EVOLUTION AND GROWTH OF POWER SECTOR IN INDIA

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Abstract:

India's Ministry of Power administers central government owned companies involved in the generation of electricity in India. These include National Thermal Power Corporation, Damodar Valley Corporation, National Hydroelectric Power Corporation and Nuclear Power Corporation of India. The Power Grid Corporation of India is also administered by the Ministry; it is responsible for the inter-state transmission of electricity and the development of national grid.

The Ministry works with various state governments in matters related to state government owned corporations in India's electricity sector. Examples of state corporations includeKarnataka power corporation limited, Andhra Pradesh Power Generation Corporation Limited, Tamil Nadu Electricity Board, Maharashtra State Electricity Board, Kerala State Electricity Board, and Gujarat Urja Vikas Nigam Limited.

Introduction:

Rapid growth of electricity 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.

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.[3]

Education and availability of skilled workers is expected to be a key challenge in India's effort to rapidly expand its electricity sector.

Electricity Generation in india

The electricity sector in India had an installed capacity of 199.87 Gigawatt (GW) as of March 2012, the world's fifth largest.[1] Captive power plants generate an additional 31.5 GW. Thermal power plants constitute 64.6% of the installed capacity, hydroelectric about 24.7% and nuclear 2.9% and rest being a combination of wind, small hydro, biomass, waste-to-electricity, i.e Renewable resorces. India generated 855 BU electricity during 2011-12 fiscal.

Electricity Generation in india

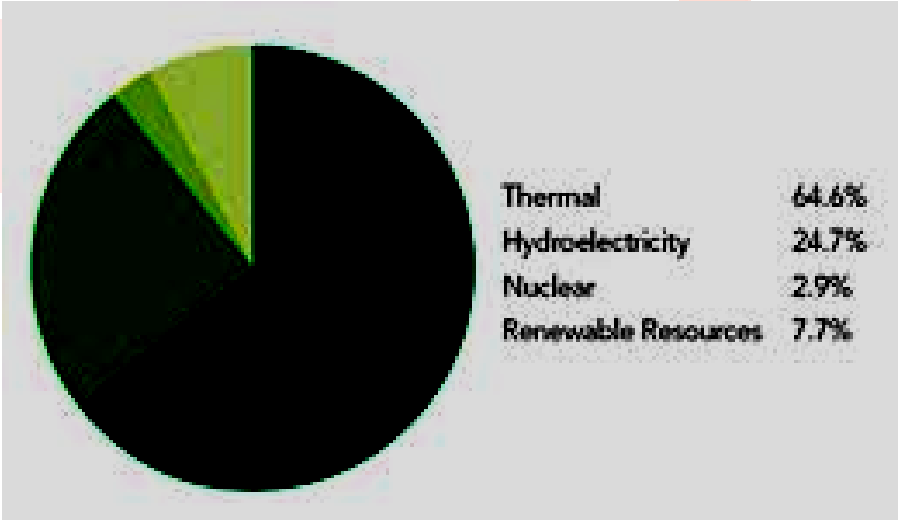

Diagram-3.1

Source: Power sector at a glance: All India data". Ministry of Power, Government of India. October 2011.

In terms of fuel, coal-fired plants account for 55% of India's installed electricity capacity, compared to South Africa's 92%; China's 77%; and Australia's 76%. After coal, renewal hydropower accounts for 21%, and natural gas for about 10%.[2][3]

Government owned power companies

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Human resource development

Rapid growth of electricity 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.

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Thermal power

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.

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.

Fuel constraints

A large part of Indian coal reserve is similar to Gondwana coal. It is of low calorific value and high ash content. The iron content is low in India's coal, and toxic trace element concentrations are negligible. The natural fuel value of Indian coal is poor. On average, the Indian power plants using India's coal supply consume about 0.7 kg of coal to generate a kWh, whereas United States thermal power plants consume about 0.45 kg of coal per kWh.

The high ash content in India's coal affects the thermal power plant's potential emissions. Therefore, India's Ministry of Environment & Forests has mandated the use of beneficiated coals whose ash content has been reduced to 34% (or lower) in power plants in urban, ecologically sensitive and other critically polluted areas, and ecologically sensitive areas. Coal benefaction industry has rapidly grown in India, with current capacity topping 90 MT.

Thermal power plants can deploy a wide range of technologies.

Some of the major technologies include:

1. Steam cycle facilities (most commonly used for large utilities);

2. Gas turbines (commonly used for moderate sized peaking facilities);
3. Cogeneration and combined cycle facility (the combination of gas turbines or internal combustion engines with heat recovery systems); and
4. Internal combustion engines (commonly used for small remote sites or stand-by power generation).

India has an extensive review process, one that includes environment impact assessment, prior to a thermal power plant being approved for construction and commissioning. The Ministry of Environment and Forests has published a technical guidance manual to help project proposers and to prevent environmental pollution in India from thermal power plants.[4]

Installed thermal power capacity

- The installed capacity of Thermal Power in India, as of June 30 2011, was 115649.48 MW which is 65.34%[4] 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 10.00% 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.

The state of Maharashtra is the largest producer of thermal power in the country.

INDIAN POWER INDUSTRY

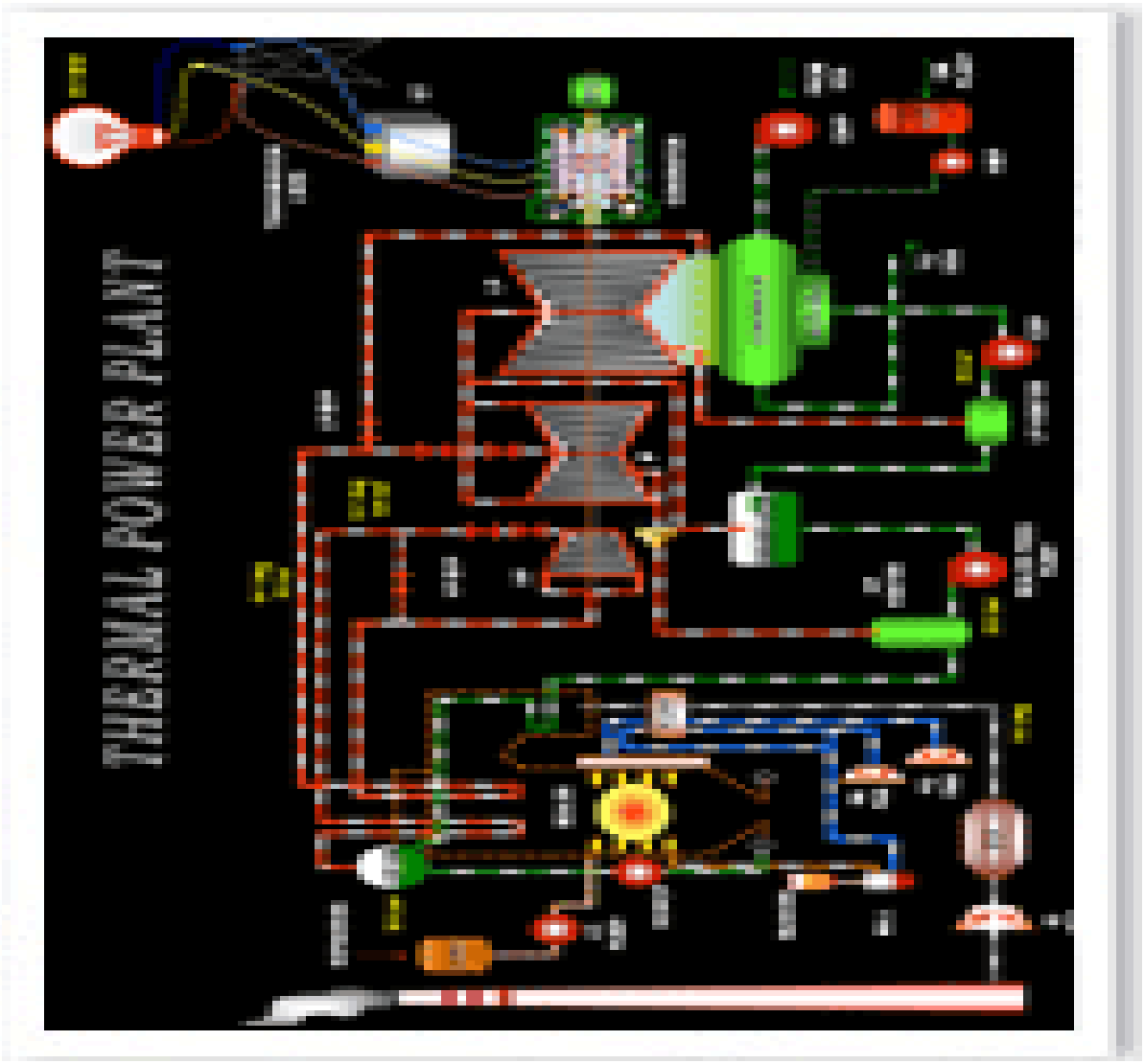
1) Power Generation

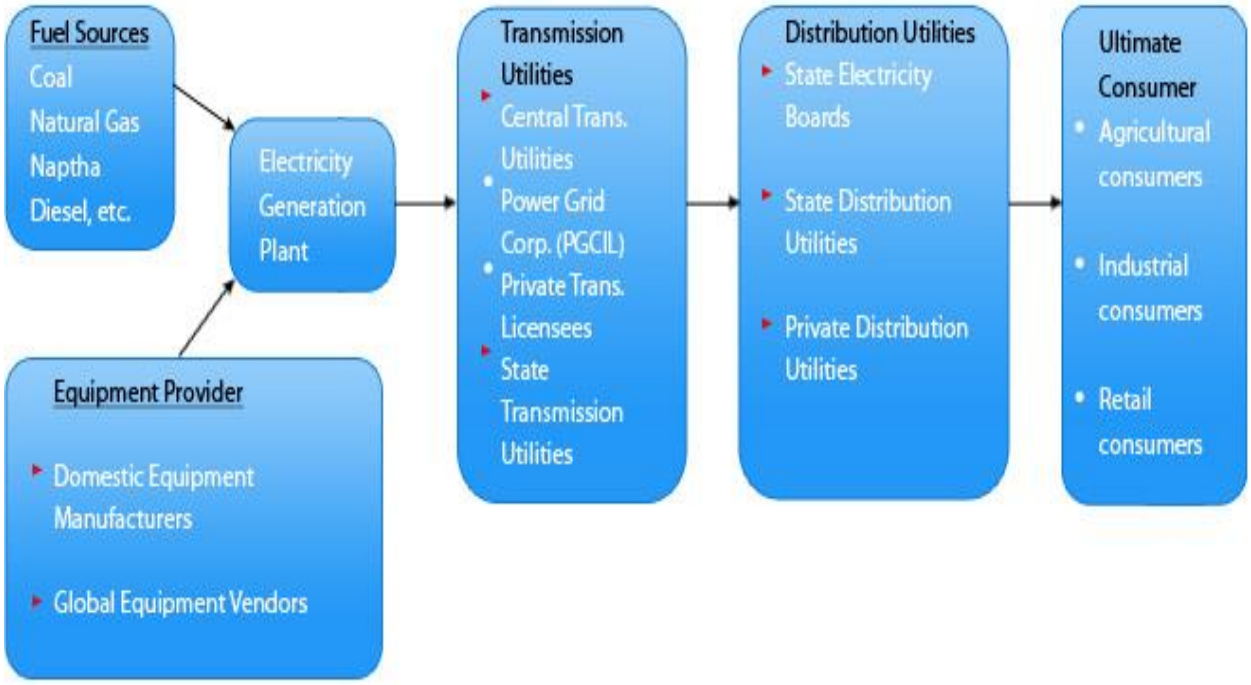
Electricity Generation covers a long chain from the fuel source to the ultimate consumer of power.

a)Power Chain

LAYOUT OF THERMAL POWER PLANT

Photo—3.1





Suorce:www.reliancepower.co/power_industry/power_generation/supply_chain.htm

b)Working of a power plant

Since most of the projects have such a long time frame, there are some inherent risks in both the internal and external environment.

Working of a power plant

Photo-3.2

Thermal power plants are one of the main sources of electricity in both industrialized and developing countries. The variation in the thermal power stations is due to the different fuel sources (coal, natural gas, naptha, etc). In a thermal power plant, one of coal, oil or natural gas is used to heat the boiler to convert the water into steam. In fact, more than half of the electricity generated in the world is by using coal as the primary fuel.

The function of the coal fired thermal power plant is to convert the energy available in the coal to electricity. Coal power plants work by using several steps to convert stored energy in coal to usable electricity that we find in our home that powers our lights, computers, and sometimes, back into heat for our homes. The working of a coal power plant is explained in brief:

Firstly, water is taken into the boiler from a water source. The boiler is heated with the help of coal. The increase in temperature helps in the transformation of water into steam. The steam generated in the boiler is sent through a steam turbine. The turbine has blades that

rotate when high velocity steam flows across them. This rotation of turbine blades is used to generate electricity. A generator is connected to the steam turbine. When the turbine turns, electricity is generated and given as output by the generator, which is then supplied to the consumers through high-voltage power lines.

Apart from thermal power plants, there are other types of energy resources being used to generate electricity. The various types of energy sources include hydro electricity, solar power, wind power, nuclear power, etc.

c) Hydro electricity

Hydroelectric power or hydroelectricity is electrical power which is generated through the energy of falling water. A hydroelectric power plant uses the force of the water to push a turbine which in turn powers a generator, creating electricity which can be used on-site or transported to other regions. This method of energy generation is viewed as very environmentally friendly by many people, since no waste occurs during energy generation. It is the most widely used form of renewable energy.

d)Solar Power

Solar power is energy that is derived from the sun and converted into heat or electricity. It is a versatile source of renewable energy that can be used in an amazing number of applications. Energy from the sun can be converted into solar power in two ways. The first way of obtaining solar power involves the use of photoelectric applications. Photoelectric applications use photovoltaic cells in converting energy from the sun into electricity. The second way involves the use of solar thermal applications wherein heating a transfer fluid is done to produce steam to run a generator.

e) Wind Energy

Wind power is power which is derived from wind. There are a number of ways to collect and use wind power, and wind power is among the most ancient forms of energy used by

humans.Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electricity.

f) Nuclear Power

Nuclear energy is produced in two different ways. In one method, large nuclei are split to release energy. Here, nuclear energy originates from the splitting of uranium atoms in a process called fission. At the power plant, the fission process is used to generate heat for producing steam, which is used by a turbine to generate electricity. In the other method, small nuclei are combined to release energy.

2) Indian power sector

***History and Evolution**

Electricity, as we know it, is largely a product of eighteenth and nineteenth century scientific and engineering developments. Many electro-scientific discoveries were made in the early part of the nineteenth century, but it was only when significant engineering breakthroughs were made resulting in the development of electro-mechanical generators and transformers that substantial amounts of electricity could be produced and distributed. Very soon it became possible to generate electricity at large central power stations, where economies of scale meant that widespread electrification switched from dream to reality.

The US was the first country that generated electricity followed by United Kingdom after 6 years. CESC Limited is the pioneer in the history of generation of electricity in India. It commenced power generation and distribution in Kolkata, in 1899. CESC started as Kilburn & Co when the company acquired the license to provide electricity to Calcutta city on January 7, 1897. The electrification of Kolkata city took place seventeen years after New York, which boasted of Electricity in 1882 and eleven years after London, which was electrified in 1888. India also started hydro electric generation by the end of 19th century. The power plant at Darjeeling and Shimsha (Shivanasamudra) was established in 1898 and 1902 respectively and is one of the first in Asia. The 4.5 megawatt hydroelectric power station near Sivasamudram falls of the Cauvery in Karnataka was the first major power station in India.

The Indian power sector has been regulated for almost a century and the Electricity Act 1910 was the first act that was introduced to govern the Indian power sector. The Electricity (Supply) Act 1948 was introduced after independence, but it did not achieve the desired results. , as the power sector's performance started to deteriorate and a need was felt to restructure the sector. Several regulatory changes were made since 1991, which transformed the industry's performance.

Based on the government's regulations and policies, the evolution of the Indian power industry can be divided into two broad phases, pre-reform and post-reform phases. The pre-reform phase (up to 1991) can be divided into pre-independence phase (prior to 1947) and post-independence phase (1947-1990) and post-reform phase.

Post-independence, the Government of India decided to entrust the development of the electricity sector to respective states through the creation of State Electricity Boards (SEBs). SEBs were expected to develop networks of transmission lines which till then had been quite under-developed, and add generation capacity. But SEBs fared miserably and by the 70s, many of the SEBs started incurring losses because of many factors including direct political interference in SEBs operation by their respective governments, mismanagement, poor industrial relations, etc.

The low tariffs for agricultural sector were sought to be covered through higher tariffs on industrial and commercial consumers. But the distortions of such cross subsidization, resulted in increasing theft and leakages, loss of accountability of revenue and misreporting. Losses of the SEBs mounted this made SEBs increasingly dependent on budgetary allocations from their respective governments reducing their ability to add generating capacity, and most importantly to carry out the periodic maintenance and upkeep of their distribution assets.

Given the deteriorating financial performance and poor operating performance of SEBs, the onus of setting up new generation capacities fell increasingly on the Central Government. It was in such a situation that the central government set up two central sector utilities; NTPC (National Thermal Power Corporation Limited) for thermal generation and NHPC (National Hydro Power Corporation Limited) for hydro power. Over the 1980s, energy shortages and poor financial condition of SEBs continued. The need to control fiscal deficit led to initiation of

reforms in the Electricity Sector in early 1990s with opening of the sector for private Independent Power Producers (IPPs).

Following the liberalisation and reform of the economy in 1991-92, the electricity sector too witnessed major policy and regulatory initiatives. Recognizing that electricity and other infrastructure sectors required substantial investments in the face of resource constraints; investment by the private sector (including foreign capital) were allowed in electricity generation. Prior to this, save some private sector licensees operating in a few urban areas,

the electricity sector was mostly in the hands of state electricity boards (SEBs) or central government owned utilities created to supplement the efforts of SEBs in generation and transmission sub-sectors. As the entities got unbundled and the role of the private sector in electricity was set in motion through the IPPs, the need for independent regulators was obvious since now there was private sector when the state itself had a significant market role.

The institution of independent regulation, the Central Government's guidance and direction of reform efforts, unbundling of the sector, legal initiatives to bring in competition, programmes to improve technical and operational efficiency of the sector to effectively procure power on a long term basis on behalf of state governments, have been initiated since then. The changes that these initiatives have brought about, while significant, have not necessarily been in the direction intended, and the core problems of leakage, viability of distribution, tariff reform and competition still remain to be addressed successfully.

The most important amongst all the policies announced by the government is the enactment of the Electricity Act. The year 2003 marked a new beginning of reforms in the Electricity Sector in India with enactment of the Electricity Act replacing the legal framework for the sector hitherto governed by the Electric Supply Act of 1948 and the ERC Act of 1998. There have been a slew of regulatory changes after the enactment of the Electricity Act in 2003 which have opened up the power generation sector and driven the sector on a high growth trajectory.

In pursuance of the provisions of the Electricity Act 2003, the Central Government came out with National Electricity Policy on 6th February 2005. Over the past few years, the Government of India has undertaken several legislative measures and carried out extensive

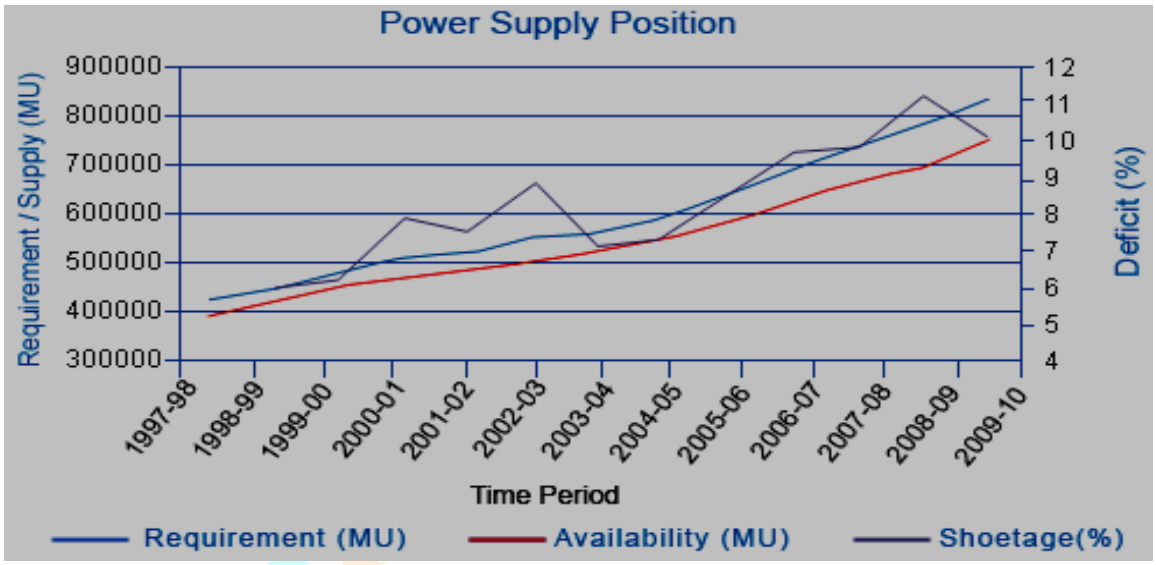
policy reforms with a view to accelerating the growth of the power sector and encouraging greater private participation. Some of these measures include National Tariff Policy, National Electricity Plan, Competitive Bidding Guidelines, and Ultra Mega Power Projects.

Now 100 percent Foreign Direct Investment (FDI) is allowed in generation, transmission and distribution segments. Incentives are given to the sector through waiver of duties on capital equipments under the Mega Power Policy. These policy initiatives have resulted in building up investor confidence in the power sector and have created an ideal environment for increased participation by the private sector.

***Demand supply Situation**

The Indian power sector has grown significantly since 1947 and India today is the third largest producer of power in Asia. The power generating capacity has increased from 1,362 MW in 1947 to over 160,000 MW by mid of 2010. Despite significant growth in electricity generation over the years, the shortage of power continues to exist primarily on account of growth in demand for power outstripping the growth in generation and capacity additions in power generation.

Historically, India has experienced shortages in energy and peak power requirements. The average energy deficit was 9.1 percent and the average peak power deficit was 12.8 percent between 2003 and 2010. The gap between demand and supply has not decreased in the last few years, leading to persistent power shortages.



Source: CEA, Power Scenario at a Glance, July 2010

Diagram—3.3

***Generation Statistics**

Power Generation capacity has inceased from 1362 MW in 1947 to 160,000MW by mid of 2010 As of march 31,2012 India had an installed power capacity of almost 200,000MW.

Installed power capacity

Table—3.1

Sector	Hydro	Thermal				Nuclear	RES	Total
		Coal	Gas	Diesel	Toal		MNRE	
State	27380	49457	4965	603	55025	0	3514	85919
PVT	2525	23450	6713	597	30761	0	20990	54276
Central	9085	39115	6702	0	45817	4780	0	59683
Total	0	112022	18381	1200	131603	4780	24503	199877

Source: CEA, Power Scenario at a Glance, July 2010

3)Regulatory Developments

- **Developments Recent**

There have been multiple reforms aimed at increasing participation and introducing competition in the sector. The government is keen to provide a level playing field for all participants and has hence introduced regulations providing opportunities in domains earlier not available to the private sector and more clarity on various aspects. The government is also taking a long term view of how things ought to be shaped and has introduced regulations which will help in the long and sustainable growth of the sector. Some key regulatory changes have been introduced recently were as below:

- **Regulation on Renewable Energy Certificates (REC)**

The REC regulation provides an opportunity for the Renewable Energy (RE) generators either to sell the renewable energy at preferential tariff fixed by the State Electricity Regulatory Commissions (SERC) or to sell the electricity generation and environmental attributes associated with RE generation separately, which can be exchanged in the form of REC. Considering the scope of getting high returns, the new regulation is expected to stimulate extensive capacity addition in renewable energy.

Terms and Conditions For Tariff Determination From Renewable Energy Sources Regulations, 2009. The regulations provide normative capital costs for projects based on different renewable technologies. The normative Return on Equity shall be pre-tax 19 percent per annum for the first 10 years and Pre-tax 24 percent per annum 11th year onwards. The high returns will encourage more capacity addition in renewable energy segment.

- **Jawaharlal Nehru National Solar Mission**

Launch of Jawaharlal Nehru National Solar Mission (JNNSM), which aims to ensure that solar energy technologies in the country achieve grid parity by 2022. It has plans for deployment of 20 GW of solar power by 2022. The programme is going to act as a propellant for growth and development of renewable energy in the Country.

- **Regulations on Transmission Pricing**

The new regulation is a big improvisation over the existing methodology of sharing of transmission charges & losses. The new approach is distance and direction sensitive and addresses various lacunae in the existing model

- **Power Market Regulations**

Provisions of these regulations would govern transactions in various contracts related to electricity. These regulations shall apply to various types of inter-state contracts related to electricity whether these contracts are transacted directly, through electricity traders, on power exchanges or on other exchanges. The regulations are expected to boost the implementation of open access of power in the country and result in an efficient price discovery.

4)Future Outlooks

Future holds greater role of private sector in power generation and increase in FDIs

Proposed capacity Additions during 11^{th} plan(2007-12): The 11^{th} plan recommends generation planning based on estimated 9.5% growth in required energy each year. As a result, a capacity addition of 78577 MW is recommeded in the 11^{th} plan is given below.

Proposed capacity Additions during 11^{th} plan(2007-12)

Table3.2

Sector	Hydro	Thermal	Nuclear	Total (%)
Central	9685	26800	2658	39865 (50.7%)
State	3605	24347	0	27952 (35.6%)

Private	3263	7497	0	10760 (13.7%)
All India	16553	58644	3380	78577 (100%)

Sources: Working Group on power – 11th plan (2007-12)

Required capacity additions foreseen by the 12th plan:

The requirement of installed capacity addition to meet the Generation requirement during the 12th plan period is given in table below.

Capacity addition required during 12th plan (2012-17)

Table—3.3

GDP Growth	GDP/Electricity Elasticity	Electricity Generation required (BU)	Peak demand(MW)	Installed capacity (MW)	Capacity addition required during 12th plan(MW)
8%	**0.8**	**1415**	**215700**	**280300**	**70800**
	0.9	**1470**	**224600**	**291700**	**82200**
9%	**0.8**	**1470**	**224600**	**291700**	**82200**
	0.9	**1532**	**233300**	**303800**	**94300**
10%	**0.8**	**1525**	**232300**	**202300**	**92800**
	0.9	**1597**	**244000**	**317000**	**107500**

Sources:working group on power-11th plan(2007-12)

Under various growth scenarios, the capacity addition required during 12th plan would be in the range of 70,800 - 107,500 MW, based on normative parameters. The 11th Plan Working Group recommends a capacity addition of 82,200 MW for the 12th Plan based on the scenario of 9% GDP growth rate and an elasticity of 0.8%.

Long term demand of power

The Ministry of Power has set a goal - Mission 2012: Power for All. Based on the 17th EPS, the total energy requirement in India will increase to 968,659 GWh by fiscal year 2012, 1,392,066 GWh by fiscal year 2017 and to 1,914,508 GWh by fiscal year 2022. This would lead to an annual electric peak load of 152,746 MW in fiscal year 2012, 218,209 MW in fiscal year 2017 and 298,253 MW in fiscal year 2022. The northern region is expected to contribute 30.1% and the western region contributes 28.4% of the overall annual electric peak load in fiscal year 2022. The Government has estimated the total investment potential of the sector at Rs. 9,000 billion for a specified period up to fiscal year 2011. This represents a significant opportunity for capacity expansion and growth opportunity for power generation companies, both in the public and the private sector

Current outlook of generation capacity addition

In line with the aggressive targets set by the government, a comprehensive Blueprint for Power Sector development has been prepared encompassing an integrated strategy with following objectives

- Sufficient power to achieve GDP growth rate of 8%;
- Reliability of power
- Improved quality of power
- Optimum power cost to ensure availability at affordable prices; and Commercial viability of power industry to make it attractive for private sector participation.

The Government, through the Ministry of Power, has laid out the following broad strategies to achieve the objectives:

- Power Generation Strategy: focusing on low cost generation, optimization of capacity utilization, controlling input costs, optimisation of fuel mix, technology upgrades and utilization of non conventional energy sources;
- Transmission Strategy: focusing on developing the National Grid, including interstate connections, Technology upgrades and optimization of transmission cost;

- Distribution Strategy: achieving distribution reforms by focusing on system upgrades, loss reduction, theft control, consumer service orientation, quality power supply commercialization, decentralized distributed and supply for rural areas
- Regulation Strategy: protecting consumer interests and making the sector commercially viable;
- Financing Strategy: to generate resources for required growth of the power sector;
- Conservation Strategy: to optimise the utilization of electricity with a focus on demand side management, load management and technology upgrades to provide energy efficient equipment; and Communication Strategy: forming political consensus with the media support to enhance public awareness.

Key risks in the sector

Power sector is a highly capital intensive business with long gestation periods before commencement of revenue streams (construction periods of 4-5 years) and an even longer operating period (over 25 years). Since most of the projects have such a long time frame, there are some inherent risks in both the internal and external environment. We monitor the external environment and manage our internal environment to mitigate the concerns on a continuous basis. Some of the key concerns being faced by the sector currently are:

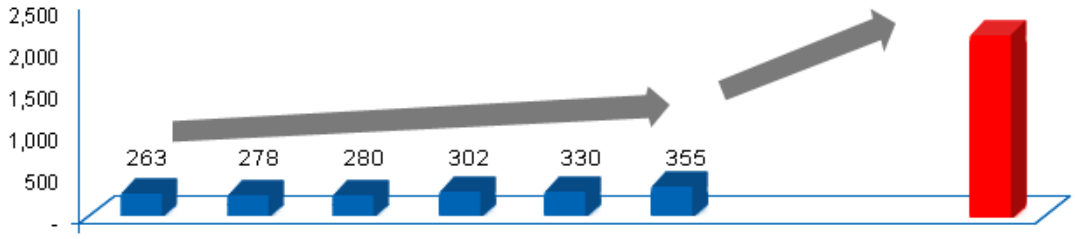
Coal supply position

More than 50 percent of India's generation capacity is coal based. According to the Integrated Energy Policy, by FY31-32, India requires 2,040 million tonnes of coal for power generation, more than 5 times its current consumption levels. The shortage of coal is so acute that most of the power generation companies are looking at imported coal as a viable alternative to domestic coal.

Coal requirement of power sector (in million tonnes per annum)

Target CAGR 8%

Target CAGR 8%



Source: www.reliancepower.co.in/power_industry/future_outlooks.htm

Diagram-3.4

Increasing importance of the private sector

India has emerged as one of the fastest growing economies in the world. Its current economic performance reflects a healthy trend based on increased consumption, investment and exports. Over the next five years, this growth is expected to continue. A key risk to the continued growth of the Indian economy is inadequate infrastructure. Infrastructure investment in India is on the rise, but growth may be constrained without further improvements. The Government of India has identified the power sector as a key sector of focus to promote sustained industrial growth. It has embarked on an aggressive mission – "Power for All by 2012"– and has undertaken multiple reforms to make the power sector more attractive to private sector investment.

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