CHAPTER-2

ELECTRICITY SECTOR IN INDIA

The electricity sector in India is predominantly controlled by government sector entities via central public sector corporations such as: National Hydroelectric Power Corporation (NHPC), National Thermal Power Corporation (NTPC) and various state level corporations (State Electricity Boards - SEBs). The transmission and distribution is managed by the State Electricity Boards (SEBs) or private companies. The current per capita power consumption during the year 2011-12 is about 794 kWh per year while the world average is 2,596 kWh [1].

India is world's 6th largest energy consumer, accounting for 3.4% of global energy consumption. Due to India's economic rise, the demand for energy has grown at an average of 3.6% per annum over the past 30 years. More than 50% of India's commercial energy demand is met through the country's vast coal reserves. About 76% of the electricity consumed in India is generated by thermal power plants, 21% by hydroelectric power plants and 4% by nuclear power plants [5].

Electricity is central to achieving economic, social and environmental objectives of sustainable human development. In the present digital age electricity has emerged as the most crucial and critical input for sustaining the process of economic as well as social development. Growth of different sectors of economy is not possible without matching development of the electricity sector. In fact it has become essential ingredient for improving the quality of life and its absence is usually associated with poverty and poor quality of life. Sub-transmission and distribution systems constitute the link between electricity utilities and consumers, their revenue realization segment. For consumers, it represents the face of the utility. Efficient functioning of this segment of the utility is essential to sustain the growth of power sector and the economy. However, the present situation is characterized by unacceptably high losses (both technical and
commercial), poor quality and reliability of supply, billing, revenue collection, frequent interruptions in supply and resultant consumer dissatisfaction, etc. Though the Indian power sector has achieved substantial growth during the post-independence era, the sector has been ailing from serious functional problems during the past few decades [6].

Per capita consumption of electricity in India increased from 178 kWh in 1985-86 to 338 kWh in 1996-97 (GOI, 2002) and 665 kWh in 2005-06 to 794 kWh in 2011-12 (General Review 2011). This level of per capita consumption is less than 1/20 th of that prevailing in the US, less than half that in China against the world average of 2400 kWh and the OECD (Organization for Economic Co-operation and Development) average of 6900 kWh [2]. According to the government of India reports, inefficiencies were mainly due to the following reasons:

- Unsatisfactory operational efficiencies, with the availability of thermal plants at less than 80 percent, losses (including theft of power) as high as 20 to 21 percent
- High transmission and distribution losses substantially higher than normal technical standards, with a high component on non-technical losses, accounted for by poor/inadequate metering and high incidence of theft of energy
- Poor billing and collection, because of incorrect reporting and billing, and inadequate collection efforts, tampering with meters and misreporting in collusion with consumers
- Imbalance in the mix of generation sources and undesirable proliferation of captive generating units
- Unmanageable size and monolithic structure, making it unwieldy, inefficient and unresponsive to change as well manpower related problems; poor productivity, low skills and lack of training for upgradation, low motivation levels.
Some 400 million Indians have no access to electricity primarily due to power shortages. While 80 percent of Indian villages have at least an electricity line, just 44 percent of rural households have access to electricity. According to a sample of 97,882 households in 2002, electricity was the main source of lighting for 53% of rural households compared to 36% in 1993. The stolen electricity amounts to 1.5% of GDP. Almost all of the electricity in India is produced by the public sector. As of 2005 the electricity production was at 661.6 billion kWh. In the year 2004-05, electricity demand outstripped supply by 7-11% [2].

2.1 GENERATION AND SALES

Gross generation has become increased from about 670 billion units in 2006-07 to about 811 billion units in year 2010-11, recording an annual average growth of 5.3 percent [1].

![Gross Generation Graph](image)

Figure 2.1 Gross Generation from 2006-07 to 2010-11 in Billion Units

Source: Central Electricity Authority

2.2 ELECTRICITY SALES

The sale of electricity which was about 213 billion units in 1992-93 has increased to 499 billion units by 2009-10. The projected sales are, however,
about 616 Bus by 2011-12. This shows an average grown rate of 7.9 percent. The figure 2.2 shows an average grown rate of 7.9 % [1].

![Figure 2.2 Total Electricity Sales from 2007-08 to 2011-12 (Annual Plan)](image)

Source: Central Electricity Authority

### 2.3 PER CAPITA CONSUMPTION

The per capita consumption of electricity in India was only about 178 units in 1985-86 which increased to 355 units in 1999-2000, registering an average annual growth rate of 7.1 percent. The per capita consumption in 2011-12 has increased to 794 units but it is still very low as compared to the per capita consumption in some select countries. The per capita average annual domestic electricity consumption in India in 2009 was 96 kWh in rural areas and 288 kWh in urban areas for those with access to electricity, in contrast to the worldwide per capita annual average of 2600 kWh and 6200 kWh in the European Union (EU). India’s total domestic, agricultural and industrial per capita energy consumption estimate varies depending on the source. Two sources place it between 400 to 700 kWh in 2008–2009. As of January 2012, one report found the per capita total consumption in India to be 794 kWh. The International Energy Agency estimates India will add between 600 GW to 1200 GW of additional new power generation capacity before 2050. This added new capacity is
equivalent to the 740 GW of total power generation capacity of European Union in 2005. The technologies and fuel sources India adopts, as it adds this electricity generation capacity, may make significant impact to global resource usage and environmental issues [1-3].

![Figure 2.3 Per Capita Electricity (kWh/year) Consumption for Some Countries](image)

**Source:** Central Electricity Authority

### 2.4 GENERATION

In case of India, the total installed capacity in the power sector is increased from 1,32,327 MW in 2006-07 to 1,73,626 MW by 2010-11. This indicates an average annual growth rate of 7.8 percent. The major share in installed capacity is of the thermal sector (about 65% in 2010-11), and within the thermal sector, coal has been the dominant input fuel accounting for about 83 percent of thermal power capacity. The corresponding share of diesel and gas has been approximately 1 percent and 16 percent, respectively [1]

#### 2.4.1 Thermal power

The installed capacity of thermal power in India, as of June 30 2011, was 115649.48 MW, which is 65.34% of total installed capacity.

- Current installed base of coal based thermal power is 96,743.38 MW which comes to 54.66% of total installed base.
- Current installed base of gas based thermal power is 17,706.35 MW which is 10% of total installed capacity.
- Current installed base of oil based thermal power is 1,199.75 MW which is 0.67% of total installed capacity.

According to Ministry of Power (MOP), about 14.1 GW of new thermal power plants under construction are expected to be put in use by December 2012, so are 2.1 GW capacity hydropower plants and a 1 GW capacity nuclear power plant. India's installed generation capacity should be 200 GW in 2012 [3].

![Thermal Power Plant](image1.jpg)

Rajasthan

Maharashtra

Figure 2.4 Thermal Power Plant in Rajasthan and Maharashtra

Thermal power plants convert energy rich fuel into electricity and heat. Possible fuels include coal, natural gas, petroleum products, agricultural waste and domestic trash / waste. Other sources of fuel include landfill gas and biogases. In some plants, renewal fuels such as biogas are co-fired with coal.

Coal and lignite accounted for about 57% of India's installed capacity. However, since wind energy depends on wind speed, and hydropower energy on water levels, thermal power plants account for over 65% of India's generated electricity. India's electricity sector consumes about 80% of the coal produced in the country [11].
India expects that its projected rapid growth in electricity generation over the next couple of decades is expected to be largely met by thermal power plants.

2.4.2 Hydro Power

India is endowed with economically exploitable and viable hydro potential assessed to be about 84,000 MW at 60% load factor. In addition, 6780 MW in terms of installed capacity from Small, Mini, and Micro hydel schemes have been assessed. Also, 56 sites for pumped storage schemes with an aggregate installed capacity of 94,000 MW have been identified. It is the most widely used form of renewable energy. India is blessed with immense amount of hydro-electric potential and ranks 5th in terms of exploitable hydro-potential on global scenario. The present installed capacity as on 30-06-2011 is approximately 37,367.4 MW which is 21.53% of total electricity generation in India.

![Image of Hydro Electric Power Plant](image)

Figure 2.5 Hydro Electric Power Plant

The public sector has a predominant share of 97% in this sector. National Hydroelectric Power Corporation (NHPC), Northeast Electric Power Company (NEEPCO), Satluj Jal Vidyut Nigam (SJVNL) and Tehri Hydro Development Corporation, are few public sector companies engaged in development of hydroelectric power in India [2-3].

In this system of power generation, the potential of the water falling under gravitational force is utilized to rotate a turbine which again is coupled to
a generator, leading to generation of electricity. India is one of the pioneering countries in establishing hydro-electric power plants. The power plants at Darjeeling and Shimsa (Shivanasamudra) were established in 1898 and 1902 respectively and are among the first in Asia. Nagarjuna Sagar Hydroelectric power plant on river Krishna. It is the world's largest masonry dam, with an installed capacity of 800MW. The dam also irrigates about 1.4 million acres of previously drought-prone land. The figure 2.6 shows the Indira Sagar Dam partially completed in 2008.

![Indira Sagar Dam](image)

Figure 2.6 Indira Sagar Dam

Bhakra Beas Management Board (BBMB), an illustrative state owned enterprise in north India, has an installed capacity of 2.9 GW and generates 12000-14000 million units per year. The cost of generation of energy after four decades of operation is about 20 paisa/kWh. BBMB is a major source of peaking power and black start to the northern grid in India. Large reservoirs provide operational flexibility. BBMB reservoirs annually supply water for irrigation to 125 lac (12.5 million) acres of agricultural land of partner states, enabling northern India in its green revolution [3].

**2.4.3 Nuclear Power**

As of 2011, India had 4.8 GW of installed electricity generation capacity using nuclear fuels. It produced over 26000 million units of electricity. India's nuclear power plant development began in 1964. India signed an
agreement with General Electric (GE) of the United States for the construction and commissioning of two boiling water reactors at Tarapur. In 1967, this effort was placed under India's department of Atomic Energy. In 1971, India set up its first pressurised heavy water reactors with Canadian collaboration in Rajasthan. In 1987, India created Nuclear Power Corporation of India Limited (NPCIL) to commercialize nuclear power [3].

Nuclear Power Corporation of India Limited is a public sector enterprise, wholly owned by the Government of India, under the administrative control of its department of atomic Energy. Its objective is to implement and operate nuclear power stations for India's electricity sector. The state-owned company has ambitious plans to establish 63 GW generation capacity by 2032, as a safe, environmentally benign and economically viable source of electrical energy to meet the increasing electricity needs of India [5].

India's nuclear power generation effort satisfies many safeguards and oversights, such as getting ISO-14001 accreditation for environment management system and peer review by World Association of Nuclear Operators including a pre-start up peer review. Nuclear Power Corporation of India Limited admits, in its annual report for 2011 that its biggest challenge is to address the public and policy maker perceptions about the safety of nuclear power, particularly after the Fukushima incident in Japan.

In 2011, India had 18 pressurized heavy water reactors in operation, with another four projects of 2.8 GW capacity launched. The country plans to implement fast breeder reactors, using plutonium based fuel. Plutonium is obtained by reprocessing spent fuel of first stage reactors. India successfully launched its first prototype fast breeder reactor of 500 MW capacities in Tamil Nadu, and now operates two such reactors [1].

India has nuclear power plants operating in the following states: Maharashtra, Gujarat, Rajasthan, U.P, Tamil Nadu and Karnataka. These
reactors have an installed electricity generation capacity between 100 to 540 MW each. New reactors with installed capacity of 1000 MW per reactor are expected to be in use by 2012 [2].

In 2011, The Wall Street Journal reported the discovery of uranium in a new mine in India, the country's largest ever. The estimated reserves of 64,000 tonnes could be as large as 150,000 tonnes (world largest). The new mine is expected to provide India with a fuel that it currently imports. Nuclear fuel supply constraints had limited India's ability to grow its nuclear power generation capacity. The newly discovered ore, unlike those in Australia, is of slightly lower grade. This mine is expected to be in operation in 2012 [3]. The figure 2.7 shows the nuclear power plant in India.

![Figure 2.7 Nuclear Power Plant in India](image)

India's share of nuclear power plant generation capacity is just 1.2% of worldwide nuclear power production capacity, making it the 15th largest nuclear power producer. Nuclear power provided 3% of the country's total electricity generation in 2011. India aims to supply 9% of its electricity needs with nuclear power by 2032. India's largest nuclear power plant project under implementation is at Jaitapur, Maharashtra in partnership with Areva, France [3].
2.4.4 RENEWABLE POWER

Renewable energy in India is a sector that is still in its infancy. As of December 2011, India had an installed capacity of about 22.4 GW of renewal technologies-based electricity, about 12% of its total. For context, the total installed capacity for electricity in Switzerland was about 18 GW in 2009. The table 2.1 provides the capacity breakdown by various technologies.

<table>
<thead>
<tr>
<th>Type</th>
<th>Technology</th>
<th>Installed capacity (in MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid Connected Power</td>
<td>Wind</td>
<td>14989</td>
</tr>
<tr>
<td></td>
<td>Small hydro</td>
<td>3154</td>
</tr>
<tr>
<td></td>
<td>Biomass</td>
<td>1084</td>
</tr>
<tr>
<td></td>
<td>Bagasse Cogeneration</td>
<td>1779</td>
</tr>
<tr>
<td></td>
<td>Waste-to-Energy</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>Solar</td>
<td>46</td>
</tr>
<tr>
<td>Off-Grid, Capative Power</td>
<td>Biomass</td>
<td>141</td>
</tr>
<tr>
<td></td>
<td>Biomass non-Bagasse</td>
<td>326</td>
</tr>
<tr>
<td></td>
<td>Waste-to-Energy</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>Solar</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Aerogen/Hybrids</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2.1 Renewal Energy Installed Capacity in India (as of August 31, 2011)

As of August 2011, India had deployed renewal energy to provide electricity in 8846 remote villages, installed 4.4 million family biogas plants, 1800 micro hydel units and 4.7 million square meters of solar water heating capacity. India anticipates adding another 3.6 GW of renewal energy installed capacity by December 2012 [1].
India plans to add up about 30 GW of installed electricity generation capacity based on renewal energy technologies by 2017. Many renewable energy projects in India are regulated and championed by the central government's Ministry of New and Renewable Energy sources (MNRE)[1].

2.5 TRANSMISSION

Electric power transmission is the bulk transfer of electrical energy, from generating power plants to electrical substations located near demand centres. This is distinct from the local wiring between high-voltage substations and customers, which is typically referred to as electric power distribution. Transmission lines, when interconnected with each other, become transmission networks. Transmission of electricity is defined as bulk transfer of power over a long distance at high voltage, generally of 132kV and above [56]. Sub transmission is part of an electric power transmission system that runs at relatively lower voltages. It is uneconomical to connect all distribution substations to the high main transmission voltage, because the equipment is larger and more expensive. Typically, only larger substations connect with this high voltage. It is stepped down and sent to smaller substations in towns and neighbourhoods. Sub transmission circuits are usually arranged in loops so that a single line failure does not cut off service to a large number of customers for more than a short time [9].

In India bulk transmission has increased from 3,708 km in 1950 to more than 265,000 km today. The entire country has been divided into five regions for transmission systems namely: Northern Region, North Eastern Region, Eastern Region, Southern Region and Western Region. The interconnected transmission system within each region is also called the regional grid.

The transmission system planning in the country, in the past, had traditionally been linked to generation projects as part of the evacuation system. Ability of the power system to safely withstand a contingency
without generation rescheduling or load-shedding was the main criteria for planning the transmission system. However, due to various reasons such as spatial development of load in the network, non-commissioning of load centre generating units originally planned and deficit in reactive compensation, certain pockets in the power system could not safely operate even under normal conditions. This had necessitated backing down of generation and operating at a lower load generation balance in the past. Transmission planning has therefore moved away from the earlier generation evacuation system planning to integrate system planning. Table 2.2 shows the growth of transmission sector since 6th five year plan up to Eleventh Plan.

Table 2.2 Growth of Transmission Sector in India

<table>
<thead>
<tr>
<th>At the End of</th>
<th>Transmission Line (Km)</th>
<th>Central</th>
<th>State</th>
<th>Total</th>
<th>Central</th>
<th>State</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400 kV Transmission Line</td>
<td></td>
<td></td>
<td></td>
<td>220 kV Transmission Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6th Plan</td>
<td>1831</td>
<td>4198</td>
<td>6029</td>
<td>1641</td>
<td>44364</td>
<td>46005</td>
<td></td>
</tr>
<tr>
<td>7th Plan</td>
<td>13068</td>
<td>6756</td>
<td>19824</td>
<td>4560</td>
<td>55071</td>
<td>59631</td>
<td></td>
</tr>
<tr>
<td>8th Plan</td>
<td>23001</td>
<td>13141</td>
<td>36142</td>
<td>6564</td>
<td>73036</td>
<td>79600</td>
<td></td>
</tr>
<tr>
<td>9th Plan</td>
<td>29345</td>
<td>20033</td>
<td>49378</td>
<td>8687</td>
<td>88306</td>
<td>96993</td>
<td></td>
</tr>
<tr>
<td>10th Plan</td>
<td>50992</td>
<td>24730</td>
<td>75722</td>
<td>9444</td>
<td>105185</td>
<td>114629</td>
<td></td>
</tr>
<tr>
<td>11th Plan</td>
<td>59761</td>
<td>27323</td>
<td>87084</td>
<td>10045</td>
<td>11705</td>
<td>121750</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>At the End of</th>
<th>Sub – Station</th>
<th>Central</th>
<th>State</th>
<th>Total</th>
<th>Central</th>
<th>State</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400 kV Transmission Line</td>
<td></td>
<td></td>
<td></td>
<td>220 kV Transmission Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6th Plan</td>
<td>715</td>
<td>8615</td>
<td>9330</td>
<td>500</td>
<td>36791</td>
<td>37291</td>
<td></td>
</tr>
<tr>
<td>7th Plan</td>
<td>6760</td>
<td>14820</td>
<td>21580</td>
<td>1881</td>
<td>51861</td>
<td>53742</td>
<td></td>
</tr>
<tr>
<td>8th Plan</td>
<td>17340</td>
<td>23525</td>
<td>40865</td>
<td>2566</td>
<td>81611</td>
<td>84177</td>
<td></td>
</tr>
<tr>
<td>9th Plan</td>
<td>23575</td>
<td>36805</td>
<td>60380</td>
<td>2866</td>
<td>113497</td>
<td>116363</td>
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<tr>
<td>10th Plan</td>
<td>40455</td>
<td>52487</td>
<td>91942</td>
<td>4276</td>
<td>152221</td>
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<td></td>
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<tr>
<td>11th Plan</td>
<td>53240</td>
<td>55127</td>
<td>108367</td>
<td>4476</td>
<td>168137</td>
<td>172613</td>
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</tr>
</tbody>
</table>

High Voltage Direct Current (HVDC) technology has also been used for interconnection of all regional grids across the country and for bulk
transmission of power over long distances. Certain provisions in the Electricity Act 2003 such as open access to the transmission and distribution network, recognition of power trading as a distinct activity, the liberal definition of a captive generating plant and provision for supply in rural areas are expected to introduce and encourage competition in the electricity sector [5].

2.6 DISTRIBUTION

The total installed generating capacity in the country is over 135,000MW and the total number of consumers is over 144 million. Apart from an extensive transmission system network at 500kV HVDC, 400kV, 220kV, 132kV and 66kV which has developed to transmit the power from generating station to the grid substations, a vast network of sub transmission in distribution system has also come up for utilization of the power by the ultimate consumers [5].

However, due to lack of adequate investment on T&D works, the T&D losses have been consistently on higher side, and reached to the level of 32.86% in the year 2000-01. The reduction of these losses was essential to bring economic viability to the state utilities [5].

As the T&D loss was not able to capture all the losses in the net work, concept of Aggregate Technical and Commercial (AT&C) loss was introduced. AT&C loss captures technical as well as commercial losses in the network and is a true indicator of total losses in the system.

High technical losses in the system are primarily due to inadequate investments over the years for system improvement works, which has resulted in unplanned extensions of the distribution lines, overloading of the system elements like transformers and conductors, and lack of adequate reactive power support [6].

The commercial losses are mainly due to low metering efficiency, theft & pilferages. This may be eliminated by improving metering efficiency, proper energy accounting & auditing and improved billing & collection
efficiency. Fixing of accountability of the personnel managers may help considerably in reduction of AT&C loss [8].

With the initiative of the Government of India and of the states, the Accelerated Power Development & Reform Programme (APDRP) was launched in 2001, for the strengthening of sub-transmission and distribution network and reduction in AT&C losses. The main objective of the program was to bring Aggregate Technical & Commercial (AT&C) losses below 15% in five years in urban and in high-density areas. The program, along with other initiatives of the Government of India and of the states, has led to reduction in the overall AT&C loss from 38.86% in 2001-02 to 34.54% in 2005-06. The commercial loss of the state power utilities reduced significantly during this period from Rs. 29331 crores to Rs. 19546 crores. The loss as percentage of turnover was reduced from 33% in 2000-01 to 16.60% in 2005-06 [5].

2.7 POWER SECTOR REFORMS IN INDIA

2.7.1 The First Phase

The Indian power sector had reached the absolute dead-end by the 1980s. The total losses of the SEBs without subsidy had crossed Rs. 3000 crores. There was little hope of any cure unless some drastic measures were taken. The sector was facing peaking shortages in various parts of the country and severe financial burden was imposed on the State Governments because of the performance of the SEBs [38].

In 1989, the World Bank had stated that request from the electricity sector from developing countries added up to $ 100 billion and only about $ 20 billion was available from multilateral sources [43]. Furthermore, there were no surpluses left within the sector for investment purposes. However, nothing really happened till 1991 when the existing electricity laws were amended to provide for private participation in generation. Specifically, the Electricity Laws (Amendment) Act of 1991 was enacted to encourage the entry of privately owned generators [46]. The change in
policy coincided with the fact that India was facing its worst ever balance-of-payments crisis and was on the verge of defaulting which would have reduced India’s bond rating in international credit markets. Further amendments were carried out in 1998 when the transmission sector was also opened for private investments subject to the approval of the Central Transmission Utility (CTU) [50]. It was the Government’s viewpoint that if additional generation capacity could be created with the assistance of the private sector, the malaise could be rectified. In order to encourage private sector participation, several other policy measures were also undertaken. The private investors were offered a guaranteed 16 percent return in equity with a full five year tax holiday. The required debt-equity ratio was also kept at 4:1. These projects were also given sovereign guarantees and escrow benefits in case there were defaults on part of the SEBs. By 1995, there were about 189 offers to increase capacity by over 75 GW involving a total investment of over US $ 100 billion. Eight projects were brought on the “fast-track” route where Government approvals were quickly expedited. In fact, some of the banks like the State Bank of India, which gave overdraft facilities to the SEBs, refused to lift its lien on the receivables of the SEBs. The IPPs faced all kind of problems, right from securing coal contracts to getting wagons from the railways for movement of their coal. There were other reasons also as to why this policy failed, for example, litigation in case of some projects, inability to secure funding from financial institutions since power projects required long pay-back periods etc. The private investors also realised that by providing incentives for additional capacity addition, the basic problem that is the bankruptcy of the SEBs does not get addressed. In fact, the problems would multiply as power from the new plants, if they do come up ultimately, would be a lot more expensive than the existing plants of the SEBs. Some economists have stated that the energy cost from these projects frequently turned out to be one-and-a-half to two times more than that of comparable NTPC and SEB projects. The high tariff was because of
high return on equity, high capital cost of plants, high variable costs due to management fee, testing fee, insurance charges etc. In the meantime some kind of political consensus was taking shape regarding reforms in the power sector. It began in 1991 when a committee was set up for the establishment of a common minimum agricultural tariff. The matter gained momentum when in 1996; the Chief Ministers conference proposed that agriculture tariffs should be at least 50 paisa per unit which should be increased to at least 50 per cent of the average cost of supply within a period of 3 years. It is another matter, however, that no state implemented it. It may be pertinent to add that the Indian agricultural community in fact was prepared to higher tariffs in exchange for a better quality of power. The small farmers, in any case, maintained that low agricultural tariffs only helped the big farmers who had access to power driven irrigation facilities. There is one study which states that the agricultural community was, in fact, capable of paying higher tariffs and gain by the incremental productivity [1].

2.7.2 The World Bank and Reforms

During the 1980s and early 1990s, the World Bank lending had been influenced by what is known as the ‘Washington consensuses. According to this, the development processes were hindered less by capital shortages, and more by economic policies that hindered market forces. The bank, therefore, began approaching privatisation as a serious policy option. The World Bank, incidentally, had assisted various power sector projects, especially at the time the NTPC was set up in 1974. It is felt that the World bank was interested in the creation of the NTPC because the Bank felt that their loans were better assured as the NTPC projects were expected to be better managed as compared to SEB projects. Over time, however, the World Bank was desirous of moving away from generation because of environmental issues. Since coal was the primary fuel for power generation which gave rise to environmental de-gradation, the Bank wanted to support projects which envisaged restructuring of the sector,
namely reforms. Of course, from this point of view, hydro projects were welcome. Orissa was the first State to get assistance from the World Bank for restructuring. In Orissa, the generating plants were running at 36 percent PLF in 1993-94, transmission and distribution losses were at 43 percent and the proportion of bills collected was only 17 percent. The entire Orissa project was in three parts and the total cost of the project was US $ 997.2 million. The World Bank provided $ 350 million and the Overseas Development Agency of the UK provided $ 110 million. There were reasons as to how it all started in Orissa. It is said that the World Bank was already negotiating a loan for the development of a hydro project. Assistance for the project was linked to reforms in the sector, leaving the State Government with no other alternative. Further, Orissa was ideally suited for reforms because its agricultural share in sales was only 6 per cent (compared to 40 percent in some other states) which meant that there was no lobby which could derail the reform process. Typically, the “Orissa Model” as it came to be called involved restructuring of the monolithic SEB into separate generation, transmission and distribution sub-sectors. Specifically, the distribution segment of the Orissa State Electricity Board (OESB) was divided into four regional utilities and later on privatised. The transmission assets remained under public ownership with the Grid Corporation of Orissa (GRIDCO). The existing hydro generation assets were vested with the Orissa Hydro Power Corporation (OHPC) and the thermal capacity of the OSEB had to be transferred to the NTPC to settle the dues of the OSEB with the NTPC. This restructuring was made possible through the Orissa Electricity Reforms Act 1995 [1].

2.7.3 The Second Phase of Reforms– Electricity Regulatory Commissions Act 1998

While Orissa was the first state to enact their own reforms act, it was followed by other states like Haryana (1997), Andhra Pradesh (1998), Uttar Pradesh (1999), Karnataka (1999), Rajasthan (1999), Delhi (2000), Madhya Pradesh (2000) and Gujarat (2003). Each of these states, after passing their
reforms act, unbundled their SEBs into separate entities of generation, transmission and distribution. The only difference was in the case of Orissa and Delhi which went a step further and privatised their distribution sector as well. In the meantime around the mid-1990s, the Government of India too had come to realise that the distribution sector will have to be addressed first and if the problems in the distribution sector can be addressed, investments in the generation sector will automatically flow. The Government of India therefore passed an ordinance which later culminated as the Electricity Regulatory Commissions Act 1998. It was similar to the Orissa Reforms Act and it paved the way for setting up of the Central Electricity Regulatory Commission. The states could also rely on this Act to set up their own State commissions or enact their own legislations for this purpose. The functions of the CERC and the SERCs were clearly demarcated. While the CERC was responsible for all centrally owned stations and other stations having an inter-state role, the SERCs were responsible for stations within their own state only. The primary intention for setting up of regulatory commissions was to ensure that tariffs were determined according to economic principles and that the entire process be free from any political interference. The role of the Government was only that of a facilitator and catalyst which would lay down broad principles of policy [1].

The enactment of the Electricity Regulatory Commissions Act 1998 was only a partial step towards reforms. The Government of India had been mulling over a comprehensive reform act which would repeal all other existing electricity laws. The first draft of the Bill was made in 2000 though there were some other steps taken by the Government during this time period to improve the functioning of the distribution sector. Three major steps were taken by the Government for improving the performance of the power sector. The first was the initiation of the Accelerated Power Development Program (APDP) in 2000-01 which focussed on giving a composite loan/grant for improving the infrastructure of the electricity
utilities. In 2002-03, under the recommendations of the Deepak Parikh committee, the structure of the scheme was changed and an incentive component was added as well. The name of the scheme was changed to the Accelerated Power Development and Reforms Program (APDRP) and the funding was made extremely liberal. The second major step taken was the constitution of the expert committee for making recommendations for one-time settlement of outstanding dues of all SEBs towards central public sector undertakings and for suggesting a strategy for capital restructuring of the SEBs. This committee was chaired by Sh. Montek Singh Ahluwalia, the then Member (Energy), Planning Commission. The committee recommended that 50 percent of the surcharge/interest on delayed payments be waived. The rest of the dues along with full principal amount aggregating to about Rs. 33,600 crores be securised through bonds issued by the respective state Governments. The bonds were to be issued through the RBI at a tax-free interest rate of 8.5 percent per annum. The third initiative taken by the Government was to sign Memorandum of Understanding (MOU) with the State governments with the intention of accelerating the process of reforms. The state governments were encouraged to set up their own electricity regulatory commissions, undertake 100 percent metering, conduct energy audits at 11 KV level, impose minimum agricultural tariff as decided in the Chief Ministers’ conference, pay subsidies on time etc. In return, the central government promised to increase the share of the State concerned from central generating stations, upgrade the inter-state transmission lines through APDRP funding, extend help for the state’s rural electrification program and provide other financial benefits. By 2005, the central Government had signed MOUs with all of India’s 28 states [1].

2.7.4 The Electricity Act - 2003

The Electricity Act (EA) 2003 came into being in June 2003. This Act repealed all the existing electricity laws, such as, the Indian Electricity Act 1910, the Electricity Supply Act 1948 etc. but saved the various reform acts
of some of the states which were already in operation. The preamble of the EA2003 states the following:

‘An Act to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity of all areas, rationalisation of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto’

The primary objective of the EA 2003 has been to promote competition in order to enable the consumers to have the best possible price and quality of supply. In order to have competition, one needs a large number of sellers and buyers and this is exactly what the EA 2003 has attempted through its various provisions. Before speaking of the various provision to promote competition, one of the most crucial (and debateable) statute needs to be mentioned i.e. Restructuring of the existing SEBs in a time-bound manner. The EA 2003 mentions that all SEBs have to be unbundled into separate entities of generation, transmission and distribution (Section 131 and 172). The model to be adopted would be similar to the “World Bank” model which had been followed by Orissa to begin with and thereafter, emulated by some other states. This type of model is also called the “the single buyer mode”. This directive of the EA 2003 has been criticised in many quarters where the opinion has been that restructuring need not be necessary and that vertical utilities have also done well in some cases in India and abroad. In order to enhance generation, licensing has been done away with completely except that techno-economic clearance would be required for hydro projects (Sections 7 and 8). Captive generation has been promoted and in fact, the definition for captive has been kept very wide, making it easier for the industry to opt for captive power plants (section 9). Open access in distribution, to be
introduced in a phased manner, has been recognised wherein a bulk consumer can access power from any other source provided certain technical constraints are met (Section 42). The EA 2003 also recognised the existence of two or more distribution licensees in the same geographical area, with the proviso that each will have its own set of wires (Section 14). This, however, is a debateable concept given the monopolistic nature of the wires business. On the issue of pricing, the provision of the Sixth Schedule of the Electricity Supply Act 1948 has been done away with and the job of price determination has been handed over to the regulatory commissions. The constitution of the state regulatory commissions was mandatory (Section 82). Power trading has been recognised as a distinct activity with the safeguard that regulatory commissions are authorised to fix ceilings on trading margins, if necessary (Sections 12, 79 and 86). For the benefit of consumers, certain institutions like the consumers redress forum and their appellate body, the ombudsman, has been envisaged (Section 42). There are other safeguards as far as the consumer is concerned with special emphasis on performance standards (Sections 57 to 59). At the same time, in order to plug revenue leaks, 100 percent metering has been made compulsory (Section 55) and provisions relating to theft of energy have been made very stringent (Sections 135 to 150) [1].

Recognizing the need for the Reform process covering the entire facets of the electricity sector comprising generation, transmission and distribution to the consumers, a comprehensive electricity bill was drafted in 2000 following a wide consultative process [5]. After a number of amendments, the bill finally sailed through the legislative process and was enacted on 10 June, 2003. It replaces the three existing legislations governing the power sector, namely Indian Electricity Act, 1910, the Electricity (Supply) Act, 1948 and the Electricity Regulatory Commissions Act, 1998. The Electricity Act, 2003 mandates that Regulatory Commissions shall regulate tariff and issue of licenses and that State Electricity Boards (SEBs) will no longer exist in the existing form and will be restructured into separate generation,
transmission and distribution entities. Regulatory function has been taken away from the purview of the government. The Electricity Act, 2003 mandates licensee-free thermal generation, non-discriminatory open access of the transmission system and gradual implementation of open access in the distribution system which will pave way for creation of power market in India. The main provisions of the act are:

- De-licensing of thermal generation and captive generation.
- Open access in distribution to be introduced in phases
- Provision for license-free generation and distribution in rural areas and provision for management of rural distribution by Panchayats, Cooperative Societies, nongovernment organizations, franchisees, etc.
- Non-discriminatory open access in transmission
- Multiple licensing in distribution
- Mandatory metering of all electricity supplies
- Adoption of multi-year tariff principles
- Provision for cross-subsidy surcharge on direct sale to consumers
- Power Trading recognized as a distinct activity with ceilings on trading margins to be fixed by the Regulatory Commissions
- Upfront payment of subsidies by the States
- Setting up of an Appellate Tribunal to hear appeals against the decisions of the CERC and the SERCs.

The Act is aimed at providing an investor friendly environment for potential developers in the power sector by removing administrative hurdles in the development of power projects and shall provide impetus to distribution reform to be undertaken in India. Provisions like de-licensing of thermal generation, open access and multiple licensing; no surcharge for captive generation shall be the basis for a competitive environment in the Indian power sector. Provisions of open access would be instrumental in the development of competitive power markets, and
multi year tariffs shall bring in necessary incentives for performance improvement and to reduce regulatory risk [5].

2.7.5 Power for All By 2012

The Government of India has an ambitious mission of POWER FOR ALL BY 2012. This mission would require that our installed generation capacity should be at least 200,000 MW by 2012 from the present level of 144,564.97 MW. Power requirement will double by 2020 to 400,000MW.

OBJECTIVES

◆ Sufficient power to achieve GDP growth rate of 8%
◆ Reliable power and quality power
◆ Optimum power cost
◆ Commercial viability of power industry
◆ Power for all

STRATEGIES

◆ Power generation strategy with focus on low cost generation, optimization of capacity utilization, controlling the input cost, optimization of fuel mix, technology up gradation and utilization of non conventional energy sources.
◆ Transmission strategy with focus on development of national grid including interstate connections, technology up gradation & optimization of transmission cost.
◆ Distribution strategy to achieve distribution reforms with focus on system up gradation, loss reduction, theft control, consumer service orientation, quality power supply commercialization, decentralized distributed generation and supply for rural areas.
◆ Regulation strategy aimed at protecting consumer interests and making the sector commercially viable.
◆ Financing strategy to generate resources for required growth of the power sector.
Conservation strategy to optimize the utilization of electricity with focus on demand side management, load management and technology up-gradation to provide energy efficient equipments.

Communication strategy for political consensus with media support to enhance the general public awareness.

2.8 PROBLEMS WITH INDIAN POWER SECTOR

India’s electricity sector faces many issues. Some are:

- Government giveaways such as free electricity for farmers, partly to curry political favour, have depleted the cash reserves of state-run electricity-distribution system. This has financially crippled the distribution network, and its ability to pay for power to meet the demand. This situation has been worsened by government departments of India that do not pay their bills.

- Shortages of fuel: despite abundant reserves of coal, India is facing a severe shortage of coal. The country isn't producing enough to feed its power plants. Some plants do not have reserve coal supplies to last a day of operations. India's monopoly coal producer, state-controlled coal India, is constrained by primitive mining techniques and is rife with theft and corruption; coal India has consistently missed production targets and growth targets. Poor coal transport infrastructure has worsened these problems. To expand its coal production capacity, coal India needs to mine new deposits. However, most of India's coal lies under protected forests or designated tribal lands. Any mining activity or land acquisition for infrastructure in these coal-rich areas of India has been rife with political demonstrations, social activism and public interest litigations.

- The giant new offshore natural gas field has delivered less fuel than projected. India faces a shortage of natural gas.
Hydroelectric power projects in India's mountainous north and northeast regions have been slowed down by ecological, environmental and rehabilitation controversies, coupled with public interest litigations.

India's nuclear power generation potential has been stymied by political activism since the Fukushima disaster in Japan.

Average transmission, distribution and consumer-level losses exceeding 30%.

Over 300 million people in India have no access to electricity. Of those who do, almost all find electricity supply intermittent and unreliable.

Lack of clean and reliable energy sources such as electricity is, in part, causing about 800 million people in India to continue using traditional energy sources – namely fuel wood, agricultural waste and livestock dung – for cooking and other domestic needs. Traditional fuel combustion is the primary source of indoor air pollution in India, causes between 300,000 to 400,000 deaths per year and other chronic health issues.

2.9 RESOURCE POTENTIAL IN POWER SECTOR

According to Oil and Gas Journal, India had approximately 38 trillion cubic feet (Tcf) of proven natural gas reserves as of January 2011, world’s 26th largest. United States Energy Information Administration estimates that India produced approximately 1.8 Tcf of natural gas in 2010, while consuming roughly 2.3 Tcf of natural gas. The electrical power and fertilizer sectors account for nearly three-quarters of natural gas consumption in India. Natural gas is expected to be an increasingly important component of energy consumption as the country pursues energy resource diversification and overall energy security. Until 2008, the majority of India's natural gas production came from the Mumbai high complex in the northwest part of the country. Recent discoveries in the
Bay of Bengal have shifted the centre of gravity of Indian natural gas production [66].

The country already produces some coal bed methane and has major potential to expand this source of cleaner fuel. According to a 2011 Oil and Gas Journal report, India is estimated to have between 600 to 2000 Tcf of shale gas resources (one of the world’s largest). Despite its natural resource potential, and an opportunity to create energy industry jobs, India has yet to hold a licensing round for its shale gas blocks. It is not even mentioned in India’s central government energy infrastructure or electricity generation plan documents through 2025. The traditional natural gas reserves too have been very slow to develop in India because regulatory burdens and bureaucratic red tape severely limit the country’s ability to harness its natural gas resources [65-66].

2.10 RURAL ELECTRIFICATION

India’s Ministry of Power launched Rajiv Gandhi Grameen Vidyutikaran Yojana as one of its flagship programme in March 2005 with the objective of electrifying over one lakh un-electrified villages and to provide free electricity connections to 2.34 crores rural households. This free electricity program promises energy access to India’s rural areas, but is in part creating problems for India’s electricity sector.

2.11 HUMAN RESOURCE DEVELOPMENT

Rapid growth of power sector in India demands that talent and trained personnel become available as India’s new installed capacity adds new jobs. India has initiated the process to rapidly expand energy education in the country, to enable the existing educational institutions to introduce courses related to energy capacity addition, production, operations and maintenance, in their regular curriculum. This initiative includes conventional and renewal energy [66].

A Ministry of Renewal and New Energy announcement claims State Renewable Energy Agencies are being supported to organize short-term
training programmes for installation, operation and maintenance and repair of renewable energy systems in such places where intensive RE programme are being implemented. Renewable Energy Chairs have been established in IIT Roorkee and IIT Kharagpur [66]. Education and availability of skilled workers is expected to be a key challenge in India's effort to rapidly expand its electricity sector.

India lit up at night. This media, courtesy of NASA, was taken by the crew of expedition 29 on October 21, 2011. It starts over Turkmenistan, moving east. India begins past the long wavy solid orange line, marking the lights at the India-Pakistan borderline. New Delhi, India's capital and the Kathiawar Peninsula are lit. So are Mumbai, Hyderabad, Chennai, Bangalore and many smaller cities in central and southern India, as this International Space Station's video shifts south-eastward through southern India, into the Bay of Bengal. Lightning storms are also present, represented by the flashing lights throughout the video. The pass ends over western Indonesia.