# Chapter – I

## Power Sector in India - Introduction

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Power sector in India

1.1 Introduction:

Power sector was under Government control till the year 1991 with all the major functions of three different areas of Generation, Transmission and Distribution to the consumers which was predominantly done by State owned companies and Boards. The government had complete grip over the entire power business through regulation and the government departments in center as well as state used to undertake the functions of Project clearance and government approvals and finalization of tariff. Load dispatch and Operation of Grid, Commercial-Regulations and Control and Managing three areas of generation, Transmission and Distribution was also owned, operated and regulated under the purview of Government control. Power was a concurrent subject with the prime responsibility lying with states for supplying the power to the consumers. Central government was doing the national planning for the entire country till 1975. In the year 1976 Central govt. also established few companies to look after the ever-increasing demand of generation addition. This efforts was not sufficient after 1990 and this became further complicated with the financial condition of the State Boards were deteriorating every year and jeopardized the financial health of this entire sector in totality.

Since independence power-sector has seen several ups and downs. The expansion in the last fifty years has also brought in several complexities, the system is large and interconnected, all the states are connected and the regions are connected in the National grid. The financial viability of the present tariff structure, Inefficient and large manpower engaged by the SEBs, huge transmission and distribution losses, Low realization of revenue and inefficient and unreliable supply are some of the major area of concern today. Government has already taken initiative in several areas to Corporatise the Boards and privatize the Distribution areas. In a nutshell the power sector is in a transition period.
In one of the Editorial of national daily The Telegraph (01) dated 20th Jan, 2002 the radical changes in perception of public utility was opined, "The most remarkable aspect of India's development as it begins to celebrate the 50th anniversary of its independence this August a dramatic shift from a society of complacent civil servants to a society of ambitious consumers." As per a survey (02) carried out by Powerline, a trade journal for power sector in the month of August, 2001 issue, "78 percent of households are not connected to any electricity at all", according to editorial in the same issue. "India appears to be mired in a typical developing country conundrum. For every one percent rise in GNP, the government estimates, demand for electricity goes up by 1.6 percent. In effect, the very effort to modernize is required to be appealing in the global environment. There is change in consumption pattern and the consumption is oriented towards installing more computer networks, illuminating chandeliers at convention centers, building more air-conditioned offices and hotels to court foreign investors but it is depleting India's ability to generate enough electricity for its citizens." Although India's manufacturing sector with over 6,500 registered companies is second only to that of the U.S., its per capita consumption of electricity is at 320 kilowatt hours per year - is one of the world's lowest: one sixtieth that of Canada, a fifth that of South Korea, less than half China's. And most electricity production is concentrated in agricultural and industrial zones, as well as in the more exclusive neighborhoods of large cities. Over 90 percent of India's generating capacity is government-owned, 70 percent of that by state boards, 30 percent by the central government. About 70 percent of all power comes from thermal plants (mostly coal-powered), 26% is hydroelectric, 3% nuclear. The country has begun opening to foreign investment.

1.2 Historical Evolution:
As per the famous book on “Electrical Engineering -electrical power system” by Thareja, "The basic scientific discovery of electricity dates back to the beginning of the 19th century. A major landmark in the evolution of science was the electromagnetic theory propounded by Maxwell in 1864, which unified the early discoveries in the field of electricity and magnetism in one theoretical structure. Based on these scientific foundations, the great 19th century American inventor and entrepreneur Thomas Elva
Edison invented incandescent light and sold the first lighting system to Northern Pacific Railroad in 1980. Soon after, Westinghouse developed alternating current (AC) system, which allowed transmission of electricity over greater distances through the use of transformers. The initial years were a period of technological rivalry between two incompatible systems AC and DC (direct current). Soon AC prevailed because of its obvious superiority. The initial usage of electricity was limited to transport and public lighting. But with rapid advancement in technology, its use spread to domestic applications. Industry found electricity the most convenient form of energy for motor power for machines and equipment. The growth of electricity in Europe followed a similar pattern as that in the US. It began about the same time, i.e. late 19th century with transport and public lighting and spread fast to domestic and industrial uses. By the 1940s, the US and western European countries had highly intensive electricity use and a vast electric supply industry. Other countries also have a long history of electricity use. For example, in India, electricity supply industry is about a hundred years old, but its growth was not as fast as western countries. Until the 1940s, the industry was confined to a few urban pockets, the total capacity being about 1,350 MW. Only after independence in 1947 was a massive boost given to the expansion of electricity through public investment. The installed capacity (of utilities) in 2002 was over 102,000 MW. The generation in billion units (BU) since independence has increased over a 100 fold from 4 BU to over 420 BU.

1.3 Growth Profile of Indian Power-Sector

Power system in India is under going a sea change. The system is growing day in and day out. The system was having total installed capacity of less than 1300Mw before independence has reached to an installed capacity of 102,000MW. A very rough estimated with the present level of growth it would touch a figure of 2,00,000MW in ten years from now. There are several agencies in this country who are responsible for such studies and the Government of India also has its Data-base collected over the years to forecast the load-growth in the Indian Power Industry. The per unit power consumption (Total Power generation in KWH / population of the country) in any country is the indicator for the countries affluence and the standard of living. Power consumption may
be dependant on so many factors and the Load growth can be dependant on the following factors:

- The growth of Industrialization. The focus is now on less concentrated loads such as Computers.
- The modernization of Cultivation and usage of pump sets in irrigation.
- The Urbanization of areas near to the cities.
- Rural electrification.
- The seasonal parameters such as Temperature, rainfall and snowfall.
- The affluence or the per capita income can also be an important factor in load growth.

Electricity is one of the most vital infrastructure inputs for economic development of a country. The demand of electricity in India is enormous and is growing steadily. The vast Indian electricity market, today offers one of the highest growth opportunities for private developers.

1.4 Parameters of Indian Power System:

India is home to 16 per cent of world population and although per capita energy consumption in India is 244 kg. of oil as compared to world average of 1471 Kg of oil, its total commercial energy requirements are estimated to be of the order of 225 MT. Nearly 60 per cent of energy requirements are met by coal, which is available in abundance but is of a poor quality. As per ministry of power reports, in India thirty percent of commercial energy requirements are met by petroleum products, Nearly 7.5 per cent by natural gas and 3.5 per cent by primary electricity. It is believed that non-commercial fuels like fuel wood, animal waste and agricultural residue meet a huge amount of energy requirements, perhaps not properly estimated. According to one estimate traditional energy sources account for 40 per cent of the total energy consumption in the country.

Increasing pressure of population and increasing use of energy in agriculture, industry and domestic is an area of concern. At the same time, the need to meet energy demand has created huge capital requirements needed for setting up power plants, pipelines, ports, terminals, railway tracks to move fuel etc. In its quest for increasing availability of electricity, the country has adopted a blend of thermal, hydro and nuclear sources. Out of
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these, coal based thermal power plants and in some regions, hydro power plants have been the mainstay of electricity generation. Oil, natural gas and nuclear power accounts for a smaller proportion. Of late, emphasis is also being laid on non-conventional energy sources i.e. solar, wind and tidal.

1.5 Power Shortage – Gap between Demand and supply:

The power sector has been characterized by shortage of supply vis-a-vis increase in demand. In 1990-91, the country faced peaking shortage of around 16% and energy shortage of about 8%. The position has worsened with peaking shortage of 18% and energy shortage of about 12% at the end of 8th Plan (1997) since capacity addition during the 8th Plan (1992-97) was much below the target. The detailed table is attached in appendix.

In a resource scarce country like India ever since independence, there is a huge gap between demand and supply. For each Megawatt of addition in power capacity generation the investment required is Fifty million Indian rupees and matching fund for transmission and distribution. The additional resources poured for generation addition has not been sufficient to meet the power shortage in the past. Therefore to manage the gap load shedding has been resorted through out the country. Power outages have long been a fact of life in India, and candles, re-chargeable lamps, power converters and generators are as much a part of urban Indian homes as the vacuum cleaner in the U.S. It is a great achievement that since independence our power generation has risen from 1,700 megawatts to over 80,000 megawatts," says V. Gopalachari (03), India's former Minister of Power. "But we didn't expect such an increase in demand. We were focusing all our energies on generation, not consumption and distribution. That is why the power situation in the country has been getting worse day by day." Delhi, the capital city is drawing far more electricity than it can afford. Six-hour cuts are an everyday occurrence in this megalopolis of 11 million. The problem is hardly confined to Delhi. "Most people in India would be happy with 16 hours of electricity per day. There are many rural areas and smaller towns that get one or two hours a day. Sometimes they don't get power for
weeks." says Alok Brara, editor-in-chief of PowerLine Magazine (04), an industry trade publication. In Bangalore, the "Silicon Valley of South Asia," power outages several hours per day. In an unprecedented summer month in Kerla, industrial consumers in the Ernakulam district, India's most socially and economically prosperous state, were without electricity for nearly three weeks. As a result, many industries were forced to lay off workers, riots broke out and people threatened to burn substations. Electricity cuts have sparked violent outbursts in small towns throughout the country.

It is difficult to pinpoint single factor for the shortage of the power. Experts explain the crisis in a variety of ways such as mismanagement, corruption, politicized distribution of state-controlled power, excessive subsidies for farmers, reluctance to privatize, and unworkable billing system. As opined by the Editorial in the Powerline journal in the September 2002 issue, “The real cause for alarm is that in this developing country, supposedly rising from Third World mendicancy into the more respectable realm of free market consumer ship, the power situation is getting worse."

1.6 Per Capita Consumption: A

As per the recently published NCEAR data on power sector, the per capita consumption of electricity for the country as a whole is 335.42 kWh during 1995-96 as against 238.0 kWh during 1989-90. The growth of the economy calls for a matching rate of growth of the power infrastructure. In order to support a sustained high rate of growth of GDP of nearly 6 per cent per annum, demand for power is expected to grow at around 9% annually. Central Electricity Authority (CEA), with active participation of SEBs have assessed the energy and peaking demand as given below:-

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<th>Table:1.1</th>
<th>Showing peak-demand and energy a per CEA National plan projections</th>
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<tr>
<td>2001-02</td>
<td>2006-07</td>
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<tr>
<td>ENERGY DEMAND (Billion kWh)</td>
<td>569.65</td>
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<th>PEAKING DEMAND (MW)</th>
<th>ANNUAL LOAD</th>
<th>FACTOR (%)</th>
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<tr>
<td>95,757</td>
<td>130,944</td>
<td>67.91</td>
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<td>68.16</td>
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Based on the 15th Electric Power Survey, CEA has prepared a National Power Plan in 1996-97 covering the 15-year period up to the end of the 11th Plan (2007-12). In the Plan, projects totaling to 52820 MW have been identified as the need based requirement in the 9th Plan (1997-2002), This would include 8413 MW capacity of hydro plants, 43528 MW capacity of thermal plants and 880 MW capacity of nuclear plants. The capacity addition needed during the 10th Plan could be 45,370 MW and the capacity addition needed during the 11th Plan would be 55,593 MW. Based on the capacity addition requirements, funds required for the generation component of the National Power Plan have been assessed. The requirement of funds for the transmission and distribution component would be about 60% of the funds requirement for generation includes funds for advance action on Plan Projects. In addition, about Rs.1,500,000 millions would be needed for advance action for 12th Plan projects. For T&D components, Rs.4,000,000 millions would be required totaling Rs.10,000,000 million (US $ 240 billion) for the power sector. (05)

1.7 Regional Concept of Power Planning and Growth:

The Indian power system is divided into five regions for the purpose of power system planning and operation viz. Northern, Northeastern, Eastern, Southern, and Western. Each region is directed by operating personnel using load dispatch and communication facilities located at regional and state load dispatch centers. These facilities are presently rather limited to serve the needs of India’s growing power system. Eastern Regional load can be categorized into the types namely Industrial, Commercial, Agricultural, Railway, Coalfield and Residential. The major loads are Railway, Steel Industry, and Coal Field. Presently due to T&D restriction there is a gap between present load demand and power generation, which tells us the amount of load shedding that is required.
Regional load is anticipated to grow at the rate of about 9-10% per year an anticipated unrestricted demand of about 13,000 MW in the year 2003. Since last ten years the National grid is also planned with the interconnection of the entire regional grid with the high voltage direct current lines as well HVAC(high voltage alternating current) lines which is in progress.

1.8 Operational Issues and Problems:

As per the operational reports submitted by POWERGRID to the regulatory commission, regional operational problems stem primarily from Constituent’s inability to satisfy the unrestricted load demand at 50Hz. This is clear case of inadequate planning and forecasting of demand by the States. The trends available may be used to get the future load growth and accordingly the capacity addition should be planned. Although there is sufficient installed generating capacity, this capacity is not always available due to factors such as: periodic and emergency maintenance; quality of coal; and the availability of water for hydro generation. These situations can lead to frequency, voltage, and network integrity problems – all of which are detrimental to system operation and can lead to equipment failure. Typically, low voltage occurs during peak load hours and high voltage occurs during off-peak hours. Low voltages generally do not pose a serious threat to system operation and are correctable by: reactive power injection adjustment, transformer taps, generator over-excitation, and load shedding. However, these corrective strategies are not always feasible. High voltages are more serious and are correctable by: reactive power injection adjustment, transformer taps, generator under-excitation, line switching, and the creation of circulating currents. Again, these corrective strategies are not always feasible. The reform process in this sector was initiated in the year 1991 with the Govt. willingness to allow few Private generators to establish their own generating plants in India. But after a lapse of more than 13 years if we review the actual investment and establishment of new generating plants in the private sector it is worth while to mention that only less than 5% of the added generating capacity came in the private sector during this period.
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This led to rethink the planners in this sector to find out the failure of Government moves to lure potential investors to invest in this area. It was recognized that the electricity supply industry in India is in emergency state and reforms are urgently needed. The direction in which the power sector reform should proceed is not universally accepted. The process the international consultants have suggested and more or less accepted by Indian planners are Restructuring, Unbundling and Privatization as the solutions to the ill financial health. In this direction the government has started to separate the two functions of Regulator and Business Operator. Government has decided to play the role of regulator to the entire sector and leave the mundane job of providing services and doing the power Business to the private operators and some of the Corporations who are doing this efficiently.

1.9 Paying Capacity of Indian Consumers:

A concern frequently expressed in India is about the capacity and willingness of the people to pay for electricity. There is a feeling that they have been spoiled too much in the SEB system. Upadhyay (1996) in his research paper has highlighted some startling facts about willingness of urban consumers to pay for power at peak time. In most of the small towns of Bihar, load shedding in the evening peak hours is almost a regular phenomenon. This is the time when the urban middle class needs electricity most. To fill this need, an unorganized, unregulated and unlicensed market has emerged. Every town has a large number of entrepreneurs, each owning very small diesel generating sets of 10-20 KVA capacity, each connected to about 100 households to give power to one or two points (say, two lights or one light and one fan). This supplies power between 6 and 10 pm, in case the SEB power fails. The consumers pay a fixed price per point per day regardless of hours of actual supply. This price corresponds to energy charges of Rs. 8-10 per unit (which has since increased by about 50 per cent with the recent hike in diesel prices). The point is that the urban has valued the price of electricity in evening peak hour at this level, and is willing to pay the price. Coming to rural areas, it is well known that the farmers pay for water taken from a nearby farmer's pump-set at economic rates. As per Upadyay, energy secretary to the government of Bihar in his published findings
mentions that “In electricity, Rajasthan SEB introduced a novel ‘nursery’ scheme to provide ‘out of turn’ connection to the farmers willing to pay the actual cost of connection (which is about 10 times the normal charge) and a tariff of Rs. 1.20/-unit instead of Re 0.50/- unit under normal connections. This attracted tremendous response—about 60 per cent of new connections were given under this scheme. In another variant of the same approach, the Punjab SEB has introduced a scheme to give power connection to private tube wells on priority to those farmers who install their own transformer. This scheme has also become extremely popular. These examples show that political populism has created an environment of uneconomic tariff and non-payment. Several instances show that consumers are more concerned with reliability and quality of supply, and if they are assured of this they are willing to pay. Unfortunately, the Indian power sector has become trapped in a vicious circle of low tariffs, poor recovery and poor quality of supply and service.”

A few points on regulatory aspects may be of relevance at this stage energy experts feel that “The issue of consumer tariff is simpler in case of Union Territories and smaller States, and can continue to be dealt with by the respective UT administration and State government for the present. In such cases, it is not necessary to hurry up the establishment of State Electricity Regulatory Commissions, which have their own cost, implications. Further even unbundling and privatization of the present State electricity departments and SEBs may not been priority in such cases, provided the distribution system (due to its smaller size) is manageable and is being managed competently. Second, when there is competition in retail supply (as is the case in England & Wales), the consumer tariffs are to be fixed by the SERC (providing cross-subsidizing for some consumer categories), competition in retail supply is just not possible.”

1.10 Need for CHANGE in the Sector:

In the published paper on power sector reforms in the year 1999, Mr. Bhanu Bhushan, Director, Powergrid has mentioned that “Government fund have not kept pace with the projected investment in this critical infrastructure because the investors have found it not
prudent to invest in any portfolio, which is prone to poor rate of revenue, high commercial loss and under-performance. The transmission & distribution losses are in the tune of 40%. A reduction of 20% could have given Rs.500crores or more to each SEB as additional annual revenue. This in itself could sustain investment of 6 times as much.”

These losses comprise the following:

i) There are technical losses arising mainly out of long low voltage distribution lines.
ii) There are large no. of registered un-metered consumption points.
iii) Meter reading and billing does not encompass all the registered consumers.
iv) Quality of meter is suspect.

As per the Ahluwalia Committee appointed by GOI (05) to look into the losses of revenue in power sector, “The above losses include pilferage of electricity, which is estimated to be at least 15% of the energy delivered. This is the area, which need immediate attention and the reform process in this sector particularly with the privatization this percentage is expected to fall below a certain acceptable level. Subsidized tariff and cross subsidies did wonders to help the economy in the villages. The leapfrog in the agriculture sector was contributed in no small measure by the availability of cheap / free electricity. However we have to remember that 54 years have passed since we became independent. Sustained subsidized/cross subsidized electricity to agriculture and other sectors has resulted in the beneficiaries taking electricity for granted and has made them obvious of the real cost of energy. The result has been wastage of electricity and lack of initiative to conserve. How long should such subsidized sectors need a crunch to stand on has to be reviewed. State regulated tariff crippled the utilities. Just the opposite was the case in advanced countries where the monopoly enjoyed by the state regulated utilities was seen to be the high tariff and windfall profit.”

As per ASCI (06) report on tariff fixation and power sector reforms submitted to SERC West-Bengal, they have pointed out that the “Private participation in generation was proposed to supplement budgetary support for increase in generation. With SEBs in the red, it didn’t work. Private participation in generation in the west was introduced to do...
away with state monopoly, introduce corporatisation and competition to reduce cost of electricity.

When privatization of generation failed to attract investors, it was presumed that the solution lies in restructuring of SEBs to segregate generation, transmission, distribution and sale of electricity and privatize them. It was hoped that it would increase efficiency and improve accountability. We failed to identify that unless pilferage of electricity was reduced/eliminated, other areas of improvement will only have a cosmetic effect. Restructuring in the West was ushered in to segregate the naturally monopolistic part of the business from that which could be brought under competitive environment and freed from regulation.

1.11.a Financial Status of State Electricity Boards:

State Electricity Boards have been the main components of the ESI in India for the last 50 years, and have rendered a commendable service in electrification of the country. Today however they are generally in a financial mess, On account of:

1.11.b Consumer Triffs:

These have been fixed at levels much below the average cost of supply, for large segments of consumer. The power in India since independence in 1947 has always treated as a facility to be provided by government and the companies providing such services were Government owned Boards with a few private players as licensee for them. The consumers of Electricity has always pampered by Government by offering them the tariff, which is even lower than the cost of production. The fixing of power tariff was more an exercise to please all sections of consumers and hardly any effort was put up to link price with cost of electricity production and transmission. The responsibility of fixing the tariff for power was handed over to independent commission as recently as 1998. The consumption of power was never considered either as the service or commodity for consumption. The financial mess in the power sector is largely due to the concept to run the Utility companies as government department and not as a Business
house. Many of the International consultants appointed by GOI (Government of India) to identify area of reforms have clearly recommended that professionals Managers rather politically connected bureaucrats must manage these companies.

1.11.e Inefficiency in energy metering, billing and revenue collection:

Most of the state electricity boards are loosing almost half of the energy sold due to improper measurement of the energy sold through metering, faulty billing and not so efficient means for revenue collection. In the complete commercial cycle the company is loosing half of the revenue due to commercial and technical losses. This loss is more prone in far flung rural areas. To get a first hand assessment of the situation we may refer the reports submitted by KPMG (07), the international consultant appointed by West Bengal State Electricity Board to work out a time bound action plan for revival of the company in terms of expansion and reforms. The company has identified five major areas of concern:

- Lack of commercial orientation
- Technical & Commercial loss.
- Cumulative losses, adversely affecting the Net worth of the company.
- Ageing workforce
- Lack of training importance.

The consultant has commented on the business environment of the company and in their report it has been mentioned that the technical & commercial losses is 36% in Nov’2002, which is high compared to any acceptable business model. The revenue losses need to be reduced considerably. In the report it is mentioned that the company is loosing Re 1 per unit of energy purchased from other agencies, generated and sold. This is almost 40% of per unit cost of the power sold in west Bengal. In case of West Bengal (08) the positive aspect of revenue collection is increase of 63 Paise per unit of revenue realization in the current financial year, but simultaneously this is being eroded by increase in cost of supply by 68 Paise per unit. Thereby the loss is further widened by a gap of 5 Paise per unit. The rate of return on investment is on the negative side and company is loosing and performing much below the prescribed statutory return of 3%.
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Consumer tariff has always been a matter of debate, deliberations and issue of public interest. Fixing of tariff for the power companies based on sound economic policy is treacherous journey towards reforms. Very pragmatic criteria would have to be applied by SERCs in fixation of consumer tariffs for different categories, balancing between social needs/compulsions, cost of supply etc. It would also be prudent to relate the tariffs with quality of power supply to consumers could expect load-shedding-free supply at a proper voltage when they are required to pay higher tariffs. The vicious loop is that this is possible only after a corresponding enhancement in generating capacity and T&D augmentation, which is not possible unless the ESI’s revenue improves substantially (through tariff increase and/or efficient metering, billing and collection).

In a World Bank report (09), it has been estimated that only about 50-60% of the electricity generated in India is actually metered at the consumers end. The rest goes as T&D losses, un-metered supplies and theft (by unauthorized tapping and tampering of meters). Only the SEBs bills for a part of the metered energy, and only a part of the latter is actually paid for by the consumers. The overall result is that the SEBs get only a fraction of the revenue that they could get, even with the present, un-remunerative tariffs, if metering, bulling and collection were to be done more efficiently. The past experience has generally shown that metering, billing and collection efficiency can be improved only marginally in the present SEB setup, due to various factors. It appears that the only pragmatic approach for tackling this problem is some sort of privatization of distribution, wherein the private entrepreneur or company, and the employees have a personal financial stake in ultimate revenue collection. Privatization of distribution systems, besides enhancing revenue collection (towards restoring the financial viability of ESI) would also provide an immediate and direct path for no-government funds to be applied for distribution system augmentation. This is a very important aspect, particularly when the Central and State governments are not in a position to provide the required funding, Efficiency improvement in the management of the distribution business would be the side benefits of privatization, land the ultimate customer of the ESI, i.e. the consumer, would gain in the long run on all the above counts.
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