Intra-State ABT – Issues and Challenges

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Abstract

Availability Based Tariff (ABT) has already been implemented in all the five regions of the country and benefits derived by adopting this commercial mechanism are widely acknowledged. The mechanism helped in improving the availability of Central generators, better grid discipline, better grid parameters, utilization of bottled-up power and reduction in cost of power. The time has come now to implement this mechanism at intra-state level also to maximize the benefits of merit order dispatch, merit order load curtailment and managing the grid under restructured environment to achieve the objectives of reforms. The paper discusses in detail the need for introduction of ABT at intra-state level, regulatory issues and implementation issues in greater detail.

1.0 Introduction

Presently, the States are notionally designated as control areas in the inter-state ABT mechanism with each State given a schedule by RLDC based on allocation from Central generators and bilateral transactions. The States are expected to vary their own generation to maintain the drawals as per schedules. The deviation from schedules are priced linking them to frequency under the UI mechanism of ABT. This largely helps in deterring the states from overdrawals and underdrawals during adverse frequency conditions and thereby maintain grid discipline thus helping the RLDCs to ensure smooth operation of the system. With the ongoing restructuring and reforms process in the States, number of entities would emerge with differing interest, however, with the common objective of optimisation of resources as well as safe and secure grid operation. It is, therefore, required to maintain good operational discipline through commercial implications for each and every actions by these entities. The scheduling methodology of ABT links commercial mechanism and grid operation so that both economy and security are achieved.

One of the main reasons for bottled up resources within the States among some state utilities and IPPs/CPPs is lack of sound commercial mechanism for promoting trading among these utilities reflecting true market conditions. With intra-state ABT, the sub control areas within the state control areas also would be responsible and accountable for their actions. Unless the resources within a state are optimised, true merit order can not be achieved. The introduction of intra-state ABT would also induce all the state utilities to precisely forecast their demands, utilise their resources in an economic manner and at the same time to achieve better grid parameters.

Through implementation of intra-state ABT, the state generating plants can also be operated such that high availability from these stations is ensured thereby reducing the shortages. Intra-state ABT would also inculcate better planning culture and competition. Ultimately, the cost to the consumer would reduce.

With the implementation of Electricity Act 2003, the States are in the process of implementing restructuring and reforms due to which the move for implementation of intra-state ABT need to be hastened. The implementation of Open Access now at inter-state level and shortly at intra-state level also requires implementation of intra-state ABT. The commercial mechanisms suggested for adoption for active and reactive power are described in the ensuing paragraphs.

1.1 Mechanism for Active Power

The salient features of ABT are tariff comprising of three components: (a) capacity charge, towards reimbursement of the fixed cost of the plant, linked to the plant's capability to supply MWs, (b) energy charge, to reimburse the fuel cost for scheduled generation, and (c) a payment for deviation from schedule, at a rate dependent on system frequency. All ISTS users i.e. Inter-State Generating Stations (ISGS) and beneficiaries are subjected to the third part, known as Unscheduled Interchange (UI). The salient features of ABT mechanism, infrastructure needed for implementation of ABT and advantages reaped due to ABT mechanism in Western region of India have been discussed in our companion paper.

1.2 Mechanism for Reactive Power

With the implementation of Indian Electricity Grid Code (IEGC), the scheme for reactive energy charges have also become effective concurrent with ABT mechanism in all the regions. The prime objective of the scheme is to induce SEBs to install capacitors timely and thereby redusing MVAR drawals, MVAR flows on long EHV lines and resultant large voltage drop. This scheme is primarily meant for SEBs which have been reluctant to install capacitors. In view of prevailing situation, prohibiting SEBs from VARs drawal from EHV grid has not been insisted upon in the Grid Code (clause 7.6.1). Therefore, this scheme includes pricing of VARs drawn/injected into inter-state system or between two states, at a nominal cost which is priced at the rate derived from cost of capacitors. The salient features of the scheme are as enumerated below:-

- Beneficiary pays for VAR drawal when voltage at inter-utility connection point is below 97%.
- Beneficiary gets paid for VAR return when voltage is below 97%
- Beneficiary gets paid for VAR drawal when voltages above 103% and
- Beneficiary pays for VAR return when voltages above 103%.
- No charges for VAR drawal/return between 97%-103%
- No charges for SEBs drawals directly from ISGS bus bars.

The reactive energy charge rate was fixed at Rs.40/MVARH for the year 2000-01 with 5% escalation every year. Present tariff is Rs. 46.10/MVARh. Similar scheme can be implemented at intra-state level for pricing of VAR flows from TRANSCO system to DISCOMS or between two DISCOMS.

2.0 Need for Intra-State ABT for Open Access

2.1 Merit Order Despatch

At the regional level, the bulk power supply market is operated as a loose power pool with States and ISGS stations forming the control areas. As per Grid Code, each state and ISGS stations are considered as notional control areas. However, within each state there could be several utilities operating as sub control areas exchanging power among themselves. For instance, Maharashtra State is considered as a single control area in the regional bulk power supply market. Within Maharashtra, the utilities operating and transacting are MSEB, TPC, BSES, BEST(BEST is embedded within TATA system and a sub-control area of TPC) and IPPs like DPC (Now not in operation) and several CPPs and wind generators that inject power into the State grid. The ABT mechanism implemented at regional level strives to achieve merit order at the regional level. However, the merit order of the region is affected if the utilities within the state systems do not achieve merit order within the state.

Some examples are described here to explain the concept. The peak load hours of TPC (Mumbai area) occur between 1200 hrs and 1500 hrs due to which TPC runs about 300 MW hydro in order to meet their peak load. However, in the rest of the regional grid including Maharashtra, the above period is considered as day off-peak with reduced demand and good frequency. As a result, the UI prices at regional level are much less than the overall variable cost of TPC generation and if merit order has to be achieved within Maharashtra, TPC can draw cheap UI power from the grid to displace costlier thermal generation run on gas and oil in TPC control area. The hydro generation of TPC can be shifted to evening peak hours of the region i.e, 1800-2100 hrs. This would help the regional grid as well as MSEB to tide over power deficits. Due to low frequency and consequent high UI prices, MSEB & TPC systems are bound to gain financially. However, since TPC system is embedded within the control area of Maharashtra state, they are not players in the regional bulk power supply market. If TPC as well as region has to achieve merit order, TPC has to be included in the regional bulk power market or alternatively ABT has to be implemented within the State of Maharashtra among the utilities within the State preferably with similar structure as implemented at the regional level.

2.2 Trading

Even though surpluses exist with the utilities within a state system, they are not able to trade their surpluses outside the state due to the existing commercial mechanisms. For example, the surpluses available with BSES and TPC were not utilized by other States in the region. There is also a case in which trading as well as merit order have been affected. The pumped storage plant at Bhira owned by TPC was not run in the pump mode due to non-availability of cheap power within TPC as thermal units of TPC run on oil. With intra State ABT in Maharashtra, TPC can draw power from the grid when UI prices are lower (during night off-peak) and pump water into Bhira reservoir and the hydro machines can generate power during regional peak hours when the UI prices are higher. This would make the pumped storage scheme at Bhira dispatchable and supply additional 180 MW power to the grid already suffering with deficit as high as 6000 MW. Such suppression of economy transactions affect merit order as well.

2.3 Utilisation of NUG Generation

The surpluses available with captive power plants could not be utilized at present as the surpluses are available only for few hours in a day. With ABT implemented at intra-state level, the captive power plants can inject power into the grid whenever they have surpluses and draw power under deficit conditions using UI pricing mechanism. The maximum UI price was determined linked to cost of diesel so that under severe deficit conditions (i.e., at frequency equal to or less than 49 Hz), the captive power plants mostly run on diesel become despatchable and can increase their generation.

2.4 Open Access

The Electricity Act, 2003 has opened up floodgates for utilisation of bottled up power through trading opportunities. Now, buyer can choose his supplier and he would need to pay only for wheeling charges and surcharge for utilising third party transmission network. The energy accounting for exchanges between Generator to End-consumer, Genco to Discom, Discom to Discom at distribution level would involve more complex arrangements when two utilities fall in different control areas. The power would be supplied at one point(s) and drawn at other point(s), the intermediary network may belong to various transmission licensee(s). Due to inherent power system characteristics, the power flows on AC networks cannot be controlled and therefore the buyers consumption and suppliers delivery of energy would not match. The power drawn would obviously have to match with power injected on real-time basis. Ensuring simultaneity of two transactions would be a task which SLDCs/RLDCs would need to undertake through pricing mechanism. The more important but less discussed questions are how to ascertain:

1. Contracted power is actually delivered by supplier or not in a particular time block?
2. The buyer is consuming more or less than the contracted power in a particular time block ?
3. Deviations of both ‘supplier’ or ‘buyer’ from their contracted quanta in the same time frames and suitable pricing for the same.

Under Open Access, it is not always possible to match the injection of power by the seller with drawal of power by the buyer. The deviations can be easily priced if ABT is implemented at intra-state level covering embedded Open Access customer within the states. As an example, consider the case of a bilateral transaction for 100 MW between TPC as seller and MPSEB as the buyer. Even in case of deviations in injection from TPC or in case of tripping of a generator in TPC system, MPSEB continues to draw 100 MW. The deviations of TPC injection are taken care of in the regional UI accounting by MSEB for which MSEB need to be compensated by TPC. The precise way of computing the requirement of compensation is not possible without UI mechanism available at intra-state level also within Maharashtra.

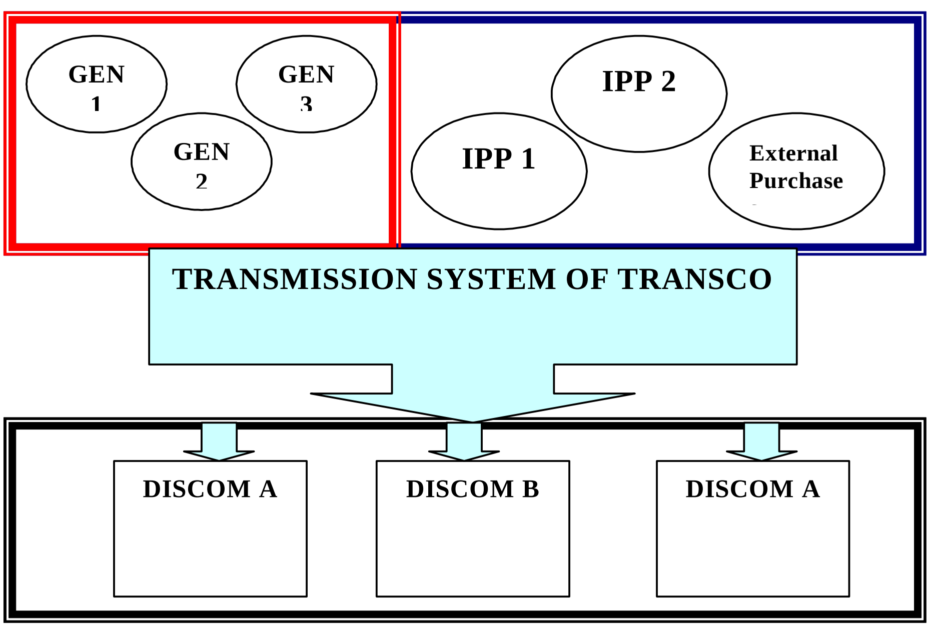
2.5 Pricing of Inadvertent Power Flows

Most of the utilities within the States have stiff commercial conditions with power flow in one direction is only priced and no mechanism is available for pricing of inadvertent exchanges. At times, these exchanges are not paid for. In case of tripping of large generator or sudden load reduction due to weather conditions or disturbances, the inadvertent exchanges occur and can not be controlled. It is essential to price these exchanges as these exchanges provide mutual assistance under distress to the utilities within the state grid. The best way to price these exchanges is to link them to UI prices.

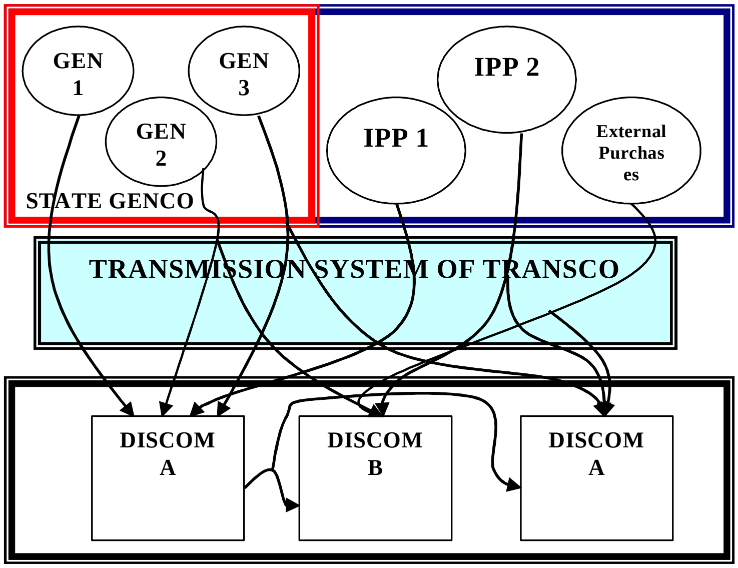
2.6 Restructured Environment

Before ABT, lacunae in the system operation existed at intra-regional inter-utility level. Some of these are: power system operation by the utilities at their will without regard to grid parameters resulting in very high frequency during low-demand periods and low frequency during high-demand period, ISGS generating without regard to beneficiary's requirements etc. All theses have largely been solved with ABT implementation. But with unbundling of SEBs, again same problems will emerge at intra-state level between GENCOS & DISCOMS of the States. In the post-reform June,2004 period, the commercial mechanism would need to be put in place to incentivise deviations in drawal/injections of GENCOS/DISCOMS and end-consumers so as to give correct and grid-friendly signals.

STATE POWER POOL : Single Buyer Model



STATE POWER POOL : Multiple Buyer Model



2.7 Merit Order Dispatch and Curtailment of Load

The licensees and bulk power customers (say with demand exceeding 1MW) can avail open access provisions of the Electricity Act, 2003. The deviations of the actual exchanges with respect to contracted power from open access would need to be priced so that deviations take place for betterment of grid parameters and avoid overloading of system and dipping of frequency to unsafe level. The mainstay of Inter-state ABT is to price the bulk power transfers to stabilize the frequency and create a spot balancing market wherein the incremental cost of power over the grid equalizes. The shortages prevailing in Indian grids normally mean that the generation would be utilized to a large extent and highest incremental cost generation would also be running most of the time during the day. The merit order despatch would normally be operative. When supply to a particular geographical area or group of customers within a control area is not sufficiently remunerative the incremental cost(UI) of the system would pressurize the load serving utilities to shed these load at particular frequency. Therefore, merit order load curtailment would also be a logical extension.

3.0 Regulatory Issues:

3.1 Restructuring & Reforms

The regulators at State level i.e State Electricity Regulatory Commissions shall have to finalize the restructuring models for the State which is a pre-requisite for effective implementation of ABT at intra-state level. With restructuring, the several utilities – generating companies, IPPs, distribution companies, private licensees can participate in variety of transactions which are scheduled by the State Load Despatch Centres. The UI mechanism of ABT could be used to price the deviations from schedules. The States can also re-negotiate their existing agreements with IPPs and CPPs so that tariff norms similar to those applicable under ABT at inter-state level can be adopted which would help in increased efficiency and competition. It is also required to decide upon the mode of allocation of power from the State owned generating companies to the distribution companies. One of the ways doing it is by pro-rata allocation from each generating station to all the distribution companies in the ratio of their demands at the time of restructuring. Another way of doing it is by purchasing power from all the generating stations by a state owned trading company which sells power to all the distribution companies at a single price (basket price) and allocations to all the distribution companies can be made based on their demands. The power from IPPs can also be dealt with in a similar way. The restructuring model also influences whether to allocate the Central allocations to the distribution companies or to the state owned trading company. The regulatory issues also shall have to cover treatment of energy purchased from the renewable energy sources(green power) like wind generators which need to be encouraged due to environmental considerations.

The state regulators should also issue order for provision of meters at the connection points of bulk consumer having load of one MW or more to enable implementation of open access. This can be done in phases – with phase-I covering customers with load of 100 MW and more, phase-II covering customers with level of 10 MW and more and phase-III covering upto one MW.

3.2 Structure of UI Mechanism for Intra-State ABT

The UI pricing at intra-state level should be similar to UI pricing at inter-state level i.e., linked to system frequency. The UI rate structure viz., slope of UI curve, ceiling and floor UI rates and ceiling and floor frequency level should be same as applied for inter-state UI mechanism. One pertinent question that arises is regarding settlement of the losses incurred (as high as 10%) in the TRANSCO system due to flow of UI power, since UI power is not scheduled. One way of dealing with this problem is the nodal agency in the State – state owned TRADECO in single buyer model or the distribution companies themselves against whom schedules are issued by RLDC would settle (pay/receive) UI payments at inter-state (regional) level based on the weekly UI accounts issued by RLDC. The UI for the entire state or distribution company-wise is shown in regional accounts. In the accounts prepared by SLDC for the state utilities, the total UI payable/receivable may not match with that computed by RLDC, the difference being losses incurred in the TRANSCO system. The difference of UI computations done by RLDC and SLDC can be distributed by SLDC to the intra-state utilities. In case UI is drawn by the state as a whole, the difference can be distributed in the ratio of UI payables by various state utilities. In case UI is injected by the state, the difference can be distributed in the ratio of UI receivables by various state utilities. Another way of matching the UI at inter-state and intra-state level could be by increasing the prices of UI for intra-state ABT by a factor that can take care of the losses in TRANSCO system.

It is essential to pass on the UI burden to the end consumers so that the distribution companies would neither run into losses nor gain undue profits due to fluctuating UI prices. One of the major problems faced by the distributing companies in California is due to selling of power to the consumers at fixed price even though the distribution companies purchase power in the highly volatile bid based spot market. The losses in the TRANSCO/DISCO systems due to open access transactions would be taken care of by the open access regulations as is being done at inter-state level. However, the open access entities may inject or draw UI power during contingencies. The losses due to such UI power can be taken care of by applying higher UI rates. For example, if average TRANSCO & DISCO losses are about 10%, the applicable UI rates for open access customers could be 1.1 times the normal UI rates for UI drawal and 0.9 times for UI injection.

The important assumption for allowing UI transactions is to tide over contingencies and effect economy transactions that would reduce overall operating cost of the state/region. Another aspect would be to remove the hurdles for despatch of generation or drawals if merit order permits. However, the UI power flow is not expected to overload the transmission network as in most cases the Indian networks are having adequate redundancy and unutilized capacities. In case transmission constraints exist in some corridors, the UI transactions become curtailable by SLDCs/RLDC which would give priority to scheduled transactions. It is prudent to reserve about 10% capacity of all the links for transmission of UI power as precise control of power flows is not currently possible with the existing grid operational practices.

3.3 Banking and Wheeling Transactions

The banking and wheeling of transactions are required for captive generation, cogeneration plants and non-conventional energy generation since they were required because generation source and consumption points are not co-located but co-owned. The Open Access provisions have addressed mainly above transactions. So far, limited consumers could avail benefits from the banking and wheeling of transactions. The wheeling of power from place of generation to place of consumption would be required on transmission system of distribution licensees but the banking would not be viable.

a) Treatment of Banking Transactions

Banking is generating electricity when it is possible but consumption of the same is not done concurrently. For example, wind, solar and cogeneration plants can generate not necessarily when it is required. Therefore, the generator banks the electricity with the utility and expects the same amount of electricity to be returned after applying losses. In the present UI pricing scheme, the time of consumption and generation are important since the UI rate is linked to average frequency of 15-minute time-blocks. Further, frequency would not necessarily be same at time of generation and consumption. Therefore, banking would outrightly be replaced with UI scheme. The banking generator would generate and inject into the utility system and draw from the utility grid with the exchanges priced at prevailing UI rates. Since the banking agency would be embedded in the Discom’s grid system, the banking agency would be required to pay for network charges. Generally, such plants are located at remote places and network losses and charges at 11/33kV system would be high, the 10% markup on UI prices may be levied on such agencies. Therefore, the accounting of energy for such banking agency can be done in the following manner:

Payment receivable by the agency for its Injection = 0.9 x ∑ UI charges for injection
Payment payable by the agency for its Drawal = 1.1 x ∑ UI charges for drawals
Net payment would be the sum of above two charges.

b) Treatment of Wheeling Transactions (Open Access within State)

The wheeling transactions would involve injection of energy at one location (source) and consumption at another (sink) concurrently. The assumption is whatever injected at source location and the consumption at sink location should match in the same time block. The deviation of consumption at sink location after taking into account the losses on network within, would be priced at UI rates. The treatment of such wheeling transactions in energy accounts would be as under:

Let the injection at source location be INJ in time block i. and consumption at sink location be CNS in same time block.

The UI would be calculated as :

$UI_i = INJ_i$ x Loss factor - CNS_i ;

Loss factor may be assumed to be 0.9 assuming intra-state losses on Distribution and TRANSCO's sub-transmission system to be 10% to start with.

Net UI Charges payable = $\sum$ (UI Rate) $_i$ * UI_i

3.4 Trading Issues

Trading among state utilities take place in the ABT mechanism through : 1. Contracts market and ii. Spot market through UI. The contracts market is under development. For intra-State ABT we would need to decide whether purchases from outside would be undertaken directly by distribution licesees or through a state-owned trading licensee (residual SEB). For instance, GEB has planned to undertake purchases from outside agencies including ISGS and other SEBs through residual GEB who would operate as trading licensee. The pooling of all purchases and allocating it to Discoms in a particular ratio would be one type of arrangement. This can be categorized as single-buyer model. Some of other SEBs may opt for multi-buyer model where each Discom would be free to locate generation and pay separately for contracted power. The ISGS allocations would be shared proportionately and schedule for the same would have to be indicated by them to SLDC. They would further compile all the requirement of Discoms and submit State's requisition to RLDC.

4.0 Implementation Issues

4.1 Metering Requirement for Intra-State Utilities

The metering for inter-State ABT was provided to match with the requirement of ABT. The Special Energy Meters of 0.2S accuracy class, static , 3-phase, 4-wire were developed to record energy transmittals for each 15-minute time block. The special meters were specified to measure and record following, inter alia other requirements:

- Wh transmittal for each successive 15-minute block
- Average frequency (codified) for each 15-minue block

- Cumulative Wh register readings at each midnight
- Cumulative VARh register readings for voltage high and voltage low conditions at each midnight.

The metering systems provided for ABT would be base solution and further improvisation would be beneficial for intra-state ABT.

Minimum Requirement for Metering Systems could be :

- Accessible Display for instantaneous and cumulative displays
- Accuracy as per IEC 687
- Capable of registering and recording flows in each direction
- Electronic data recording and data storage facilities stamped with time, average frequency and Wh and VARh for time-blocks
- Electronic Data transfer facilities from metering installation to central metering database
- Capable of communicating from meter to local PC at the sub-station.
- Capable of storing 40-days data.

Further suggested improvisations are as enumerated below:

- Dynamic Error Compensation
- Watch-dog Function
- Remote Meter Reading
- Real-Time Metering Data Access
- Metering System Standards
  - Common protocols/format for data storage
  - Common tags for data tamper, meter problems like low voltage stamps, meter advance/retarding, time synchronisation etc.
  - Common communication protocols for remote metering
  - Data conversion software for conversion of coded file to different file formats like txt, CSV or XLS, DBF etc., may differ in their features but the output format should be same so that user can develop a common programme for reading such files.
- Multi-Mode Communication
- Scope of Metering Data collection Agencies – New Ancillary Services can step in.
- Internet Based Data Collection

4.2 Billing and Settlement Systems

Presently the billing and settlement for inter-State ABT is being done by REBs/RLDCs. The TRANSCO being the only licensee with no interest in generation and distribution, it would be logical that SLDC operated by TRANSCO would be involved in billing and settlement. The extensive arrangements include system hardware and software to collect data from the inter-utility exchange points. The infeed points for receiving ISGS power from CTU's network are already provided with meters. Following additional points would be metered:

1. Transco-Discom Exchange points
2. Inter-Discom Exchange points
3. Genco-Discom exchange points
4. Embedded IPP/CPP-Discom points

TRANSCO would own 66kV and above network whereas Discoms own33kV and below network. On an average the inter-utility exchange points for intra-State ABT run into few thousands. The data collection would preferably be done automatically through leased lines. But remoteness of substations and non-availability of reliable communication would require manual data collection. The task has to be undertaken to manage grid with accountability. The others who would also be covered under intra-state ABT would be those licensees and bulk consumers who opt for open access transactions with schedules issued for drawal of power from licensee other than incumbent utility. The connection points with those open access customers having more than one MW demand also need to be metered.

The SLDCs are required to carry out Energy Accounting and billing. They are also required to maintain pool accounts for UI and Reactive Energy Charges.

5.0 Conclusion

For achieving objective of cheaper power to the end consumer, it is essential to implement open access and tariff mechanism like ABT at the state level. The open access has already been allowed by the Electricity Act, 2003. This would enable cheaper generators to despatch their power by providing transmission access. All the utilities in the country, by availing open access, can purchase their requirements from cheaper generating sources. The intra-state ABT would help in meeting the real time requirement of power by creating a spot market for the state utilities who can balance their demand and supplies in real time. The ABT mechanism would also help the utilities to trade among themselves or with those outside the state in real time itself without any hurdles or need for negotiations/contracts. The implementation of open access has to precede the restructuring within the states so that IPPs and CPPs can come up and can be located at pit-heads. This would also help in siting of Distributed Generators(DG) at load centres based on the cost economics and prevailing UI prices. The open access can be successfully implemented only if ABT is implemented concurrently as deviations in open access transactions can be priced matching with market conditions. The total merit order in the region can be possible by implementing intra-state ABT to supplement the inter-state ABT in a seamless continuum across the country.

ABT has already been implemented in all the five regions which gave boost to trading and availability of more power in the regions without significant additions to installed capacity. The efficacy of UI mechanism helped in improving the grid parameters dramatically. For instance, the Southern region frequency shifted upwards by 2 Hz from 48 Hz average to 50 Hz. In Western region, the frequency in the allowable band (49-50.5 Hz) is around 99% as compared to 63% in the pre-ABT era. In the Eastern region, no more high frequency operation around 52 Hz and all generators dispatched fully with more than 2000 MW exported to other regions. The success stories can be repeated within the state also by harnessing all available power without any restrictions. Since already ABT is functioning at the regional level, it is easy to implement at state level also with minor adjustments in the procedures. Further, cost of changeover is minimal except for the cost of metering and settlement systems. If restructuring and reforms have to be successful, the implementation of ABT should be at the center-stage and expedited even before the restructured entities starts functioning. Incidentally, ABT would also help in improving the security levels which is most important aspect in grid operation under restructured environment.

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