

Transmission and Distribution of Electricity in India Regulation, Investment and Efficiency

Yoginder Alagh

Chairman, IRMA and

Former Minister of Power and Science Technology of India

Introduction

Adequate investment in capacity and efficient working of transmission and distribution systems in developing economies with high growth of electricity demand are important objectives. Market oriented reform processes are required both for the creation of capacity and for electricity as a product. This invariably requires unbundling of transmission and distribution capacities from generation capacities. In this context alternative governance structures need to be explored. Concretely there has to be major emphasis on development of mechanisms of moving from State owned centralized planned and public sector owned electricity utility systems to public private partnership models for transmission and distribution. Transparency and different bidding procedures are essential during the transition.

Overarching legislative back up to the process and the influence of political interest groups which arise including the need to protect the interests of small consumers and backward regions in a public utility is a policy management challenge in the larger context in which the transition takes place. Examples of the political process of successful management of the newer legislation for PPPs in developing economies are not that many and need analysis as best practice cases.

Regulatory mechanisms including the rules for open access, the development of availability tariffs for inter regional transmission and time of the day and spatially differentiated pricing systems for distribution of energy in large federal countries are discussed in the policy literature but not that many successful examples are there. Examples generated from the literature generated by forward looking regulators and legal case literature, need attention. Resistance to such 'efficient' systems, both at the level of regulators finding cost plus systems more convenient, parastatals taking refuge in 'practical' alternatives, but in fact possibly increasing their monopoly power, need to be focused to show the ongoing nature of the problem. The importance of such systems for interregional grids across national borders and the superiority of rule based systems as compared to Bismarckian diplomatic negotiations needs exploration.

Problems of technical management of efficient transmission and distribution systems and in particular of integrating decentralized generation through mini hydel, wind or photovoltaic sustainable generation mechanisms with grids are of interest. Case studies of captive and backup

generation capacities with spot trading electricity markets through real time provide a backdrop for this analysis.

Financing systems, including viability gap funding in PPPs, both in unbundling reform and in project execution when regional or equity considerations become important in politically acceptable solutions requires work. Newer financial products for funding and risk mitigation which work need to be outlined. In addition to the national level, the integration of such systems with reform at the global level, including the OECD and G20 requires to be explored to integrate state of the art practice in the reform process.

Finally fast moving technological change including modern information system practices and the need to improvise and integrate system designs with local practices, histories and management cultures, as emphasized in the case study literature by experts and scholars like Pierre Audinet (2000), Joel Ruet (2005) and K.P.Kannan (2005) for example, needs attention to keep the process on track.

This paper was originally designed to provide a general framework for this discussion, but later was mandated to discuss these issues in the context of Indian experience.

The Inherited Structure and the Larger Picture

The inherited model of energy development and consumption in India was that of a centrally planned system in largely publicly owned and operated electricity and energy system, with a substantial Central Government capacity and the rest in State Electricity Boards (SEBs). The driving force of this system was achievement of generation targets and meeting the objectives set up by administrative and political leadership groups, rather than commercial objectives (For a description of the internal logic and system features see Joel Ruet (2005) and K.P.Kannan (2005). They have also shown on the basis of field work that reform is not possible by outside intervention, without an understanding of the system of organization and incentives and disincentives actually working in State Electricity Boards in India).

Growth of capacity and generation of electricity in the period of the reform process since 1991 slowed down. Thermal capacity which grew by 160.23% in the decade 1980/91 only went up by 60.70% in the decade of reform (Table 1). In other words with a substantial increase in the growth rate of the economy, thermal capacity growth was only 38% of the decade before privatization. Since thermal capacity was a large part of the total the growth of total generation capacity in the Nineties was around half that of the previous decade. The situation in this decade up to 06/07 with a growth rate of 27.31% was worse. In this decade growth of hydel and wind capacity goes up substantially, since it was 33.51% in the decade of the Nineties and is already at 38.25% until 06/07. This is particularly true of wind capacity of which growth is encouraging and which stands at 9000MW now.

Table 1

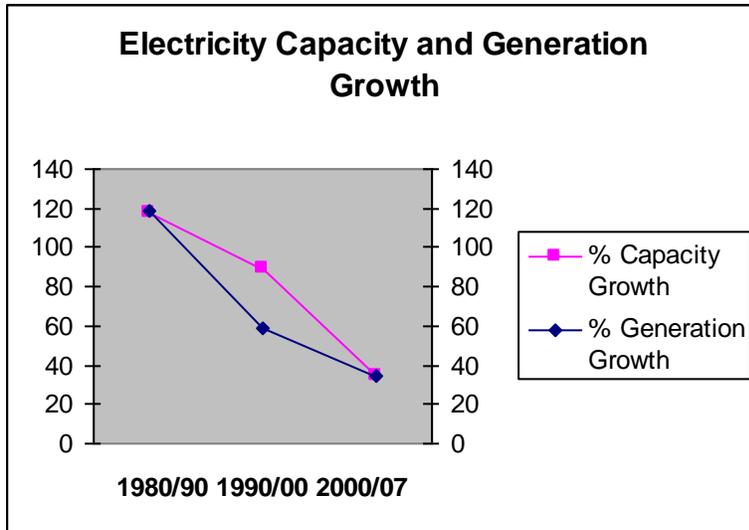
Growth of Capacity and Generation of Electricity									
(%Growth in Decade)									
S,No	Period	Generation Capacity				Electricity Generation			
		Hydro+wd	Thermal	Nuclear	Total	Hydro+wd	Thermal	Nuclear	Total
1	2	3	4	5	6	7	8	9	
1980/81-1990/91	59.32	160.23	61.67	118,15	26.90	204.24	103.33	118.79	
1990/91-2000/01	33.51	60.70	93.3	58.71	3.9	118.32	177.05	88.99	
2000/01-2006/07	38.25	27.31	34.5	30.22	52.3	31.22	10.06	33.63	
Source: GOI, 2008a, p.S 26									

How did India energize its growth with this dismal performance in the electricity sector capacity growth? There were three factors at play which redeemed the failure. First generating units were run better, not only in the Central Public Sector, but also in the States. The plant load factor in the electricity sector improved and generation was growing faster than capacity. Second ‘efficiency led economy level growth’ was accompanied by substantial gains in energy efficiency in the power consuming sectors. For the manufacturing sector this emerged partly as a matter of strategy since the second half of the Eighties of the last century and partly from the X efficiency factor. Third there was a substantial increase in capacity in the non-utilities captive power sector as the grid failed to supply power.

Table 1 shows capacity growth which was at around 120% in the decade of the Eighties went down to around 60% in the decade of the Nineties and was only around 30.2% in the period 2000/07. Generation growth was also around 120% in the Eighties and so capacity use was roughly constant. But in the Nineties at around 90% it was much higher than expansion of capacity at 60%, showing a substantial increase in Plant Load Factors. However in this decade the slack seems to have been used up and both capacity and generation growth are similar at around 30 to 33%. The Chart below describes these trends. The Plant Load Factor on an average is around 75% for an average hydel year and this is high since planned shutdown for repair is

also necessary. Generation growth is now around 5 % annual as compared to around 9% in the last decade and a near crisis situation is emerging.

Chart 1



Source: Y.K. Alagh (2009, CIGI, pp.234-235 and 2009b)

There is some difficulty on recent figures, but if we take the higher Ministry of Power, as compared to the lower Central Electricity Commission's figures, the following picture emerges for the period 2006/07 to 2009/10, which also shows generation growth slightly higher than capacity:

S.No	Capacity/Generation	Growth Rate		
		07/08	08/09	09/10 ¹

- | | | | | |
|----|-------------------------------|------|------|------|
| 1. | Capacity Growth (Utilities) | 8.09 | 3.50 | N.A |
| 2. | Power Generation by Utilities | 7.74 | 5.98 | 6.00 |

Source, GOI, Economic Survey, 2009/10, pp.237, A27

1. refers to April-December 09/10 over 08/09

According to the Planning Commission, 'The likely growth of supply in first three years of Eleventh Plan works out to 5.59 per cent as compared to actual growth of 5.32 per cent in The Tenth Plan period. But generation efficiency seems to be peaking as a source of growth since plant load factors now are not increasing (Table2).

Table 2

Plant load factor of Generating Stations
(In percentage)
Year Central State Private Overall

2006-07	84.8	70.6	86.3	76.8
2007-08	86.7	71.9	90.8	78.6
2008-09	84.3	71.2	91.0	77.2

Source: GOI, 2010, p.322, Table 15.10

As regards transmission and distribution, India by now has one of the largest HVDC transmission capacities at around 1500 CkM, which is to rise to 1600 Ckm (Table3). 765 kV lines are at 1088 CkM and will reach around 2500 CkM. 400 kV lines around 17000 CkM and 220kV lines at around 17000CkV will be doubling in the next two years

Table 3

Targets and Achievements of Transmission Capacity Addition
(In CkM)

Voltage	Programme of Eleventh Plan
Targets Achievement (Up to October 2010)	Anticipated Achievement (At the end of Eleventh Plan)
HVDC 5,400 1,480	1,600
765 kV 5,273 1,088	2,773
400 kV 47,446 16,982	40,000
220 kV 30,396 10,813	24,300

Source: GOI, 2010, p.326, Table 15.11

The development of a national grid facilitates optimal utilization of resources by bulk transfer of power from surplus regions to deficit regions in the country as well as to facilitate scheduled/unscheduled exchange of power between regions and has been an objective from 1997. India has the largest capacity in High Voltage DC lines in the world. Inter-regional transfer capacity currently available is 20,800 MW and will go up to 32,650 MW by 2012. During the last two years the Power Grid Corporation of India Limited (PGCIL) has added 5,900 MW of transmission capacity. This capacity is becoming critical as open access becomes operational. India's North Eastern (NE) Region is a hub of hydel generation. A major part of this power is exported to the power deficit Northern and Western Region. Considering the contingency and reliability needs and total power evacuation from the NE Region through what is called the Chicken neck area, five to six HVDC lines (800 kV) and three to four Extra High-Voltage Alternating Current (EHVAC) lines (400 kV) would have to be established to eventually evacuate about 50,000 MW in NE Region and 15,000 MW from the Sikkim/Bhutan area.

These very substantial achievements co exist with major problems.

“Although the power transmission segment has been opened to private investment in 1998 there has been only a limited success in attracting private investment.” (An official assessment according to the Planning Commission, this year, GOI, 2010, p.327).

T&D losses at the national level were at 29 per cent in 2006-07 and are expected to fall to 27 per cent in 2007-08. But AT&C losses are reported to be over 30 per cent. While T&D losses are technical losses incurred in transmission and distribution of electricity to the consumer, AT&C represents aggregate technical & commercial losses which estimates commercial losses (covering theft and deficiencies in billing and collection) besides T&D losses and is a true indicator of total losses in the system (1- billing efficiency X collection efficiency).

Table 4

Financial Performance of 20 Major States excluding Delhi and Orissa

Particulars	2005-06	2006-07	2007-08	2008-09 ¹	2009-10 ²
Energy Sold (MU)	3,51,200	3,90,232	4,29,709	4,69,427	5,25,140
Energy Sold/ Energy Available (percent)	65.40	65.41	72.42	74.72	76.27
Sales Revenue (Rs.00crore)	1014	1173	1321	1542	1777
Commercial Loss (Rs.00crore)	208	284	338	409	384
Average cost of supply (Paise/Kwh)	368	391	405	433	429
Average tariff (Paise/Kwh)	289	301	308	329	338

Source: GOI, 2010, Table 15.3

Notes: 1.Revised Estimates 2.Provisional

This leads to high financial losses. The total loss, incurred by the distribution companies, taken together is estimated at about Rs. 40,000 crore in 2009-10. It is likely rise to even higher levels because of the increasing share of short term purchase of power at high prices. The weakest part of the power sector in India remains distribution which is incurring large losses. This description highlights the considerable achievements of the Indian transmission system and its major problems to which we will now turn.

Market Oriented Reform: Capacity Creation and Electricity T&D; Summary Description

Interstate trade in power started on large scale in 1997/98 and soon after merit order pricing also started. Agencies were mandated to back up interregional power trade and a retail market in power was underway. But the institutional systemic backup was weak. Before we discuss transmission and distribution reform, reform of the traditional system of electricity generation and supply was attempted from 1991. The evolution and main features of the process in terms of facts have been summarized well in a monograph by Kandula Subrahmaniam published by the Center for the Advanced Study of India (CASI) of the University of Pennsylvania

(K.Subrahmaniam, 2004). Titled “Thirteen Years of Power Sector Reform in India: Are We Still Groping in the Dark?” highlights of the reform process in that period were listed. The reform process for this sector was from the beginning not very successful. In some detail Subrahmanian describes that “at the beginning of the 1990s, when the process of economic reform and liberalization was initiated, it was believed that since the government had to cut back on its expenditure, it would be necessary to end its monopoly on the power generation industry. It was widely expected that private investment would take up the slack left by the government. (The) government under the Congress regime of Prime Minister P. V. Narasimha Rao and his Finance Minister Dr. Manmohan Singh...committed itself to a World Bank-International Monetary Fund (IMF) inspired economic liberalization program as part of its New Economic Policy (NEP).Following this, a policy of opening electricity generation to private participation was announced by the central government in October 1991. It was suggested that the only possible source of funds was the private sector and since it was unlikely that the Indian capital market would be able to make a significant contribution, foreign private investors would be welcomed” (Ibid.,pp.23-24).

The 1991 policy set up the structure of Independent Power Producers (IPPS). These followed an American legislation which was meant to allow renewable energy producers to enter the power grid. “To say that the 1991 power policy was not well conceived would be an understatement. According to Y. K. Alagh (the power minister under the Gujral government), former finance minister Manmohan Singh “has been generous enough to admit that the power policy of the early nineties was a mistake.” Dr. Manmohan Singh spoke out against the reforms for the first time in 1996 at a seminar organized by the Tata Energy Research Institute in New Delhi. In an interview given later, Dr. Singh stated:

I think we should have evolved a more coherent policy for economic reforms. Reforms were “...essentially a case by case liberalization. In the power sector, problems like Enron and now Cogentrix would have been avoided if we had evolved a more holistic approach.”(K.Subrahmanain, CASI, p.76).

The present policy system is governed by the overarching Electricity Act, 2003. The Act replaced existing legislation like the Electricity (Supply) Act, 1948 (which had earlier effectively nationalized the sector), and introduced a host of reforms like unbundling of State Electricity Boards (SEBs), open access, competition, development of market mechanisms and independent tariff setting and regulation. It also paved the way for greater private sector participation into a hitherto public sector dominated space.

The reform and restructuring of the electricity sector to bring it in line with global practice by the Electricity Act of 2003 has by now made very substantial progress but the background stated above is of interest in analyzing the problems that remain. The Central and State Electricity Regulatory commissions and the Appellate Tribunal for Electricity (ATE) are in place. Most SEBs have been disaggregated into Generation, Transmission and Distribution Companies, various policies like the National Electricity Policy, Tariff Policy, Rural Electrification Policy mandated by the Act, along with Rules and Regulations are also in place. Trading licenses have been issued, power trading has commenced and about 3% of the total power produced was traded in 2009. Two power exchanges are in operation and traded 217 MUs in February, 2009. The

National Grid Code and most State Grid Codes were notified. There were however many unresolved problems.

The bulk of power distribution in India consists of the erstwhile SEBs and is still state owned. This state owned power distribution continues to lose large sums of money every year as we saw and have high AT&C losses. A key intent of the unbundling mandate of the Act was to eventually privatize distribution in order to speed up their return to health. However, so far only Delhi and Orissa have been privatized. Unlike telecom and airlines where competing private entrepreneurs were brought in with good results, in case of power distribution the wires business being of its nature a natural monopoly, the only way to bring in private enterprise without duplication is by privatizing the erstwhile state discoms as has been done in Delhi with great success using a PPP model. It is now hoped that the Delhi experience and the outstanding performance of the private distribution licensees of Mumbai, Kolkata, Ahmedabad and Surat whose robust business model has been sustained over a century will lead to acceleration of distribution privatization in the country in the near future and open up huge investment opportunities for both suppliers and utilities. Apart from reduction in AT&C losses, the desired state for distribution is separation of “wires” and “supply”. “Wires” is a natural monopoly and can be regulated. “Supply” on the other hand can be competitive thus bringing in lower tariffs for consumers. Even wires can be further disaggregated into “ownership”, “operation”, “O&M”, “Metering”, “and Billing” and be offered to different entities having these core competencies. This is a development that will require legislative changes, as well as healthy distribution systems as a precondition.

Utilities wishing to involve the private sector efforts in reducing distribution losses may either go for privatization of certain areas, or resort to franchise arrangement for services such as metering, billing and revenue collection. The major cities, where distribution has been privatized are Kolkata, Mumbai, Delhi, Greater Noida (UP), Ahmedabad, Surat and Orissa. T&D losses in the cities managed by private companies are noticeably lower than the publicly managed utilities. The reported loss levels in these cities in 2008 are: CESC Kolkata 14.3 per cent; AEC, Ahmedabad 11 per cent; NDPL, Delhi 18.5 per cent, CESC, Noida 8.0 percent (only distribution losses). More recent experience suggests that initial results of the franchising process in difficult areas with large scale power thefts like Bhiwandi in Maharashtra are encouraging. UP decided to hand over distribution in Agra and Kanpur to a private company on a franchise basis. The Agra system has been finalized and the Ahmedabad based company Torrent has been awarded an input based franchisee management contract of a kind described below for Delhi. AT&C losses have to be reduced to 15% in seven years.

Some of the best practices adopted by various utilities in the distribution sector include in: Delhi (NDPL) Revenue Management and Monitoring SAMBANDH (Solution for All Modules in Billing System) an IT based application designed to provide a comprehensive and centralized record of the billing and revenue recovery from various consumer segments: Andhra Pradesh (SPDCL) Customer Information Management and Analysis Consumer Analysis Tool (CAT): Bhiwandi for monitoring, metering, billing and collection. Maharashtra Torrent Power AEC Limited Distribution, Management (Franchisee) Bhiwandi, Experience with a total consumer base of 140,000 consumers and a geographical area of 721 square kms largely comprising power looms. known for high distribution, losses, poor collections and poor state of infrastructure

(Approx. Rs. 8 billion pending arrears to the utility): Assam- three distribution companies, Distribution Management (Franchisee)-Single Point Power Supply (SPPS) Scheme- rural consumers are provided with quality supply and quality services through rural distribution franchisees operating on behalf of the three distribution companies: Karnataka Bangalore Electricity Supply Company Limited- Rural Load Management (RLM)-Irrigation pumping loads is controlled by using Programmable Logic Controllers (PLC). PLC is used for alternate switching in or out IP loads as per demand schedule to facilitate continuous 3-phase power supply to non-IP loads: Uttar Pradesh Noida Power Company Limited-end-to-end GIS solution for analyzing and optimizing power distribution network. GIS developed and deployed to detect network as well as commercial losses: Computerized spot billing is now common, as also conventional applications like inventory management, etc.

There are therefore many interesting applications underway, in spite of the slow process of reform at the macro level and in fact official agencies expect the accelerated reform programme under way to make progress faster. However it also needs to be noted that the separation of transmission and distribution in terms of unbundling is still not a complete process. According to the Planning Commission website (www.planningcommission.nic.in) thirteen out of twenty two States have separate Transmission and Distribution Companies, although the major States are covered.

We now attempt to discuss the major aspects of Transmission and Distribution reform in terms of details of program development and execution to draw implications for acceleration of the process and lessons elsewhere. We discuss the following specific issues;

1. Unbundling Structures; Transparency; Bidding and PPPs: Access
2. Reforms and Political Backup, Legislative Backup
3. Regulatory Mechanisms and Tariff and Pricing Formulations

There is some inevitable overlapping. The discussion is on India and selective. The focus is on contemporary problems, but wherever needed the past is referred to if it is important for understanding the present stalemates and possibilities.

Unbundling Structures

Since India is a federal country, while The Electricity Act 2003, provided the overarching framework there were many interesting variations in the unbundling structures experimented with. Some in fact were thought of in detail but not wholly implemented.

For transmission the entire country has been divided into five regions-Northern Region, North Eastern Region, Eastern Region, Southern Region and Western Region. Power supply to end consumers such as domestic residential connections, industrial load, agriculture load, public street lighting etc is made by Distribution Companies (Discoms) which hold license to make such supply within a specified geographical area.

The power demand of a distribution Company was categorized into three different categories:

- Discoms generally procure base load power requirement through long term Power Purchase Agreements (PPAs) normally having 25 years contract period.
- For seasonal loads, the Discoms, procure power on a short term basis which is usually a period of less than a year. At times Discoms buy such power only for part of the day to meet their specific requirement Say night power to meet agricultural load.
- Daily fluctuating load or unexpected increase / decrease in loads which can't be predicted accurately on a periodic basis and needs to be managed on day to day basis. This is managed by procuring power from Power Exchanges or traders as well as over draw from the grids i.e. Non – scheduled drawl from the grid which are settled through Unscheduled Inter-change pricing mechanisms.

Different methods were used to unbundle (S.Sinha, 2003). The original Orissa experiment for privatization was not well structured and led to hardly any improvement in losses and a consequent blame game at different levels. The Delhi privatization was an interesting experiment, replicated in other cases. The reduction in loss levels/efficiency gains to be achieved was to be determined by competitive bidding. 51% equity shares would be offered to the winning bidder at face value. The AT&C loss defined above, which in Delhi's case was very high was the measure of overall efficiency and the basis of tariff determination and incentives. Subject to this a normal rate of return was assured. Bulk Tariff rates were used to transfer electricity to the Discoms.

A different experiment was designed in Karnataka in which the private party would get a base distribution margin and an incentive. The distribution margin was based on a bulk rate but would include political risks including inability to raise tariff, political pressure on worker wages and other contingencies. The incentives were designed on various technical efficiency parameters. Penalties were the inverse. The scheme was not implemented with a change in Government.

Earlier experiments were designed, for example in Rajasthan, in which the private party would bid for the assets of the transmission and distribution company subject to conditions on tariffs and work force reduction for the transition period. This was also not implemented.

The Electricity Act 2003 has introduced open access to transmission and distribution system where any one that has surplus power or one who has requirement of power can pay applicable transmission and distribution charges and use the transmission and distribution for sale directly to consumers or purchase directly from generators. Initially, power trading was in the hands of state owned companies such as Power Trading Limited and NTPC Vidyut Vyapar Limited. However, with increasing awareness amongst generators and consumers about the power sale and purchase using the open access facility, the number power trading entities has also increased. Today, there are many power trading firms from the private sector operating in the country.

With the advent of electricity exchanges in India in June-2008; the whole scenario of power trading changed which were earlier limited to bilateral contracts and Power Purchase Agreements (PPA). Given the limitations of long-term bilateral contracts and banking arrangements for meeting short term power demand, power exchanges came as the right answer providing the solution for short term power demand at a price discovered through competitive bidding on electronic system. At present, there are two power exchanges operating in the country. Power trading on Exchange platforms is limited to Day-ahead and Week Ahead power contracts. Going forward, contracts for month or longer duration are also expected to be introduced in the market. During monsoon period, on days when there are heavy rains in some of the states, the prices on the Exchanges are generally low reflecting the low demand and greater supply. Similarly, during high summer season, the power prices are generally high reflecting high demand of power due to Air-condition load. There is also a facility of drawing more than the scheduled contractual quantum by the Discoms. Over draw is permitted without any limit if the system frequency is within comfortable zone (say above 49.7 Hz). However, if system frequency falls below the threshold, the over draw becomes stringent and is charged at a floating rate (Unscheduled Interchange rate or UI rate) which increases with the fall in frequency and vice versa (UI rate is '0' at a frequency of 50.2 Hz pointing to the fact that the system is in high surplus condition and it goes as high as Rs.17 per unit at a frequency of 49.2 Hz or below indicating that the power demand is very high and over draw needs to be discouraged.)

The Electricity Act (2003) mandates non-discriminatory open access for inter-State as well as intra-State transmission and distribution networks is provided by the Utilities. In the case of distribution utilities, Open Access was to be introduced through regulations, in a phased manner by the State Electricity Regulatory Commission (SERC) and the Act mandated that by January, 2009 open access would be available to all the consumers who require supply of electricity with the maximum power to be made available at any time exceeds 1 MW. The CERC has issued detailed regulations for open access and 23 SERCs too have issued relevant regulations. Most of these SERCs, also notified charges relevant to open access.

Reforms and Governance

It is obvious that in recent years considerable advance has been made in unbundling the system and involving private players and economic incentives and disincentives in electricity markets. But its weaknesses in terms of performance have been noted and while the islands of change are now more than best practice cases, the momentum needs acceleration. Very recently the Planning Commission has the following critical assessment; 'A robust trading system is very important for a free and fair competitive electricity market operation. Though most of the supplies of electricity are under long term contracts, electricity is also traded on a short term basis. The volume of such trading has increased substantially and trades are occurring at very high prices. The Unscheduled Interchanges (UI) mechanism, meant to ensure grid discipline (described above: author's insert), is being used by many state power utilities as a trading platform and this is one of the reasons for trading at high rates. Trading of power at high rates has a distortion effect since state utilities are paying very high prices for such purchased power and not reflecting this in the tariff charged to consumers. This will lead to large financial losses which will have negative consequences on the sector. This problem needs to be tackled by state

governments on a priority basis. Ideally, surplus power available with merchant plants should be sold to large consumers via open access. However, the open access provision in the Electricity Act has not been effectively operationalised.’(GOI, 2010, p.328)

Why does India like many other developing countries find it difficult to cover the last mile in accelerated reform? This is not a technical problem alone since the best practice cases have been listed and more examples will follow. Examination of recent history and structures show the basic forces at play. There are examples of governance managed for change and the other way around. It is important to analyze these in larger systemic terms rather than technical matters alone. Reform to be enduring will have to be at both technical and political levels.

According to Subrahmanian, “..by 1996, the Government of India (GOI) realized that their generation tariff policy was flawed and similar problems needed to be avoided in the case of transmission...The central government, in parallel, was working out the technical feasibility of amending the act to allow private investments in the transmission sector.” The original Transmission Bill was introduced in 1996 was seen through a Parliamentary Committee which was very cautious, particularly on private agents running an energy grid. The problems were political and since they were not resolved, the technical solutions don’t work. The Left had genuine concerns on public control of energy wheeling in privately constructed systems and they were fully met in a period of almost a year. There were no short cuts in these issues and the quick fix comes unstuck. A The Opposition MP Jag Mohan chaired the Parliamentary Committee which patiently and laboriously saw through these objections, supported by the present author as Power Minister. Finally the Bill was approved by the Parliamentary Committee unanimously, which later led to support for reform oriented provisions in legislation and practice and finally in the Electricity Act,2003. Based on this policy success foreign investment in transmission was possible. Private investment in transmission, power trading and other features were to follow. There were however problems created in this process and the momentum dried up.

Contrast this with legislative attempts at fixing a minimum price for delivered power, the failure here leading to high AT&C losses listed above. This has been a vexed question for almost a decade and yet no one has seriously commented on the political failures, as shown by legislative glitches. The original legislation for the CERC had two essential features in it. It for the first time laid down that a minimum price of one and a quarter rupee per unit of electricity will have to be paid by law. Second it said that the decisions of the CERC would be mandatory. The author’s predecessor was not allowed by Parliament to table the Bill, since it was genuinely controversial. On 14 August 1997, as Power Minister the author tabled the Draft Bill in the Lok Sabha. The successor Government, we believe wrongly and I said this to the then Power Minister, the late Kumaramangalam, who was a friend, instead of politically managing the Bill brought out an administrative Ordinance, which was a ditto copy of the act introduced in Parliament on 14 August 1997. Two Chief Ministers, Mr. Badal of the agriculturally rich State of Punjab and Madam Jayalalita of Tamil Nadu, important parts of the then NDA coalition protested in public on the minimum power rate and the mandatory powers of the CERC.K.Subrahmanin notes’ The Tamil Nadu government had opposed the 50 paise concept even during Alagh’s tenure, and wanted this condition to be dropped.’ (p.60). The Ordinance was crippled and the vagueness continued in all subsequent legislation, including in the Electricity Bill and leads to the outcomes

even today. This month the Planning Commission notes' Under the provision of the Act, the power tariff for all categories of consumers was supposed to be brought within 20 per cent of the average cost of supply. This has not happen. A great deal of effort is required for revision of agriculture tariff and timely payment of committed subsidy by the States to ensure healthy power utilities.'(GOI, 2010, p.328)

The political steps at that early stage led to large scale commitments of FDI in the Power sector and also considerable investment in the period 1996/98, including the only private sector large transmission project under operation, namely the National Grid of UK's Transmission Project in the Mangalore STP. It is now being said in official documents that the Tala transmission project is the first such project. "Although the power transmission segment has been opened to private investment in 1998 there has been only a limited success in attracting private investment. The only public-private partnership project – the Tala transmission system – has been operational since May, 2007. (GOI, 2010, p.327-328)." This is incorrect. The first project was approved and implemented in the late Nineties, but once that reform was given up, the memory of the investment also vanished. In 1997 FDI approvals reached Twenty Five billion rupees (approximately US \$ 675 million) from less than a tenth of that earlier and actual inflows reached around Ten billion rupees from nothing earlier (In 1997/98 the exchange rate was US \$1=Rs.37.17). In his analysis, K.Subrahmanian notes 'The framework of this draft legislation(Parliamentary Committee approval to the Transmission Bill discussed above; parentheses added) was used to approve the first major private transmission private sector Mangalore project in India in 1997, by Y.K.Alagh as Minister.'(K.Subrahmanian, p.40-41) Subrahmaniam notes that 'The National Grid of the UK, which was to execute the Mangalore transmission project, is the only foreign utility company in India maintaining operations to date. That (the legislation) was cleared only in 1998, and to date there have been no private investments in the transmission sector. (p.41)'. Foreign Direct investments dried up in the period 1999/2005 and already by 2001 was close to zero. Approvals declined to less than a tenth by 1998 and reached close to nothing by 2004 and so did actuals. The legislative policy failures and management of the political fallout has tremendous consequences. So do successes in political management. There is now revival in FDI in generation projects, but not in transmission and therefore the lament of the Planning Commission this month on limited success in private investment in transmission.

Power Trading and Pricing

With growth of power market, power trading activity and Power Exchanges, have enabled availability of power sending signals to market participants both for capacity use and long term planning of investments, but pricing in open access systems has been a problem. The history of parastatal domination and cost plus pricing takes time to change. Early experiences cast their shadow and irrational pricing was a bottleneck from the first large interregional exchange of electricity. In 96/97, electricity growth in India was only 3.7%. This growth was minus 8% in April 97 and 2.85 in May 97. With special efforts it went up from 7 to 8% from June to October 97. In November 97, demand in the Northern, Eastern and Western region started slackening. In spite of full reservoirs a number of States backed down hydel generation. Energy deficits, as high as 12 to 14 %, went down to 6 to 8%. Large generating units like Rihand, Badarpur, Kahalgaon,

and Talcher, thermal units of DVC and in the State sector, plants like Bhatinda, Ropar, Kota, Kolaghat and Titagarh had to back down. But the Southern Grid was still having large deficits. The United Front Government decided to approve a National Grid and a Power Trading Corporation. But this would take time. In the short run it was decided to explore all possible methods of transmitting more power to the South. First the Power Grid Corporation's Chandrapur Ramagundam HVDC line was targeted for completion. Then back to back arrangements were worked out by the CEA. Interestingly once the technical feasibilities were worked out, economics became a bottleneck. The Eastern Region SEBs as also the Central parastatals with excess capacity, wanted full cost reimbursements. If PLF is low, overhead costs per unit would be high. Some units wanted Rs.6/kwh of electricity, thrice the marginal cost those days. Inefficient rules never make sense. Parastatal units were willing to shut down but would not supply at marginal cost, the first rule for profit making. The then CM of Andhra called up the Power Minister to say that the power coming to him from plants working at very low levels of capacity was billed at seven rupees a unit. Government forced through an availability tariff administratively, in spite of publicly stated objections including by Central parastatals. In January 1998, 2 million units of electricity went from the Eastern coal belt to Kerala. But the battle continues.

In January 2010, new regulations were issued by the Central Electricity Regulatory Commission (CERC) to fix the margin for inter-state trading in electricity. Trading margin would apply to short-term buy and short-term sell contracts for the inter-state trading. These include day ahead, week ahead and month ahead contracts. According to these regulations, trading margin would not exceed 4 paise per unit if the selling price of electricity is less than or equal to Rs 3 per unit. The ceiling of trading margin shall be 7 paise per unit in case the selling price of electricity exceeds Rs 3 per unit. However, CERC exempted long-term agreements from trading margin in order to facilitate innovative products and contracts for new capacity addition that involve higher risk in transactions. Also, the trading margin on long-term contracts was not consistent with the tariff-based competitive bidding guidelines that envisage discovery of electricity prices through competition among suppliers. According to CERC, if more than one trading licensees are involved in a chain of transactions, the ceiling on trading margin would include the trading margins charged by all the traders put together. In other words, traders cannot circumvent the ceiling by routing the electricity through multiple transactions. The new ceiling rates on trading margin would come into force after a period of one month so that the existing contracts can be re-aligned by the parties, if required.

The partial nature of reform implicit in this statement and the continuous tampering with it without attacking the fundamentals is obvious in the latest assessment of the Planning Commission, which is as follows;

‘A robust trading system is very important for a free and fair competitive electricity market operation. Though most of the supplies of electricity are under long term contracts, electricity is also traded on a short term basis. The volume of such trading has increased substantially and trades are occurring at very high prices. The Unscheduled Interchanges (UI) mechanism, meant to ensure grid discipline, is being used by many states power utilities as a trading platform and this is one of the reasons for trading at high rates. Trading of power at high rates has a distortion effect since state utilities are paying very high prices for such purchased power and not reflecting

this in the tariff charged to consumers. This will lead to large financial losses which will have negative consequences on the sector. This problem needs to be tackled by state governments on a priority basis. Ideally, surplus power available with merchant plants should be sold to large consumers via open access. However, the open access provision in the Electricity Act has not been effectively operationalised. The Electricity Act (2003) mandates that non-discriminatory open access for inter-State as well as intra-State transmission and distribution networks be provided by the Utilities. In the case of distribution utilities, Open Access was to be introduced through regulations, in a phased manner by the State Electricity Regulatory Commission (SERC)s and the Act mandated that by January, 2009 open access would be available to all the consumers who require supply of electricity with the maximum power to be made available at any time exceeds 1 MW. Effective implementation of open access is crucial for opening up consumer choice as well as encouraging a healthy trading function operational in the country. This is also expected to facilitate (i) desired market signal for investment; (ii) inducting improved service from the existing utilities; and (iii) enabling consumers to get power from any source of their choice.(GOI,2010,pp.333-334).

That such admonitions by the Planning Commission do not deter the operating Ministry from centralized control mind sets shows up in a recent report that the Union Power Ministry has decided to rework a Cabinet note on hastening the implementation of open access, where large consumers of power will be allowed to choose their supplier. An inter-ministerial task force on open access, headed by Planning Commission member B K Chaturvedi, had given an earlier report. Post this, the Prime Minister's Office had asked the Cabinet Committee on Economic Affairs to finalize a policy on the matter. Apart from ensuring state governments' compliance, another point of contention was an earlier proposal by the Planning Commission to allocate a portion of power generated from centrally-owned utilities for open access to large consumers. The power ministry had opposed the proposal, fearing loss of its control over allocations from the central quota. "The proposal was to go to the Cabinet, but we withdrew it. We had made a number of recommendations, but there was dilution in certain provisions. We are reworking on this to incorporate more measures and further strengthen it" a Power Ministry official is reported in the press. (Business Standard,2010).

Regulatory Structures

On Regulators, Subrahmanian notes that "it was only during Y. K. Alagh's tenure under the Gujaral government that it was decided that the CEA would not be removed" (p.59). Subrahmanian doesn't get into the details, but the Government in earlier years was not allowed to present a Bill for setting up a regulator in Parliament. Finally after considerable ground work on 14 August 1997 a Draft Bill was successfully introduced in Parliament. The Central Electricity Regulatory Commission (CERC) would co-exist along with the CEA. Subrahmanian points out that in 1998, the BJP-led government carried this decision forward and first passed an ordinance for the creation of the CERC and the State Electricity Regulatory Commissions (SERCS), and thereafter adopted the Electricity Regulatory Commissions (ERC) Act in 1998 (p.59). But the successor Government instead of following through the patient political process of negotiating the legislation forced it through as an Ordinance. They had then to withdraw two of the original bills main provisions; mandatory nature of the CERC orders and a minimum tariff rule. These infirmities continued in modified form in subsequent legislation. In the process,

procedures for appointment were changed with the minimum age rule introduced instead of the maximum age rule initially there to accommodate retired civil servants in the regulatory structure, also as we saw the minimum rural tariff rule was eliminated. The Regulators are almost all retired civil servants and the original intent in the legislation in 1996 to avoid this was and set up a transparent process for professionally qualified persons was later amended. India's first and best professional electricity regulator has the following to say; "as studied and reported by Joel Ruet, the Ministry and Executive control the electricity enterprises under the central and state governments, and the enterprises look for all direction, policy and procedures from them. The enterprises especially in the States function in an administrative and not an enterprise fashion. The Ministries do submit annual reports on performance to the legislature but they are little debated in the legislatures. Advisory committees to the departments are more window dressing than true consultative mechanisms." and again "Search, selection and appointment of regulators have so far been left largely to government servants and have resulted in filling most appointments with former government servants. The relative lack of commercial and enterprise expertise is unfortunate since there is no understanding on what state electricity enterprises must do to develop such cultures. Members invariably are appointed at an age when they are nearing retirement or have retired." (S.L.Rao, 2006)

S.L.Rao in his detailed work on regulators argues that while the BJP-led government was quick in capturing the success of passing the ERC Act in 1998, the CERC was not given office space and staff for a period extending beyond two months. They were also not given the freedom to select staff for the organization. In a majority of SERCs (seven out of ten), bureaucrats and those with peripheral exposure to the power sector, managed to find positions. Close scrutiny of the appointees to the SERCs in 10 states indicates a large proportion of IAS officers regardless of their experience and knowledge. Also, almost all appointments were of persons nearing or reaching superannuation.

Technology

Advances in transmission technologies in India including a large HVDC system have been noted. Technical losses of interregional transfer of power are low and globally comparable. More recently Power Grid Corporation of India Ltd (PGCIL) has established a 1200-kV National Test Station for developing the technology for transmitting power at 1200 kV. As noted in the best practice cases description earlier there are substantial applications of information technology in managing transmission and distribution reform. The Planning Commission has recently stated; 'Application of Geographical Information System (GIS) and effective Management Information System (MIS) can help in carrying out load demand/supply analysis and demand forecasting; improve network planning and execution skills; identifying the high AT&C loss level areas and improved billing and revenue collection. MIS would facilitate quick decision making and improve governance of the distribution sector both in terms of operational and financial performance. This will lead to improved customer services and overall reduction in service costs of the utility.(GOI,2010,p.334).

The Accelerated Power Development & Reform Programme aims to strengthen sub-T&D networks, thus reducing the aggregate technical & commercial (AT&C) losses. Complete feeder metering has been achieved in twenty states. In a first of its kind project in the world, the

Karnataka Power Transmission Corporation Ltd (KPTCL) has attempted to strengthen its power networks and the constituent distribution utilities, for a consumer base of almost 16 million. An integrated Scada solution will include monitoring 867 T&D stations with one million input/output points across Karnataka from a single control room in real time in Bangalore. The project will help KPTCL manage distributed generation from independent power producers, non-conventional energy producers and mini hydel plants in the KPTCL grid. A significant step in the direction of making the grid smart, this project will also help reduce line losses, voltage irregularities and energy billing.

The idea of open access was introduced for the first time in India by the Electricity Act of 2003, which had assigned the deadline of January 27, 2009, for grant of open access to all consumers with electricity requirements of above one Mw. The idea was to introduce more competition in transmission and distribution and enhance efficiencies in power supply for consumers. While applications seeking open access for over 25,950 Mw have been given till date, implementation has been only for 7,400 Mw. That too largely for captive power, according to the latest data from the Forum of Regulators, a government body consisting of heads of state power regulators and that of Central Electricity Regulatory Commission.

India has a good record in energy efficiency. All indicators show that its energy consumption per unit of GDP or industrial output has been falling in the period of high growth and it is one of the low energy consumption economies in the world (See Y.K.Alagh,2009, in M.Agarwal. CIGI). The industrial reform of the Indian economy started in the Eighties. As major industries were brought out of quantitative control of output, import, prices and investment, tariffs, domestic taxes, dual prices (for the controlled and open market segments) were all used to give signals for technological change through scale economies and higher capacity use. There was clearly a huge energy saving potential in a single product continuous process industry, where technology mattered and start up costs of unplanned shutdowns were high. This actually happened in the great energy guzzlers, cement, paper, steel, aluminum, petrochemicals and fertilizer. The first strategy of the Eighth Plan paper presented to Rajiv Gandhi in 1989 said that reform would mean higher factor productivity and lower capital cost for rupee of output. Energy use for cement would on the basis of investments underway by the private sector go down from 1.3 giga. Cal per ton to 1.0, for aluminum from 19000 kwhs/ton to 17000, steel from 700 kwhs to 415/ton and so on. The Bureau of Energy Efficiency showed that this actually happened and has argued with their latest data that it has continued. For the decade 1995/05, specific energy consumption has gone down by 3.5% annual in steel, 7.5% in cement and 1.8% in aluminum. This happened in many other areas like public transportation, lighting and so on. In terms of kgoe/\$2000 of GDP in purchasing power parity terms, China has an energy consumption of 0.23 in 2003 as compared to a global average of 0.21 and India at 0.16 compares well with 0.14 in UK, 0.15 in Japan and 0.22 in the USA. The Indians adversity to an advantage in many sectors. If privatization and reform in electricity is slow, be more efficient everywhere else in using it.

There is the need to maintain further momentum. Some of the policies in place include:

a. Perform Achieve and Trade scheme as a market-based mechanism to enhance energy efficiency in the 'Designated Consumers' (large energy-intensive industries and facilities). The scheme includes, Goal setting: Set a specific energy consumption (SEC) target for each plant -

Reduction phase: Within a three-year period (2009-2012) the designated consumers try to reduce their energy intensity according to their target- Trading phase: Those consumers who exceed their target SEC will be credited tradable energy permits. These permits can be sold to designated consumers who failed to meet their target.

b. Accelerated shift to energy efficient appliances in designated sectors will be enabled through innovative measures. These products would be made more affordable. This target would be achieved by DSM measures, supported with CDM financing wherever possible.

c. Financing Initiative focusing on the creation of mechanisms that would help finance demand side management programmes in all sectors by capturing future energy savings. The initiative includes Fiscal instruments like tax exemptions for the profits and gains made from energy efficiency projects by ESCOs and Venture Capital funds and reduction of VAT for energy efficient equipment (e.g. CFLs), a revolving fund to promote carbon finance and a partial risk guarantee fund to provide commercial banks with partial coverage of risk exposure against loans made for energy efficiency projects.

d. A Power Sector Technology Strategy aiming to enhance energy efficiency in power generation, including a roadmap for IGCC demonstration plants ,development of know-how for advanced super-critical boilers and a road map for fuel shift .

e. Supporting initiatives

Financing

The certain method of mobilizing finance is to hasten the reform process. A beginning has been made to provide the institutional mechanism for power trading. A few States have introduced mechanisms for those who pay to get electricity from relatively assured sources. But the basic issues of free power and financial viability still remain. If this is not solved other short run fixes like guarantees, escrowing local or regional revenue sources, special funding mechanisms have a limit.

A more complex issue is the lumpy nature of energy investments. This creates viability problems for financial institutions in terms of prudential norms. For example if a long term financing system is not in place, a power system may exceed prudential norms for lending to a sector or a group of companies. While the viability of the loan needs scrutiny these kinds of limits may need examination at government or central bank levels. In India, there has been see saw in this matter leading to some uncertainty but at present such norms are relaxed. Long term lending institutions and infrastructure development funding institutions are another solution. Global assistance to viable reform programs is another.

Equity

Access to energy in rural areas is a major issue. While 85 percent of Indian villages are electrified in some areas progress is lower. According to the Planning Commission ‘there is clearly a very slow progress in providing connections to BPL (Below Poverty Line) households (38.3 per cent). A number of habitations in the villages however remain uncovered.’ (GOI, 2010 ,p.327) .

Some problems arise on account of the reform process itself. In the mid nineties a study of Gujarat's electricity system showed that even when power was available it was not delivered at the level of the 11kva village feeder on account of faulty transmission and distribution systems(Y.K.Alagh, J.Shah and V.Shah,1998). A system of 3 phase supply at market rates of power was recommended in addition to the existing unreliable supply system at the village level. Such systems are now implemented in Gujarat, Andhra, Haryana and some other States. But studies show that energy consumption of small farmers went down. Sebastain Morris has argued a case for structured subsidies to rural consumers (S.Morris,2001,pp.104-128). The difficulty as the Planning Commission suggests is in implementing structured and limited focused subsidies and cross subsidization.

Conclusion

The Indian experience suggests:

First the need to experiment with alternative administrative and bidding procedures in the unbundling process of transmission and distribution from centralized electricity systems. In the Indian case a system of bidding on targets of reducing AT&C losses in a phased manner, with share of equity awarded to the lowest bidder (in terms of AT&C losses) seems to have worked better than say a tariff based system with an incentive thrown in.

Second there is a need to move away from cost plus pricing in transmission and distribution at the earliest. It may be noted that the AT&C loss minimization strategy is a variant of a long term marginal cost pricing strategy advocated by Indian experts.

Third a transparent regulating system and the infrastructure of transmission and distribution needs to be set up at the earliest and the Indian experience are helpful in terms of such structures in a large democratic federal country. The Central and State Electricity Regulatory commissions and the Appellate Tribunal for Electricity (ATE), SEBs disaggregated into Generation, Transmission and Distribution Companies, various policies like the National Electricity Policy, Tariff Policy, Rural Electrification Policy mandated by the Act, along with Rules and Regulations have to be in place. Trading licenses have to be issued, power trading has to commence. National Grid Code and State Grid Codes have to be notified. Only then unresolved problems can be taken up.

Fourth the Indian experience brings out the need to persist with reform ideas at the highest political levels. The successes of private transmission and availability tariffs in the initial stages and later problems underline this. These aspects need to be integrated in case studies of reform, which in turn have implications for negotiating reform packages.

Fifth technological improvement packages, say as in open access programs need to be accelerated anyway and the Indian experience shows that while the important issues lie in the reform and unbundling package, the technical packages have a usefulness of their own .

Sixth equity aspects need to be embedded in the program of reform, recognizing fully well the difficulties in a structured subsidization policy.

Seventh while the reform itself will make most electricity investments viable, sectoral and company level prudential rules may need careful review in view of the lumpy nature of power investments. Long Term Financing institutions, Infrastructure lending Banks and experienced regulation by central bankers may be needed to fund otherwise viable projects.

Some general comments may be in order at this stage. When discussing competition in infrastructure industries two problematiques lend themselves for analysis. The first is competition in the short run. This becomes the question of rules for improvements in capacity utilization and cost reduction, which in many cases are two sides of the same coin. For example in a continuous process like electricity generation, unplanned shutdowns lead to high costs since start up costs are high. Rules and organizations which lead to improvements in management systems for delivery efficiencies at the user end also become a part of this analysis. The second problem is the question of a market for capacity creation. Here again the question is the set of organizations and rules which create incentives for capacity creation and modernization at the cheapest possible prices in terms of unit deliveries of output. There are related questions of avoidance of exclusion and externalities which become important if environmental concerns are objectives are also policy concerns. It may be noted that policies for incentives include disincentives to discourage perverse behavior, namely raising costs or discouraging benign technical change.

The approach of macro reform has also however to be simultaneously followed up with the specifics of reform around lending packages for new projects or subsystems of the power economy. This is the concept of “islanding”. It goes on the precept that while progress is being made towards the macro reform of the entire system, organizational, technical and economic reform has also to be seen through at the level of projects or subsystems of the sector. Some experts have said that this is not possible. I disagree and would begin with a counter factual example. When I visited some districts in Western Rajasthan there was no energy shortage in Rajasthan. In fact, the Kota Thermal Power Station had backed down and the frequencies of power supply at all the 132 KV Distribution and Transmission systems I visited were normal and in some cases unfortunately above normal. However, it is my habit to go into field level details and every time I would pass a 11 KV distribution station I would walk in. On examining the records of each 11 KV line to different villages I found that between 8% to 27% of the time of the last month, power supply was not being delivered at the lowest level on account of distribution constraints. There were no circuit breakers and even the fuses were in some cases of an unacceptable kind. The operators were generally untrained. It is interesting that the Government of Rajasthan had introduced a new scheme called “Tatkal” connection or the “Immediate” connection at the farm level in which they had declared a rural electricity tariff rate of Rs.1.25 which is close to the target rate recommended in the Electricity Regulatory Authority legislation introduced in Parliament. It was interesting to note that during this financial year of the registered connections 1203 had still to be given in the district of Chittor, 409 in Udaipur and 212 in Ajmer. In all these districts, more than 15000 farmers each wanted to take advantage of this scheme but were not registered since the distribution capacities did not exist. I would say that the Rajasthan Government has “islanded” reform for investment in the rural transmission and distribution system for this project.

Similar examples can be constructed for reform packages around channelling the borrowings to specific rehabilitation and modernization projects, transmission projects and generation projects.

If at the project level organizational mechanisms can be created for a search for efficient technology and investment packages, implementation machinery and economic reform so that the repayment of the principal and debt servicing is clearly identified by a banker, this kind of policy reform should go hand in hand with the reform of the State Electricity Boards as a whole. In fact, it can be reasonably argued that to wait for the reform process of the entire Electricity Board to be completed before project level lending and investment can begin seems to be an approach which would delay the process of the rejuvenation of the Electricity Sector. Mao Dze Dong was once asked how the Red Army would face the Japanese Army, the strongest in the World. He said if we can't face them we will surround them. Islands of reform surrounding obstruction will succeed in India. May be also elsewhere.

References and some Readings

Alagh, Yoginder, 1997a, Fuel for Power, Second Lov Raj Kumar Lecture, Current Science, 73:1212, Indian National Science Association, December 25, pp.1051-1056,.

....., 1997b, Economics of Nuclear Power in India , Nu-Power, Vol. 11 , No. 1-3. Also see NTI Country Overviews, 1997, India Nuclear Chronology.

....., 1998, Strategy for Power Generation, Yojana , Vol.42, no.1, January.

....., J Shah, VK Shah, 1998, Power Economics in Gujarat, Delhi, Har-Anand.

....., 2000, Foreword, in P. Audinet, et., al, India's Energy, below.

....., 2000a, Global Sustainable Future and Developing Countries, in Fu Chen Lo, et.al., below, Ch.19

....., 2000b, Also see Y.K. Alagh, Sustainable Development India, 2020, UNU, IAS, reported in UNU 2002 below.

....., 2005, On Sherpas and Coolies; The L20 and Non Brahmanical Futures, in J. English, et.al., ed., Reforming From the Top: A Leaders 20 Summit, below, UN University

....., 2006, India 2020, Journal of Quantitative Economics, Vol.4, No.1, pp.1-14

....., 2007, India's Energy Future; Problems and Prospects, CIGI, Draft Working Paper

....., 2009, Energy and High Growth in India; Sustainability Issues, in M. Agarwal, below

Agarwal, M., 2009, ed., Sustainability of High Growth Rate in India, Waterloo, CIGI

Audinet, P., P.R. Shukla and F. Grare, 2000, (ed.), India's Energy; Essays On Sustainable Development, Delhi, Manohar.

Business Standard, 2010, Govt Reworking Open Access Proposal, New Delhi, 22 September.

Government of India, CERC, 1999, Discussion Paper on Energy Pricing, New Delhi.

....., 2006, Approach to the Eleventh Five Year Plan, New Delhi, Planning Commission.

....., 2010, Mid Term Appraisal of the Eleventh Five Year Plan, www.planningcommission.nic.in

....., 2006a. Economic Survey:2006/07, New Delhi, Finance Ministry

....., Planning Commission, 2006b, Integrated Energy Policy, New Delhi, August.

....., Planning Commission, 2008, Eleventh Five Year Plan,;2007-2012, New Delhi, Oxford University Press

Kannan, K.P., et. al., 2005, India's Power Sector, Trivandrum, CDS

Morris, S., 2003, India Infrastructure Report 2003, Delhi, Oxford

Ruet, J., 2005, Privatising Power Cuts?: Ownership and Reform of State Electricity Boards in India, Delhi, Academic

Scwank, O., T.vonStokar and N.North, 2000, Long Term Carbon Emmission Targets, in P.Audinet, et.al., above.

Sinha, S., Transition Plans for Power Sector Privatization: The Case of Delhi and Karnataka, in S.Morris, ed., above

Subramaniam, Kandula, 2004, Thirteen Years of Power Sector Reform in India: Are We Still Groping in the Dark? , CASI Occasional Paper Number 15, Philadelphia, Center for Advanced Study of India, University of Pennsylvania

Rao, S.L., 2006, Evaluating and Building Capacity in Regulatory Commissions, Delhi, TERI