AVAILABILITY BASED TARIFF
AN ALTERNATIVE FOR REAL TIME PRICING BASED ON SYSTEM FREQUENCY FOR DEVELOPING COUNTRIES

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ABSTRACT

Large scope existed for trading of short term energy exchanges as and when available but not fully harnessed at present due to constraints in the commercial mechanism rather than any technical reasons. The short-run marginal cost based pricing system is suitable for economy transactions. However, to facilitate economy transactions, large infrastructure and investments are required. The Availability Based Tariff (ABT) provided pricing mechanism for short term energy transactions without the need for negotiations on price or quantum in real time. The infrastructure costs for implementation of ABT and changeover costs to the new system are minimal and poses no problems in switching over to the new framework. Further, the ABT framework promotes trading, grid discipline, new investments and encourages development of ancillary market and utilization of captive and private generation in a cost effective manner. The ABT framework suits ideally for real time pricing of electricity. This model can be used in other developing countries also due to its simplicity and no significant expenditure in change over.

1.0 INTRODUCTION

Why was introduction of Availability Based Tariff necessary?

The regional grids in India were so far operating in a very dis-satisfactory manner. There were large deviations in frequency from the rated frequency of 50.0 cycles. Low frequency situation results when the total generation available in the grid is less than the consumer load connected at that time. This was to be checked by enhancing the generation and/or curtailing the consumer load. High frequency used to be result of insufficient backing down of generation when the total consumer load comes down during off-peak hours. The earlier tariff mechanisms did not provide any incentive for either backing down the generation during off-peak hours or for reducing the consumer load/enhancing the generation during peak-load hours. In fact, there was a financial advantage for the generators, under the earlier mechanism in going on generating at a high level even when the consumer demand has come down. In other words, the tariff mechanism encouraged grid indiscipline.

The Availability Based Tariff was devised to directly address these issues. Firstly, by giving incentives for enhancing the output capability of the power plants, which would enable more consumer load to be met during peak load hours. Secondly, backing down during off-peak hours should not result in a financial loss to the generating station. Thirdly, the shares of beneficiaries in the Central generating stations would be given a meaning which has not been there so far as the pre-ABT mechanism is based on drawals rather than allocations. The schedules given to generating stations and the states for grid operation and dispatch are not considered by the pre-existing mechanism with commercial implications. The beneficiaries would have well defined entitlements, and they would be able to draw power up to this at normal rates of the respective power plants. In case of over-drawals, they would have to pay at a high rate during peak load hours, which should discourage them from overdrawing and pulling down the frequency. This payment would go to the beneficiaries who received less energy than scheduled.

How everybody would benefit?

The mechanism streamlined the operation of the regional grids. The defined scheduling procedures would encourage constituent utilities to follow the given schedules for generation and drawal. Any constituent which helps the regional grid by under-drawing from the regional grid in a deficit situation, would get compensated at a good price for the energy under-drawn. Secondly, the grid parameters would improve, and the equipment damage correspondingly would reduce. The only way to improve the frequency during peak load hours is to reduce drawals, and necessary incentives would be provided in the mechanism. High frequency situation should also get checked by encouraging reduction in generation during off-peak hours. Thirdly, because of clear separation between fixed and variable charges, generation according to merit order would be encouraged and pit-head stations would normally not have to back down. The overall generation cost would accordingly come down. Fourthly, a mechanism would be established for harnessing captive generation and co-generation and for bilateral trading between the constituents.

2.0 PRE-ABT TARIFF MECHANISM

All regional grids in India used to have Inter-State Generating Stations (ISGS) built and commissioned by Central/Union government owned companies particularly for the reasons that States did not have adequate funds for capital investment and borrowing capacity. These ISGS are shared by all states within a region. The ISGS own 20% of generating capacity with about 25% contribution to total generation. The ISGS were paid two-part cost-based regulated tariffs. The first part being capacity charges and the other energy charges.

In the pre-ABT tariff mechanism prevailing in almost all the regions, total ex-bus generation of all multi-shared projects form a pool of power. The beneficiaries draw from this pool and pay for actual energy drawals at a pool rate which is weighted average rate of all the ISGS stations within the region. The generating stations receive total cost of their generation from this pool. This way each beneficiary pays to each station in

proportion to its drawal. The entitlements of beneficiaries in different power projects have no sanctity.

The generation tariffs of Inter-state generating stations (ISGS) based on coal & gas are calculated in two-parts: Fixed charges (Rs. /Year) are calculated based on total annual fixed costs comprising Interest on loan, Operation and Maintenance (O&M) charges, Return On Equity (ROE), taxes, duties, interest on working capital, etc. and are recovered in 12 equal monthly installments paid by the states in proportion to their drawals. The ISGS fully recover its fixed charges at Plant Load Factor (PLF) of 63.5% and at PLF above 68%, ISGS receives incentives. However, an ISGS can recover 50% of the fixed costs even at 0% PLF.

Variable charges (in Rs. /Kwh) are recovered as per ex-bus generation of each power station and are payable as per actual drawals. The equal-landed cost methodology was prevailing in all regions except in Northern region. The payments as per actual drawals and actual generation don't impose planning on day-ahead or hour-ahead basis. All these had given rise to improper signals for system operation and pool participants had to pay for simplicity.

3.0 SALIENT FEATURES OF ABT

As the name signifies, the major part of payment for the stations' output in this tariff scheme is based on stations' availability, rather than on MWH/MVAH output or peak MW/MVA as in conventional two-part tariff applicable presently.

Payments under ABT basically comprise of three parts – capacity charge, energy charge and charges for deviations. The capacity charge for a time block (15-minute time block or one day) is paid for the declared MW output capability of the station for that particular time block (for target availability of 80% in the year). The capacity charge is meant to cover the total fixed cost for the generating station i.e. interest on loan, return on equity, loan repayment provision or depreciation/ amortization, fixed O&M cost, insurance, taxes, interest on working capital, etc.

The energy charge is meant to cover the variable cost of the station that is the fuel cost component which goes up with amount of energy generated and paid based on schedules and not on actual drawals.

The third part which is of much importance is charges for deviations. These charges are payable for deviations of injections of Central plants and drawals of SEBs from their respective schedules and are linked to average frequency in particular 15-minute time-block. Schedules for SEBs shall be prepared on the basis of their requisitions from the declared capabilities of Central plants. The charges for deviations i.e. unscheduled interchange (UI) rates are maximum at 49Hz and below and zero at 50.5Hz and above, with constant slope between two extremes and prices applicable at steps of 0.02 Hz as shown in figure 1. The maximum rate (presently 420 paise /kWh) has been linked to

diesel-generation cost of power and minimum of zero is linked to over-flowing hydro power with zero incremental cost.

Any extra generation beyond the schedule is deemed to be going to replace the generation of highest incremental cost operating at that time. Similarly, when SEBs draw more (or less) than the schedule at a particular frequency, they are deemed to be drawing power from the grid at these frequency-linked charges i.e. third part which should always be more than their own incremental cost. It would be therefore logical to fix the pool price equal to incremental cost of that generating unit which has the highest incremental cost and is not inflexible i.e. it can increase or reduce its output. As the regions' demand goes up or down, different generators are taken to full or minimum load, the systems' incremental cost would also go up and down. In general, the pool price would rise to a ceiling level (say 420p/kWh) when all generation is in and load shedding is required (peak load hours) and frequency dipping to lowest allowable limit i.e. 49.0Hz, and would fall to zero when all generation has already been backed down to the lowest technically allowable level (off-peak hours) and frequency touching highest allowable limits i.e. 50.5Hz.

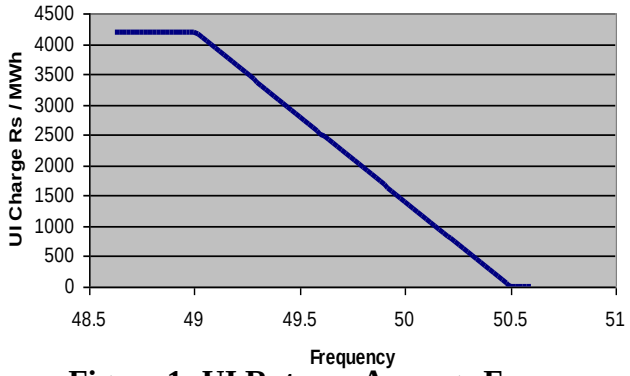

Figure 1: UI Rate vs. Average Frequency

4.0 IMPLEMENTATION OF ABT

4.1 METERING ARRANGEMENTS:

Availability Based Tariff (ABT) was introduced in the Western Region[1] w.e.f 1.7.2002 and subsequently introduced in other regions of the country. The new commercial mechanism for inter-utility exchanges would not have been implemented without complementing it with compatible, easy-to-use and cost effective end-to-end metering solutions. POWERGRID[2] did envisage the requirement of metering systems required for new commercial mechanism and put in place in all the regions of the country for smooth transition. The specifications of metering system were developed by POWERGRID in

[1] Indian grids are divided in five regions and Western Region having installed capacity of 31 GW is the largest region.
[2] POWERGRID is a transmission utility for inter-state power transfers similar to NGC of UK.

1994. They have also developed a prototype and thoroughly tested it. The specifications and testing of the meters is conformed to IEC standards.

The total cost of infrastructure required for ABT constituted mainly Special Energy Meters (SEMs) and hand-held data collection devices (DCDs). With indigenously developed Special Energy Meters of 0.2 S class at very cost effective price of about less than US$700, the total investments were less than only about half a million US dollars for WR grid. The modality of data collection and its conveyance to a central place i.e. WRLDC[3] were made simple, practical and at the same time tamper-proof. Weekly settlement is being carried out on the basis of 15 minute block–wise readings.

4.2 SCHEDULING ARRANGEMENTS:

The scheduling arrangements were also finalized and approved by the regulator before implementation. Scheduling and despatching on a day-ahead basis are done by system operator. ISGS are asked to declare their capability one-day ahead by 11:00 hrs and beneficiary utilities are to give requisition from with declared capability (only up to their entitlements). In case of contingencies, both ISGS and the states revise their schedules and these revised schedules become operative after one hour. Similarly, bilaterally contracted power can also be scheduled and revised before one hour.

4.3 SETTLEMENT SYSTEMS:

The system adopted was weekly accounting for UI and monthly accounting for capacity charges, energy charges and incentives. The metered data is collected every week on Monday for one-week period ending on Sunday. The data is checked and validated using check and standby meters. The accounts are issued by the following Tuesday. The same is posted on WRLDC's website namely www.wrldc.com. The data collection is manually done using DCDs at substations. The conveyance to central computer is through internet even from remote places. The remote metering may be a solution which would be tried in the next phase. The beneficiaries, who are required to pay for deviations i.e. unscheduled interchanges (UI), would pay to Pool Account maintained by WRLDC by 10th day and to be disbursed to receiving beneficiaries in next two days. The capacity and energy charges are paid to the generators on a monthly basis.

4.4 BULK POWER SPOT MARKET:

The ABT mechanism automatically created an efficient and highly convenient Spot Market. The UI prices which are based on real time grid frequency (which reflects load generation balance) reflects the availability vis-à-vis need for power by the pool members and a true economic value of power in real time. This is akin to marginal cost of power. All the pool members can transact in real time at UI costs without any need for negotiations in respect of price. Neither any contract or agreement is required. The inadvertent exchanges need not be returned but priced and paid using the UI mechanism.

[3] Western Regional Load Despatch Centre is system operator for Western Regional grid created through statute and designated as apex body for grid operation in the region.

Any generator is free to inject power in to the grid is free to draw power from the grid at UI prices. The spot market allows for transactions without negotiations and covers deficiencies in planning. The UI mechanism also provides for trading of infirm power (as and when available surpluses) as well as economy exchanges (in conjunction with Frequency Linked Despatch Guidelines). The spot market led to utilization of bottled up power in the country with transactions crossing phenomenal Rs. 1000 crore mark in the country in less than one year and Rs. 500 crore mark in WR, in just one year.

5.0 EXPERIENCE SO FAR

The salient features of Grid Operation under ABT regime are discussed below:-

- ***Curtailment of High Frequency*****:** ABT has been successful in containing high frequency problem to a great extent. During low demand-periods, there used to be, in the earlier commercial mechanisms, reluctance on the part of utilities as well as ISGS stations to reduce generation. Constituents are presently backing down their costly thermal generation to avail cheap UI power from the grid. In fact, the generators dispatch as per the frequency linked dispatch guidelines. The generator compares its variable cost with the UI cost and reduces generation if the UI cost is lower than its variable cost.

- ***Merit Order Operation*****:** ABT has acted as a catalyst in prompting all the constituents to follow merit order generation to gain commercial advantage. It has prompted all the constituents to back down their costlier generation. For example, consider the case of utility whose thermal generation is costlier because of high cost fuel (situated away from pithead). The utility tends to draw more than schedule from ISGS during high frequency regime. However, as frequency comes down and UI price goes up, the utility maximises its generation / increases load shedding such that their drawal is less than schedule to gain UI advantage.

- ***Minimal RLDC's Intervention*****:** ABT has aided in controlling the grid parameters by virtue of its inbuilt disciplinary mechanism. Intervention of RLDC is not required frequently in improvement of frequency and voltage profile. Constituents on their own are controlling their MW/MVAR drawal to maintain grid parameters in safe range.

- ***Datum for Trading established*****:** Clear cut commercial / operational datum is established for all the constituents as well as generating stations. It has helped all the constituents / generating stations to take proactive measures such that they are commercially benefited. It has also led to better operational performance and improved grid discipline.

- ***Meeting more demand in the absence of capacity addition*****:** The WR grid peak demand has touched 31GW whereas installed generation capacity is also 31 GW. The rolling blackouts are the only means to meet demand. No capacity has been added in last three years and some capacity idles due to high cost. With ABT, the additional demand has been met using otherwise idling capacity. Last year, WR

grid met more demand of 945 MW without any addition to installed capacity largely due to infirm injection of power by idling capacity. The mechanism also facilitated import of cheaper power from other regions.

- ***ISGS Operation at Schedules*****:** ISGS stations are adhering to schedules. The PLF based incentives are computed based on scheduled generation rather than actual generation.

- ***Flattening of load curve through Demand Side Management*****:** ABT is also incentivising the constituents to implement time-of-day tariff for their HT consumers. For example, Chhattisgarh State Electricity Board (CSEB) has implemented time of the day tariff for HT consumers. Gujarat Electricity Board (GEB) also planned their requirements and flattened their load curve. Karnataka shifted about 1000MW of loads from peak to off-peak periods.

- ***Harnessing of bottled up generating capacity*****:** ABT has also prompted utilities to harness captive generation within their control area to maintain drawal as per schedule particularly during high-demand period when spot prices(UI) are high. In fact the captive generators became despatchable with the current level of deficits.

- ***Boost in trading through bilateral agreements*****:** Power exchanges through medium and short-term agreements have seen a quantum jump last year. On an average all deficient utilities have attempted to source their requirement (which earlier was drawn from the grid only causing dip in frequency and grid security problems). Western region traded more than 1000MUs with Eastern region through bilateral contracts in the year 2002-2003 as compared to zero in the previous year. The total exchanges through bilateral trades jumped from 1829MUs to 4077MUs in the first year of ABT as compared to same period of last year (July 2002-June 2003).

- ***Better Grid Discipline*****:** The grid discipline has improved and overdrawals by load serving utilities are being curtailed, on their own, without system operator's intervention.

- ***Dramatic improvement in frequency*****:** The frequency of all regional grids has improved significantly. In WR, the frequency now is more than 95% time in the 49.0-50.50 Hz range (as compared to about 60% earlier).

- ***Managing demand-pick ups through better planning*****:** During the 10-day Ganesh festival (From 31st August 2003 to 9th September 2003) a celebration period in Maharashtra, ABT has helped MSEB(the state owned utility) to tide over the major demand pick-up with overriding pressure not to shed the load during evening peak hours to residential and commercial consumers. MSEB could garner bilateral trades of 150MW during peak and 550MW during off-peak periods and further assistance could not be tied up as no clear surplus was available with other states. However, infirm power was available due to demand

diversity. The infirm power available was therefore utilized by MSEB through Unscheduled Interchanges (UI) during the Ganesh festival from 31.08.03 to 09.09.03. The purchase of their additional requirements in real time spot market through UI prices resulted in savings of US$ 2million (Rs 10 Crs) as well as saving of water at their hydro stations.

Similar was the case due to demand-pick up at the time of world cup finals on 23rd March 2003. Utilities relied on infirm energy in the grid available due to diversity.

6.0 CONCLUSIONS

Though, it is unconventional to use system frequency to send system deficit/excess signals to utilities for pricing, it has been found very useful and at the same time significant benefits have been reaped by all utilities to move to a regime of better system discipline and operation. This was particularly helpful since the frequency otherwise was deviating to a large extent and disciplining through directions from system operators and regulators were generally not met with good response.

Developing countries generally face shortages and political pressures on vertically integrated state-owned utilities would not allow them to shed the load during peak period. The price of power should not be too high and the spot market prices should therefore be regulated with a ceiling price linked to diesel generation. Therefore, all generators whose costs are less than highest marginal cost (i.e. diesel) become viable and no separate Power Purchase Agreement (PPA) is required for them to inject into the grid. The shortages are mitigated and idling capacity is minimized.

In the Open Access (OA) regime in India, ABT suits Open Access requirement also. The bilateral contracts requires negotiations and pricing of these may require regulator's approval. This may lead to non-utilization of as and when available surpluses. Trading of such surpluses are economy transactions. Further, trading of infirm energy in the form of Unscheduled Interchanges can be treated as highly curtailable power. Therefore, no wheeling charges are to be levied. Therefore, wheeling charge issue, otherwise relevant in (computation of which are highly debatable) OA regime need not be paid for under ABT.

Non-utility generation (NUG) is the next area for which ABT mechanism provides a solution. India already has several thousands of MW of captive generation in industrial plants, but the same are not being integrated with the grid because of present frequency fluctuations and due to absence of proper commercial mechanism. On the commercial side, we could simply stipulate that any NUG injection into the grid would be priced as per the aforementioned frequency-linked rate. What the NUG injects into the grid can be left entirely to be decided by the NUG. And the whole system would operate without any online communication between the load despatch centers and NUGs.

In the present structure, when we like to bring investments, a long term signal must be available to power producers for making decisions on the choice of technology and the fuel for new plants etc. ABT mechanism best serves this purpose. The capacities which are not being requisitioned in full, gives idea about what fuel and technology are unattractive. The incremental costs i.e. UI pricing provide right signals for building new capacities. The average frequency below which the constituents take action gives signals of their incremental costs.

The costs of putting new arrangements for changeover to ABT are insignificant as compared to millions of dollars spent in each power pool of developed countries for bringing competition at wholesale level. In UK, the cost of development and running the new wholesale market for first 5 years was approx. US$1.1billion. and after a decade of high prices, Britain spent an additional 100 million pounds to institute NETA(New Electricity Trading Arrangements).This is apart from what electricity industry spent to install computer systems and trading desks to participate in bidding process. Whereas, in ABT mechanism, there are no major changes which are required to be brought out either at utility-level or RLDC-level except change of procedures and cost of Special Energy Meters (SEMs). It is expected that implementation of intra-state ABT would unleash the full potential of ABT mechanism as captive generation surpluses so far unutilized may become despatchable.

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