How price reform revolutionized the operational discipline of India's power sector*

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International Journal of Regulation and Governance **5**(1): 41–59

Abstract

The development of an incentive-based tariff scheme has had a significant impact on the operation of the Indian power sector. Voltage fluctuations have been minimized, greater supply made available, and costs reduced. All this was achieved through the ABT (availability-based tariff) introduced in 2000. This paper considers the development, implementation, and results of this sector's change bulk tariff system.

* The views expressed in this paper are of the authors and not of the World Bank.
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Background

India's century-old electricity industry has grown rapidly since the country's Independence in 1947.[2] Of the approximate 112 000 MW (megawatt) of installed capacity in 2004, 31 600 MW was provided by the central sector generating capacity.[3] However, despite these investments, much of the country is still blighted with power shortages and the grids constantly face demand and supply mismatches. Until recently, the situation was further exacerbated by grid indiscipline. In their attempts to draw their allocation of central sector generation, at times when grid supplies were restricted due to plant unavailability, the state utilities dragged down the system frequency, often to unstable levels. Also, to supply the power even when not required, bulk generators would continue to drive the system to unnecessarily high frequency levels rather than backing down their capacity. This indiscipline led to large fluctuations in the grid frequency, and on a number of occasions, complete grid blackouts occurred causing serious losses to India's economy and damage to expensive system components and local equipment.

In the 1990s, in parallel with the state-level power sector reforms, India's transmission and system operations went through an extensive national restructuring programme. POWERGRID (Power Grid Corporation of India Ltd), established by the GoI (Government of India) in 1989, took up the implementation of this programme. Between 1994 and 1996, all RLDCs (regional load dispatch centres) and their operational responsibilities were transferred to POWERGRID from the Central Electricity Authority.

The bulk supply tariff mechanism for sale of electricity from central generating stations was initially a single-part tariff. A unit price per generated kilowatt-hour covered all costs related to generation, including capital expenditures as well as other costs such as those of operating, maintaining, and fuelling the power stations. States tended to compare the total cost of central generators with the variable cost of their own stations as for

[2] India's installed capacity has grown from 1362 MW in 1947 to about 112 000 MW in 2004. In 1963, India's electricity system was divided into five electrical regions to promote the concept of integrated power system developments transcending state boundaries—the northern, western, southern, eastern, and north-eastern.

[3] Output from the central stations is shared among the states in India on an agreed basis—the Gadgil formula.

them the fixed costs of state-owned stations were sunk costs. This made central generation appear more expensive than state-owned stations, even though on a variable cost basis the former was often cheaper. Also, no formal scheduling process for fixing generation and drawal levels existed. There was no system of merit order dispatch. The demarcation of scheduling and dispatch responsibilities between the different stakeholders was unclear. Tariff did not encourage the states to invest in installation of power factor correcting capacitors, which, in many instances, led to unavoidable and expensive exchanges of reactive power and the concomitant low voltages.[4] Furthermore, buyers were not liable to pay the fixed costs associated with the share of capacity allocated to them. Thus, buyers who decided not to draw energy could avoid payment of the inherent fixed charge related to it, which then had to be paid for by the buyers drawing energy. This was unreasonable because it disproportionately increased the cost of energy for those buyers who actually drew energy within their entitlement. Further, the generators were even provided financial incentives for achieving high PLFs (plant load factors), which were attained, by continuing to generate even when the consumer demand had dimi-nished. Thus, the single-part tariff mechanism actually encouraged grid indiscipline. By the end of the 1980s, the GoI was intent on replacing the current single-part tariff with a tariff system that would address these problems.

Development of an alternative bulk supply tariff mechanism

With a view to reduce or eliminate the problems caused by the then existing single-part tariff, India's Ministry of Power constituted the K P Rao Committee[5] to review tariff. The committee's recommendations were a major step towards a two-part tariff

[4] Reactive power is an engineering concept used to describe the background energy movements in an alternating current system. These energy movements arise from production of electric and magnetic fields in equipment connected to the system. Reactive power flows give rise to reduced voltages and higher losses across the system. Thus, it is necessary to maintain reactive power balances between sources of generation and points of demand on a zone-by-zone basis. The problems associated with reactive power are predominantly overcome by connecting to the system banks of reactive power-supplying capacitors, and to be most effective, they need to be sited at the point of load.

[5] The K P Rao Committee submitted its *Report of the Committee on Fixation of Tariffs in Central Sector Power Stations* in June 1990.

system.[6] However, there was room for further modification and improvement. For example, the recommendations included that the PLF be used as a basis for calculation of fixed cost portion, thus continuing to send misleading signals to the generators during low demand periods. Also, compared to international standards, the targets set for plant loadings were too low. Besides, tariff did not provide for any incentives to encourage grid discipline. Finally, although the GoI accepted the recommendations in their entirety, implementation was only partly carried out.

When POWERGRID was established in 1989, the GoI had discussed with the World Bank the implementation of reforms in the bulk supply tariffs under the umbrella of the ongoing central-level power sector reforms. Simultaneously, it, supported by multilateral funding, was developing modern system coordination and control facilities and regional power pools. It also began carrying out a programme to strengthen interconnections between the regional systems with the intent of eventually moving towards a national grid. This would facilitate (a) movement of power between regions (in essence, improving utilization of the existing available generation capacity) and (b) increased power imports from the neighbouring countries. These developments and the emerging regional electricity markets of the early 1990s enabled generators and state-level utilities to improve the efficiencies of their system operations, and facilitated the trading of power, which was needed to supplement supplies being received under long-term power purchase agreements. However, to further facilitate and reduce the cost of energy trades, a radical change in the bulk supply tariff was needed and POWERGRID worked together with their consultants on a proposed new incentive-based tariff design.

After the GoI conducted detailed consultations, the CERC (Central Electricity Regulatory Commission)[7] held hearings and considered the evidence from all concerned parties. It passed orders in January 2000 for implementation of the new bulk power tariff[8] for the country. The CERC's detailed order also covered

[6] The payment to the generator was split into fixed costs and energy charge components but was also dependant on the plant's achieved utilization—the PLF (plant load factor).
[7] Consequent to the formation of Central Electricity Regulatory Commission in 1998, the mandate for fixing tariffs for the central sector generating stations was passed on by the government to it from May 1999.
[8] CERC orders (including the availability-based tariff, dated 4 January 2000) can be seen at <www.cercind.org>.

various aspects, including (a) procedures for determination of available capacities, (b) handling of unallocated shares from a given plant if not allocated by the GoI,[9] (c) force majeure conditions, and (d) establishment of penalties for mis-declaration of available capacities.

Conceptual design of market and tariffs

India's new bulk power market and tariff structure has many distinctive features, but in short, it is a system of commercial incentives to increase the efficiency and utilization of India's scarce generation and transmission resources, and to improve the reliability and security of supply. The frequency-linked pool rate for unscheduled interchanges, which is an integral component of the new bulk power tariff and trading system, is virtually unheard of outside India. The tariff's main features are described subsequently. Although it encompasses a much wider scope than the regular availability tariffs used in other countries, the new tariff regime is popularly known in India as the ABT (availability-based tariff).

Market mechanism

The market mechanism in India is one of decentralized scheduling, interstate and inter-regional trading, alongside the centralized dispatch of central sector generation at the regional level. This form of market mechanism provides maximum freedom to states. It enables them to make and to be responsible for their own operational decisions, and to bear the primary responsibility for operating at the minimum variable cost. The RLDCs perform the coordination and facilitation role. Each day is divided into 96 blocks of 15-minute periods for the measurement of average frequency and estimation of unscheduled interchanges. Specially designed meters have been installed for this purpose at all interface points. The bulk buyers and the generators provide RLDCs with one-day-in-advance demand and availability schedules. RLDCs then coordinate with participants of the regional power pool to decide the following day's schedules. There is also a provision to enable changes to be made to the schedules if exceptional circumstances arise. The RLDCs are responsible for metering the interchanges and maintaining accounts of the regional pools.

[9] 15% capacity of every central generation plant is unallocated and can be allocated to any state at GoI's discretion.

Interchange tariff

The new bulk power tariff regime identifies the interchanges between the central sector generators and state utilities in two ways. An interchange, which is as per the agreed schedule of dispatch for the period of interchange, is termed as *scheduled interchange,*[10] and any other interchange is called the *UI* (*unscheduled interchange)*. The UI is calculated for a generator as the difference between the actual energy generated and the scheduled energy to be generated during a given period. Similarly, for a user, it is the difference between the actual energy drawn from the regional grid and the energy scheduled to be drawn during a given period. Also, to provide disincentives for reactive power drawls, there are voltage-dependent charges along with incentives for drawing/injecting reactive power into the grid.

- *Scheduled interchange tariff* Each of the entities is allowed a significant latitude to negotiate transactions, which are in mutual interest of the parties to the transactions. Both, (a) non-standard interchange products with market-based pricing and (b) standardized products with cost-based pricing are possible. In the cost-based pricing mechanism, the tariff is in two parts: (a) fixed cost recovered through a capacity charge and (b) variable cost recovered through an energy charge. For the non-standard interchange product, each price element is based on the market and may or may not directly be linked to cost.
- *UI tariff* The UI tariff is linked to principles of grid control tariff with the addition of a frequency-sensitive component. It is based on deviations from the scheduled interchange as well as being linked to deviations from India's nominal frequency of 50 cycles per second (Hz). During low-frequency periods, usually caused by inadequate generating capacity, the UI is priced at the marginal variable energy costs associated with supplying it within the region. However, during high frequency periods, which usually occur when there is plentiful supply of generation, UI is priced at a relatively low cost so that its suppliers may not necessarily recover all their variable costs for these periods. The base UI rate is now 5.70 rupees (initially 4.20 rupees) per kilowatt-hour for

[10] Long-term power purchase agreements, such as National Thermal Power Corporation's bulk power purchase agreements, would be covered under the scheduled interchange.

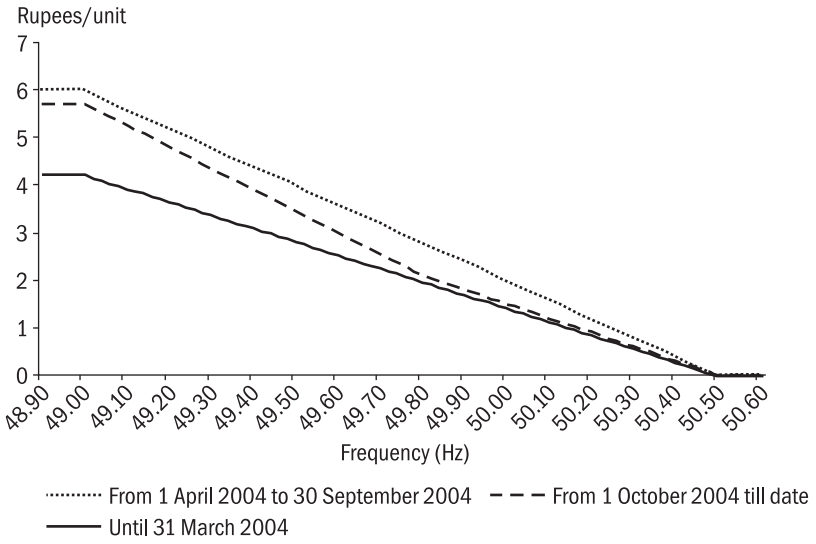

Figure 1 Unscheduled interchange charges and their link to system frequency

interchange at the grid frequency[11] of 49.0 Hz or below, and becomes zero at frequencies of 50.5 Hz and above (Figure 1).

- *Reactive energy* The tariff mechanism includes incentives to encourage participants to provide adequate quantities of power factor correcting capacitors in their systems. When the actual voltage is low compared to the nominal voltage at the point of supply to the utility's transmission system, consumption of reactive power is charged at the equivalent of an average carrying cost of capacitors multiplied by the total reactive power consumption during that period. The same rate will be paid to utilities, which provide reactive power to the transmission grid under low voltage conditions.[12] On the other hand, if the actual voltage is greater than nominal at the utility supply terminal, such absorption of reactive power will also be paid for at the same rate. Imposition of reactive power charges will induce bulk purchasers to invest in and to appropriately operate reactive power compensation equipment. The specified rate is payable/receivable when voltages deviate

[11] Grid frequency for the purpose of these charges will be the average during each of the 15-minute time blocks.

[12] A utility can change the amount of reactive power it is contributing to the system by installing capacitors, and switching them in or out according to the system requirements.

beyond ±3% of normal voltages, and is 40 rupees for each MVARh (million volt ampere reactive hour) exchange, with a provision of 5% per annum escalation from 1 April 2001. The rate is the same for all voltage deviations beyond the normal range.

Transmission tariff

The charges to a state utility for use of the regional transmission system are based on the pro rata share of the total annual carrying cost of transmission-related investments, excluding any investment for coordination or dispatch activities and any facilities that serve only one utility. The pro rata factor is a ratio of each state utility's entitlement of the regional central sector generation capacity to the total central sector generation capacity within the region. The annual carrying cost of transmission-related investments, which serve only one state utility, will be fully paid for by that particular utility.

Generation tariff

The tariff accommodates, with respective values, the interchange of electricity from thermal and hydroelectric sources.

- *Thermal generation* Under the new bulk power tariff mechanism, the fixed and variable cost components are treated separately. Payment of the fixed cost, and thus return on the generating company's investment, is linked to the availability of the plant, that is, its capability to deliver power on a day-by-day basis. The total amount payable to the generating company over a year towards the fixed cost depends on the average availability (megawatt delivering capability) of the plant over the year. If the average, which is actually achieved over the year, is higher than the specified norm for plant availability, the generating company will be rewarded with a higher payment, and vice versa. This is the first component of ABT and is termed as the *capacity charge*. Thus, there is an incentive to generators to ensure, with operational efficiency, that actual availability for generation is above the specified norms.[13] The capacity charges are determined on an annual basis but settled monthly.

[13] The norms for plant availability, above which an incentive would be provided, are specified by the Central Electricity Regulatory Commission.

The second component of ABT is the *energy charge*, which accounts for the variable costs of supply. It is made up of the fuel cost of both primary fuel (for example, coal) and secondary fuel (for example, start-up oil) based on the standardized accounting methodology of the power plant for generating energy as per the given schedule for the day. It is important to note that the per-unit energy charge relates to the scheduled generation and not to the actual generation and plant output.

In cases where there are deviations from the schedule (for example, if a power plant delivers 600 MW when it was scheduled to supply only 500 MW), the energy charge payment would be for the scheduled generation (500 MW) only, and the excess generation (100 MW) would be handled through the UI tariff described above. Hence, if the grid is being injected with surplus power at the time of interchange and thus the frequency is above 50.0 Hz, the UI rate will be low. However, if generation is being provided during a deficit period (in which case the system frequency would be below 50.0 Hz), payment for the extra generation will be at a higher rate.

- *Hydro generation* The tariff methodology for conventional hydro generators is a *hybrid cost allocation tariff,* in which recovery of the annual fixed cost is divided between plant availability payments and payments from energy sales because there is no fuel cost (variable charge) associated with hydro generation. The availability payment is based on the mechanical availability of the plant and ensures full recovery of the fixed costs once the target availability is met. The CERC has ordered the use of a *capacity index*, which is related to the availability of water and availability of the machines. This index ensures that lack of water does not affect the payment of fixed costs to generators when the generator's machines are available. Incentive charges would be paid whenever a generator ensures a higher availability of its plant.[14] The primary (designed) energy charge is linked to 90% of the variable cost of the most efficient central sector thermal unit in the region. This rate is also used for merit order dispatch. Hydro generators also receive benefits for

[14] Currently, the hydro generators get incentive/disincentive on annual fixed cost less primary energy charges, for every percentage of availability above/below 85%.

secondary energy (energy generated in excess of design energy when there is more than the expected level of water flow), which is valued at the same rate as the primary energy. Various tariff principles have been provided for by the CERC to cover different types of hydro stations.[15]

Impact of ABT—experience since 2002

The actual implementation of ABT took a considerable time, reflecting the challenges of implementing fundamental reforms in a federal structure having a number of independent participants with conflicting interests and capacities. The first region to take the lead was the western region where implementation started from 1 July 2002. Subsequently, all other regions (the most recent being the northeastern region from 1 November 2003) have decided to implement the reforms and the new bulk power market tariff regime. Thus, the pricing methodology is being applied to power that crosses state boundaries. The intent is that it should also be applied to intrastate transactions in due course.

Improved trading under scheduled interchange

One of the key changes noted after implementation of the ABT regime has been the improvement in the discipline with which utilities forecast their demand schedules and the generators provide the daily availability of their plants. Based on this data, the SLDCs/RLDCs prepare an optimal generation schedule and dispatch the required generation in line with the economic merit order.[16] This also facilitates better resource planning for the generators and better load management for the utilities.

Majority of the bulk power transactions are under the long-term bilateral PPAs (power purchase agreements). With implementation of the availability-based two-part tariffs under this regime, generators are recovering their fixed costs, independent of the actual generation required. With this change, merit order operation has started in earnest in a way experienced never before in India. This is evident from the increased utilization of the

[15] Pumped storage, run-of-the-river, and reservoir types. These orders can be viewed at the CERC's website. <www.cercind.org>.

[16] 'Schedule', in the Indian context is used to indicate the quantum of planned generation indicated to the load dispatch centre, and 'Dispatch' is the actual level of the load supplied by the generating unit.

more efficient/low-cost pithead plants in comparison to the more expensive plants located at the load centres. For example, generation from a pithead plant (Singrauli) at a PLF of 98.4% is at a much higher level as compared to a PLF of 77.5% for the more expensive variable cost plant located at (Dadri) in the Northern region. Backing down generation during the off-peak hours no longer necessarily results in a financial loss to the generating station, and this neutralizes the earlier perverse incentive towards not backing down.

The two-part tariff for scheduled interchange of power has allowed for an increasing share in power supply for some of the power-deficit SEBs (state electricity boards) while other power-surplus SEBs are able to earn revenues by trading this surplus. Significantly, it appears that more power is being extracted from the same power system as system operation is optimized. In addition to operation of pumped storage and exploitation of available captive plant, part of this apparent power surplus has come from a more efficient draw down of the SEB's entitlements in various central sector plants and IPP (independent power producer) plants contracted under the long-term PPAs.

Improved operation of hydropower stations

Introduction of the ABT regime has greatly helped in optimizing the operation of hydropower plants and enabled effective utilization of the pumped storage facilities. Water is being conserved for peak-hour generation, wherever feasible, in coordination with the demand for irrigation facilities. Pumped storage hydro stations are also able to operate. For example, for the first time after it was commissioned, a 400-MW pumped storage station at Kadamparai in Tamil Nadu is now being operated under pumped storage mode (after ABT implementation started in the southern region in January 2003). The plant began pumping during the off-peak hours and generating during peak hours. The stabilized system frequency helps the operation of the Kadamparai plant whose equipment has been designed for operation between 49.5–50.2 Hz, and the high UI rates recover its cost of pumping and regeneration. This operation has continued even though during the past three years, the region faced drought conditions leading to a reduction in water flows and low generation levels. Figure 2 shows the energy generation in the past three years in both the generation mode and the pumped mode.

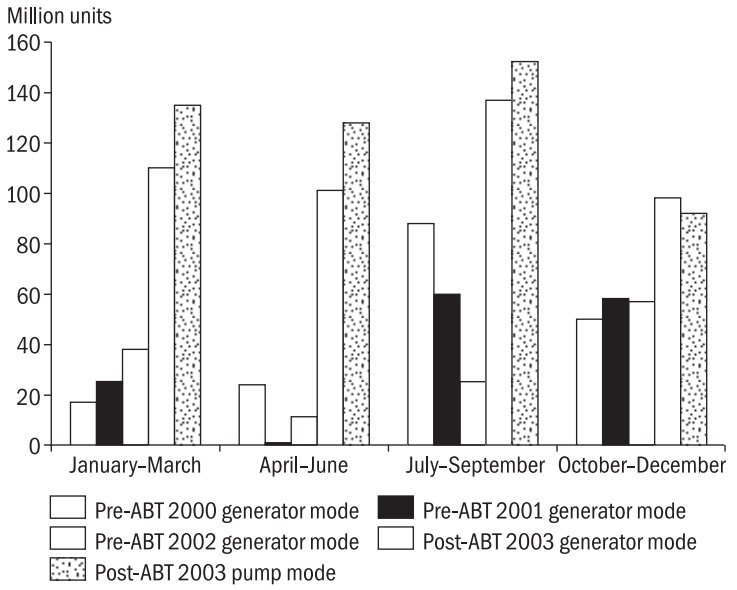

Figure 2 Utilization of Kadamparai pumped storage plant

Improved grid discipline

The UI tariff, with its link to frequency, has improved grid discipline (Box 1) and increased opportunities for power trading as well as harnessing the underutilized decentralized generation, including captive and renewable stations. In order to establish the incentive, the UI-rate at low frequency periods is higher than the variable cost of most decentralized generators and is higher than the total cost of many decentralized generation options.

The UI charges have led off-takers to make contracts for power rather than just abusing the grid and overdrawing their schedules. From implementation till April 2004, 42 026 million rupees have been exchanged across all regions. This constitutes about 12% of the total power bill for scheduled exchange during the same period. Table 1 provides region-wise details of the UI

Box 1 Illustration of the discipline imposed by the new system

Shortly after the ABT (availability-based tariff) was introduced, Tamil Nadu contracted with Kerala for purchasing power from the Kayamkulam CCPP as despite its high cost of 3.80 rupees per unit, this power was cheaper than the cost of overdrawal of 4.20 rupees per unit from the grid from the implementation of ABT.

Table 1 Region-wise details of the UI (unscheduled interchange) charges exchanged between stakeholders from inception of the new bulk power tariff reforms

Region	*UI charges billed* (rupees)[a]	*Amount paid* (rupees)[b]	*Per cent realized*
Northern	28 196	23 027	82
Western	17 262	15 729	91
Southern	12 392	12 392	100
North-eastern	2 590	2 383	92
Eastern	15 930	14 470	91
Total	**76 370**	**53 225**	**86**

[a] Billing up to December 2004 since inception of the new bulk supply (ABT) tariffs
[b] Collection till February 2005 for the billed amount

charges exchanged between stakeholders from inception of the new regime. It also records actual payments made by them against the billing, which stands at a good 86% level. There are about five major defaulters and some of these cases are due to the pending resolution of their power shares with the new states, carved out of the existing states. The CERC, on appeals filed by the RLDCs, has agreed to pursue the defaulting states seriously for as per the grid code, payment of the UI charges has priority over other payments. However, a suitable mechanism for ensuring compliance by states on payment of the UI charges needs to be developed by the CERC, government, and RLDCs.

Improved quality of supply (grid frequency and voltages)

The most significant benefit of these reforms has been a considerable improvement in the grid supply quality, which will help utilities ensure a better quality of supply to consumers. Incentives for better scheduling and penalties for overdrawing have led to a dramatic reduction in frequency variation on the grid. Previously, frequency and voltage fluctuations were significantly beyond the levels expected in most other countries. This improvement has led to enhanced efficiency of the equipment operation (Box 2).

Figure 3 shows the grid frequency in the southern region comparing a week of new tariff regime (ABT) implementation against the same period a year before.

Box 2 Karnataka—impact of improvement in the quality of supply

The city of Bangalore in Karnataka had been suffering from an acute water shortage for many years due to a low-voltage at the booster stations on the T K Hally–Bangalore pipeline. With the recent improvement in voltage at these booster stations, the water supply to Bangalore has increased substantially. Similarly, farmers in Karnataka are now much more satisfied with the supply voltage and frequency. They find an improvement in the volume of water pumped, and it has helped them cope with the limited hours of power supply. Industries like the Kudremukh Iron Ore Company are also able to operate their sensitive machinery efficiently because of the improved voltages, which was not possible before the bulk power market reforms.

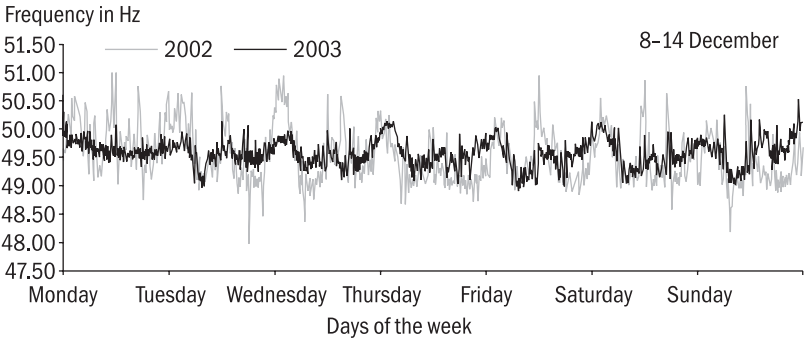

Figure 3 Frequency profile comparison for the southern region
Note Details available at SRLDC website <http://www.srldc.org/ftp/frequency/2003/50TH%20WEEK.jpg>.

POWERGRID has developed a measure of frequency variation, known as the FVI (frequency variation index), based on the variation above and below 50 Hz as measured at 10-second intervals.[17] Table 2 shows the value of this index in the period after implementation of the new bulk power tariff regime and in the same period of the previous year before implementation of the ABT.

Similarly, there have been substantial improvements in the voltage profiles on the grid and all regions have shown improvements, as can be seen in Figure 4.

[17] $\text{FVI} = \dfrac{10\sum(F-50)^2}{24 \times 60 \times 6}$ where, F is frequency measured at 10-second intervals.

Table 2 Frequency variation index before and after ABT implementation

Region 2002/03	*Frequency variation index*					
	*Prior to implementation**			*Post-implementation period*		
	Average	*Maximum*	*Minimum*	*Average*	*Maximum*	*Minimum*
Western	11.97	20.57	5.10	4.16	7.17	1.81
Northern	3.61	6.72	2.30	2.22	5.02	0.88
Southern	26.77	44.62	4.87	0.99	2.51	0.25
Eastern	10.35	13.40	8.71	1.91	4.08	1.22

* Based on comparable months according to the data available.

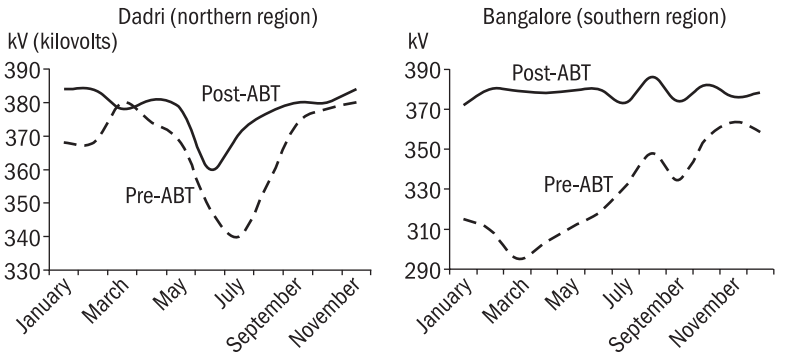

Figure 4 Minimum voltage profiles before and after ABT implementation (in 400-kV system)

There has also been an improvement in the levels of the peak demand met. Even when the effect of additional generation is isolated, substantially higher peak demand has been met while using the same generation available—as can be seen from Figure 5 for the eastern region where no generation was added during the period.

Efficiency gains

The most important benefit of the ABT to date is improvement in the supply availability and quality for consumers. Utilities are in a better position to know, well in time, the availability of generation, and although load shedding is still inevitable, they can plan their load scheduling better and give consumers more

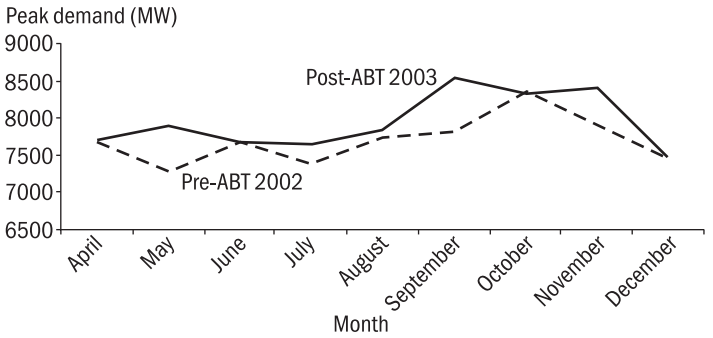

Figure 5 Peak demand met—eastern region

certainty. With a more consistent system frequency, voltages have improved and it is easier for utilities to provide supply to consumers with fewer voltage fluctuations. This results in more efficient operation of all types of electrical plant, machinery, and equipment. For example, increased water delivery for the same power leads to financial and economic benefits for India. Other financial and economic gains accrue from the following factors.

- It is now possible to set the under-frequency load shedding relays properly, and to get them to act effectively and save the system from collapse in case of a serious contingency (Box 3).
- Less stress is placed on the power equipment, which will consequently have a longer, useful economic life.
- The state's allocated share of power from different central stations now has a real meaning, both operationally and commercially. As opposed to the pre-ABT commercial mechanism, which recognized only the actual energy drawals, not

Box 3 Win-win situations

On the day of the last World Cup Cricket Final, Karnataka overdrew as much as 600 MW. Hydrostations were run in the neighbouring states to supply this power to Karnakata as 'unscheduled interchange'. (Operationally, this was not unscheduled as it was planned in advance, but the ABT regime afforded these states the opportunity to trade this power at UI rates.) This enabled Karnataka to ensure that there was no load shedding during the critical period and it improved the state's image, while the neighbouring states were well remunerated for providing short-term power, which would not have been possible under the previous tariff regime.

the share and schedules, now all states can either fully use their allocated shares of power from the central station or trade for any unused share through the UI mechanism or by bilateral transaction.

Reasons for mixed performance in different regions

The new tariff regime has not produced as much impact in some regions as in others. Although some of these differences are due to the grid characteristics, the major reasons for mixed performance have been the difference in preparation of the participating members in a region and determination to make the maximum gains from this new bulk supply tariff regime. Those achieving the highest gains have prepared simple decision-making charts to help the load dispatch centre staff to make effective decisions even at night, without waiting for approval of their senior officers. Further, RLDCs have been prompt in billing the UI charges and members have been prompt in paying their dues. For example in case of the southern region, payments against the UI charges are 99% of the billed amount as against the national average of 89%.

Issues requiring further resolution

The implementation experience, to date, has also brought into focus some issues that need further study and resolution. The CERC, GoI, and the market participants will have to resolve these issues.

- Some power stations are still working to maximize their PLF, the traditional measure of plant performance, rather than their availability and commercial efficiency. The performance incentive for generating company and their employees on performance needs to be changed to ensure that the incentives are aligned to the ABT system.
- Some of the generators still do not operate in 'free-governor' control mode. If stations were allowed to operate in the free-governor mode, the grid frequency could be smoothly controlled with automatic matching of the generation with the load demand. Most state-owned generating stations in the southern region are now operating in free-governor control mode. This is one of the reasons for the reduced grid frequency fluctuations in the southern region, but greater efficiency gains could be achieved if the other generating stations were also controlled like this.

- To be fully effective, the ABT system needs to be implemented at an intra state level as well as at the interstate level. Several states are already working on this and installing the necessary boundary meters to be able to allocate the UI charges amongst the distribution companies.
- As the ABT becomes accepted and grid discipline improves, the frequency-related element of this tariff may become unnecessary. Further, there is likely to be more power trade with the advent of open access mandated in the Electricity Act, 2003. This may necessitate changes to the national tariff regime and a review of the ABT mechanism. Thus, periodic reviews of the tariff system, the incentives therein, and the overall operation of the grid will be necessary if the system is to support the development of the power markets in India.
- The CERC and RLDCs should work on a mechanism to ensure that payment of the UI charges continues at the high levels seen over the past couple of years. The CERC may have to levy strict penalties on defaulting participants.

Summary: a win-win situation for India's power sector

Implementation of the ABT bulk power tariff regime has been possibly the most significant practical development in the power sector in India in the past decade. It has improved the quality of power supply dramatically, brought the much-needed commercial discipline among the generators and utilities, and laid the foundation of a power market. The ABT is already leading to improvements in what were highly volatile grid frequencies. Consequently, it is most likely to help prevent system collapses and lead to a more efficient use of India's current installed generating capacity. The impact of the new regime will also encourage increased investments in the power sector and will provide incentives to generators to enhance the output capacity of their power plants. This, in turn, will enable more consumer load to be met during the hours of peak demand. Also, because of tariff arrangements, generators will now back down generation during off-peak hours, which will result in economic benefits for India.

The ABT regime has also encouraged interstate trading and merit-order dispatch, which will minimize the financial cost of power for the bulk purchasers with further benefits for India's economy. However, the real winner will be the consumer who in the past has suffered as a result of grid indiscipline. With proper

control of grid frequency and improved system voltages, it will be easier for utilities to provide the consumer with more reliable supply of power, allow for more efficient use of equipment, and reduce the costs of back-up power supply reduced. Overall, reforms in the bulk power supply tariffs will result in an installed generation capacity supplying more energy at a lower cost. The new tariff will also result in less system component damage, increased interest by would-be investors, and substantial benefits for the Indian economy.