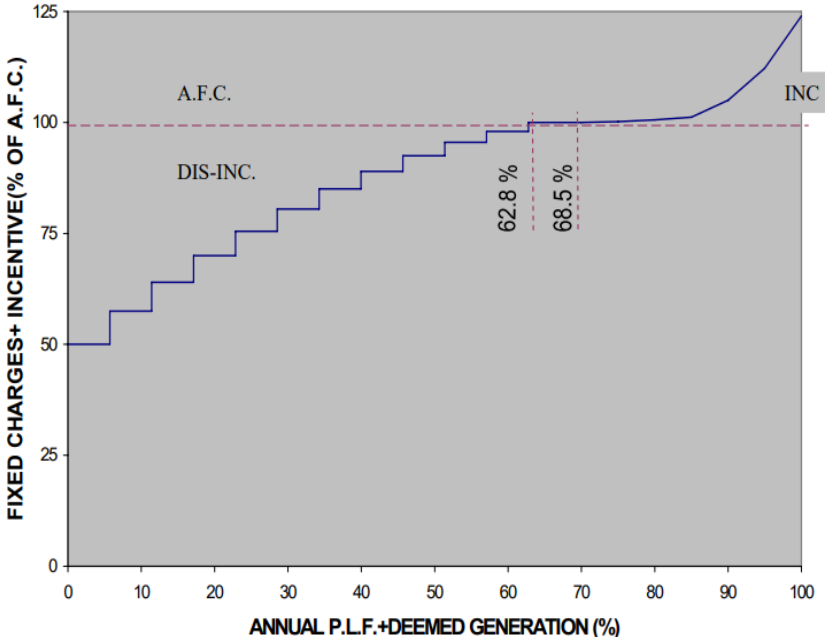


FIGURE- 2: K.P.RAO COMMITTEE



(ii) **Post ABT regime:** Even after implementation of two part tariff scheme, serious problems of regional grid operation continued as some SEBs were overdrawing during peak load hours and under drawing during off peak hours causing serious frequency excursions and perpetual operational/commercial disputes. To overcome these issues, a unique tariff scheme ABT (Availability based Tariff) was implemented in July, 1999 which proved to be the first big ticket reform of Indian electricity sector. Deviation charges were introduced to the existing two part tariff in ABT mechanism.

ABT mechanism comprises of three parts- Capacity, energy and deviation charges. Capacity and Energy charges are meant to cover total fixed (ROE, Interest on loan, depreciation, O&M, etc.) cost for generating station and variable (fuel) cost respectively. Deviation charges are the charges for deviating from scheduled interchange. These charges are linked with frequency i.e. higher in low frequency regime and lower if the interchange is carried out at or near normal frequency (50 Hz). Availability based Tariff (ABT) mechanism is thus a tariff mechanism which ensures reliable and quality supply by sending commercial signals to both the generators and beneficiaries thus ensuring Grid discipline. Graph of frequency variation and UI rate applicable during 2004 is as shown in Fig. 2a.

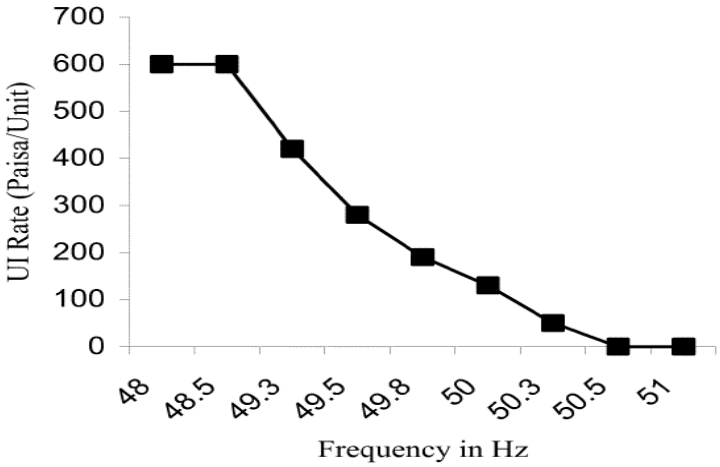


Fig. 2a UI Charges w.r.t. frequency

Over drawal (excess over allocated schedule) by beneficiaries and under generation by generators against their approved schedule in low frequency conditions and under drawal (less than allocated schedule) by beneficiaries & over generation by generators in high frequency were penalised commercially and vice versa under ABT. This improved the frequency and introduced self-discipline wherein utilities were able to take drawl decision based on the grid frequency. Besides this, ABT also helped in voltage improvement, increase in transmission capacity, improved grid security, resolution of commercial and operational disputes, tapping of maximum price for hydro potential, etc. ABT mechanism ensured that grid discipline is responsibility of both the generators and beneficiaries. Fig. 3 and Fig. 4 represent Grid Average Frequency and maximum & minimum frequency from Jan'98 to Mar'18. These figures clearly indicate the improvement in frequency achieved due to regulatory and operational efforts.

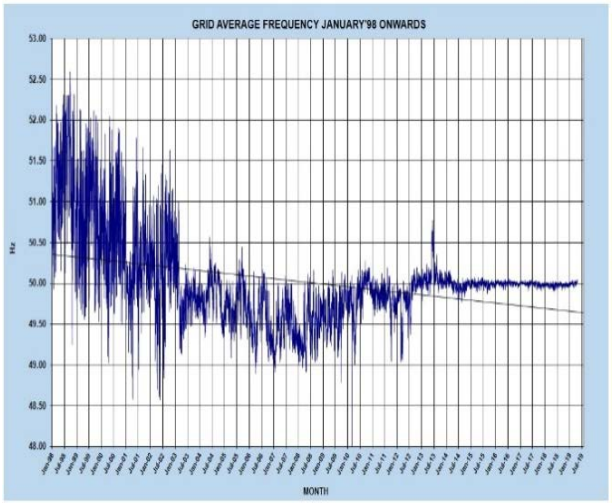


Figure 3 Grid Average Frequency

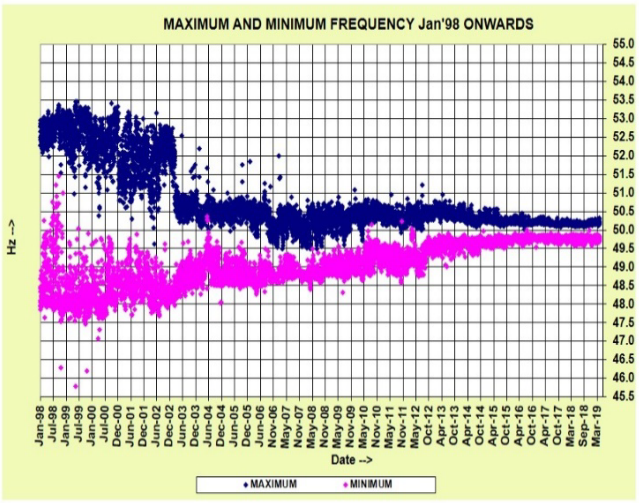


Figure 4 Maximum and Minimum Frequency
Source: POSOCO NLDC report on frequency

REGULATORY STEPS IN DEVELOPMENT OF ELECTRICITY MARKETS

CERC has played a very crucial role in establishing and developing electricity markets in India through it's regulations based on the feedback from all it's stakeholders after long deliberations. Open access in ISTS regulation, 2008 & Power market regulations, 2010 issued by CERC have primarily contributed to the development of electricity markets in India. With the enactments of Indian Electricity Act in 2003, Open Access in transmission was introduced opening the sale and purchase of electricity as commodity. National Electricity Policy 2005 envisioned that 85% power of new capacities will be tied up in long term PPAs to take care of financial obligations and debt coverage and balance 15% will be transacted through Electricity markets. Also, the URS (Un-requisitioned Surplus) power will be traded in markets thus optimum utilisation of installed capacity. The quantum of URS power remained un-dispatched during 14-16 is depicted in Fig. 5 Also, the power sector participants especially private players which do not have PPAs could transact through market mechanism.

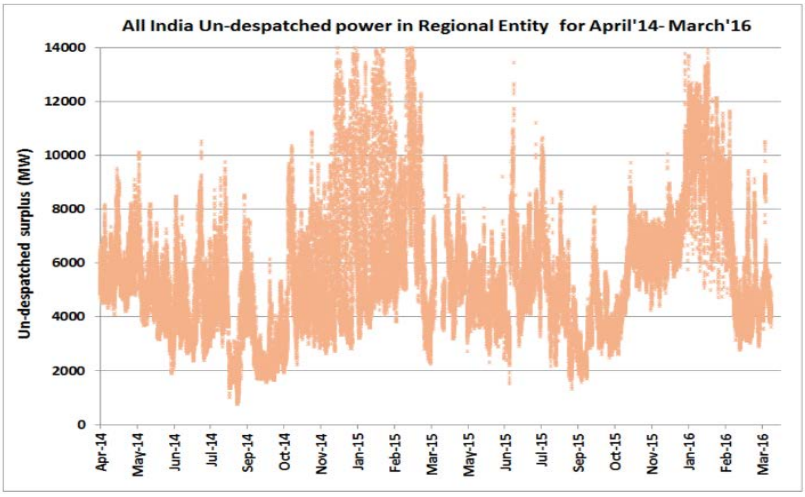


Fig. 5– Un-despatched surplus power during Apr-14 to Mar'16
Source: POSOCO report on RRAS implementation

Vide CERC's regulation "Sharing of ISTS Charges & losses, 2010 Point of Connection (POC) mechanism was introduced that contributed immensely for development of electricity markets as it enabled the transmission pricing to be distance and direction sensitive and based on the usage of network. POC mechanism helped to strengthen the inter region transmission corridor and recovery of its charges from the entities which utilized the corridor for transfer of power.

Power market regulations 2010 mandated for development of a platform where automatic price discovery could happen to promote competition, economy, and efficiency in electricity markets. To facilitate market mechanism, consumers (1 MW and above) were empowered to choose their source of supply from a trader and/or Power exchange. This started the era of power market in India. Main hurdle in development of power markets is that most of the generators in India are having long term PPAs which is the first and foremost condition of financing by the investors. Due to this, most of the power is still stuck up in these PPAs and hence only 10 % (approx. 5-6% in bilateral & 4 - 5% in exchange) of total installed capacity is available in open electricity markets even after 10 years of establishment of Power exchange. Presently CERC is in process of introducing new bid (order) types so as to expand the ambit of electricity markets.

CONTRIBUTION OF GRID OPERATIONAL STEPS IN DEVELOPMENT OF ELECTRICITY MARKETS

Robustness of grid and it's operation in real time maintaining load and generation balance is the foremost requirement for electricity markets. Based on the studies carried out by POSOCO, the Grid operator of India, CERC has introduced various regulations viz., Measures to relieve congestion in real time operation, 2009, Deviation settlement mechanism & related matter regulations, 2014 and Ancillary services operations (AS) regulations, 2015, etc. These measures have been phenomenal in developing backbone of electricity markets in India.

Power procurement planning through term contracts (long, medium & short), dispatch of energy in day ahead, term ahead and real time horizons and handling of last mile system imbalances has been integral part of system and market operation in India. 90% of power is being covered by long term contracts and balance 10% is available for medium & short term contracts. Discoms self-schedule based on their long term contracts and has right to recall this contracted power till four time blocks before actual despatch. Generators can also revise their schedules without any financial liability similar to discoms. Due to this system operator has to toil hard to manage real time imbalances and lot of URS (Unrequisitioned surplus) power remains un-dispatched due to poor demand forecasting and scheduling. Presently, the real time energy balance in India is being handled through DSM and ASM (Ancillary services mechanism). Due to lower rate of DSM price as compared to MCP (market clearing price) discovered in power exchange, beneficiaries were

resorting to DSM to handle their imbalances which was disturbing the grid discipline and that too in peak demand periods. CERC has recently amended the DSM regulations by linking DSM price with MCP and mandatory zero crossing in six time blocks and penalty in case of non-compliance thus preventing beneficiaries to use DSM as a tool for their improper planning. DSM price vector and proposed DSM rate comparison is shown in Fig. 6.

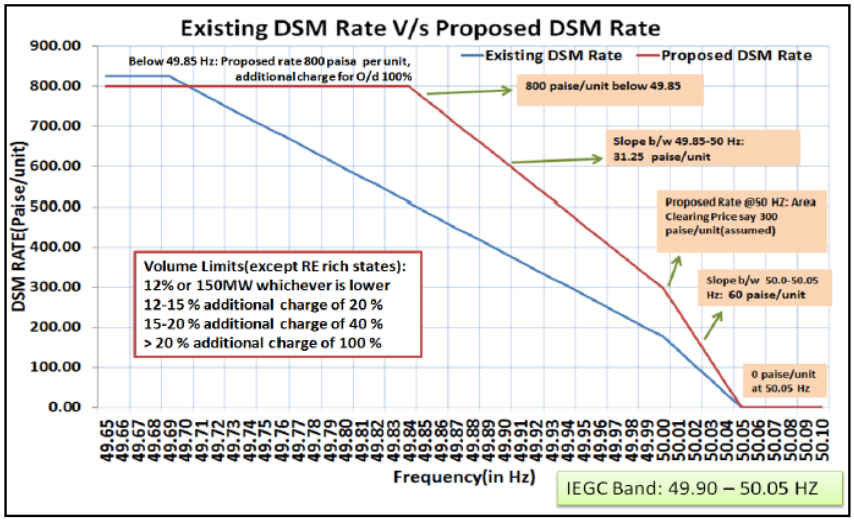


Fig. 6 – Comparison of existing DSM with proposed DSM rate

The objective of AS regulations is to maintain the frequency at desired level and relieve the congestion of transmission network. Presently approximately 70 power plants are providing AS at administered price mechanism and nodal agency for AS services is NLDC. Based on two years of AS operation, it has been observed that only a small quantum of un dispatched surplus is available for despatch in high demand periods thus defeating the very purpose of AS.

Grid operator is pushing hard to shift from present 15-minute scheduling to 5-minute scheduling so as to have finer control on despatch. Liquidity is the fuel for any market to flourish and same is absent in Indian electricity markets presently. To bring the un-dispatched surplus power (of long term contracts) in market, CERC is in process of introducing various initiatives that will converge to full fledged electricity markets in coming times.

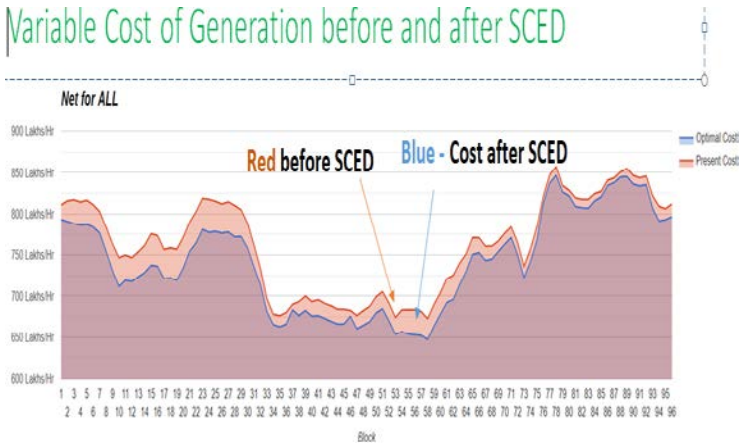


Fig. 7- Pre & Post pilot SCED Scenario
Source: NLDC, POSOCO

Due to decentralised and region specific despatch mechanism, some low cost generation in silos still remain un-despatched and higher cost generators get despatched. To tap the generation from

low cost generators, regulators have implemented pilot SCED (Security Constrained Economic despatch) which is running successfully since April '19 saving approx. 3-4 crores per day. Figure 7 depicts the scenario of pre and post- pilot SCED implementation price differences.

RECENT INITIATIVES

Commission has proposed various new initiatives, viz., Re-designing RTMs (Real time markets), Ancillary Services Mechanism, MBED (Market Based Economic dispatch), etc.

The sole purpose of RTM is to bring in URS power in markets and increase liquidity in market so as to discover real price of energy at power exchange. The RTM seeks to encompass two elements viz., change over from continuous trade to uniform auction in the intra- day market of the power exchange and introduction of the concept of Gate closure. Currently, discoms have the right to recall (it's contracted power with generator) 4 times blocks (01 time block=15 minutes) ahead of actual despatch. After introduction of Gate closure concept, flexibility to revise schedule by discoms ceases. Introduction of gate closure gives ample time to operator to dispatch URS power in real time without any difficulty, thus managing grid in a better way.

For supporting RTMs, grid operator is also in process of formation of online platform for open access termed as 'NOAR (National Open Access Registry). NOAR will provide single point interface for all the stakeholders, including open access participant, trading licensees, Power exchanges, NLDC/RLDCs/SLDCs and Regional Power committees. This platform will be advantageous in many ways like automate STOA (Short Term Open Access) transactions, provide audit trail, act as central online repository, interface with power exchange & scheduling software, etc. with minimal human intervention thus reducing procedural time.

MBED discussion paper's objective is to meet the system load by dispatching the least cost generation mix while ensuring grid security. According to this mechanism, all generators & discoms have to declare their availability and requirement respectively on day ahead basis. The buyers will be supplied electricity as per their load and the generators will get dispatched in merit order up to the point where the total system load is met; and the contracts would be settled bilaterally, but at MCP (Market Clearing Price) discovered on power exchange. The settlement of BC(Bilateral Contract) shall be based on difference between the market clearing price and the contracted price, entails a payment by the generator to the discom equal to: *(MCP – CP) x Contracted Capacity scheduled under MBED summed over all blocks in a day*. This mechanism protects the interests of stakeholders, maintains grid security, honour sanctity of bilateral contracts and also works on sound commercial principles.

The objective of transformation from administered ASM to a market based ASM is to increase the ambit of potential providers of such services at efficient market discovered costs and enhanced reliability of the grid. This mechanism suggests for competitive and market based environment for all stakeholders, transparency and preparedness for the future. Generators would bid simultaneously for Day ahead (DA) energy and DA ancillary services and two shall be cleared together at power exchange. Later the settlements shall be done based on these discovered prices for ancillaries. AS thus provided will be fairly priced and also motivate power plants to provide these services whenever required by Grid operator.

Apart from these initiatives, commission is also in process of introducing Electricity derivatives, separation of Carriage and content and many more which will further strengthen the electricity markets.

WAY FORWARD

Electric vehicles, DERs (Distributed energy resources), RE (Renewable energy) integration, electricity storages, etc. which act as enablers as well as disruptors whose integration with age old technologies is the upcoming challenge. Necessary up-gradation of old generators in line with latest technologies like enhancing ramping capabilities, low carbon emission, optimum fuel efficiency needs to be taken up on priority. Introduction of gate closure, five minute scheduling, SCED, NOAR,

RTMs are the milestones that needs to achieved on priority for further stabilising the grid. CFDs (Contracts for differences), electricity derivatives, DLRs (Dynamic Line Ratings) for assessing real time congestion, etc. are some of the measures which are being discussed among the planners and regulators for early implementation. To build a strong & resilient grid and introduce full-fledged electricity markets, role of policy makers, regulators, grid operator and stakeholders is mandatory as they are responsible for shaping up of act, regulations, operating principles and compliance measures.

CONCLUSION

To build and operate one of the largest synchronised grid, lot of challenges were faced and many lessons learnt during the whole process. It has been consistent endeavours of policy makers, regulators, grid operator and stakeholders for construction and operation of Indian grid in a reliable, secure and economic manner. As a result of these efforts, Indian grid has not suffered any major grid collapse in last seven years. Continuous comprehensive evaluation of grid parameters, assessment of evacuation infrastructure, financial settlements and adoption of latest state of art technologies viz. PMU & WAMS, artificial intelligence, big data analytics, block chain, can be the driving force for planners, regulators and operators for developing full-fledged electricity markets. Lot of challenges and hurdles faced during said journey have strengthened the grid in all respects.

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