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POWER SECTOR IN INDIA: GROWTH, POLICIES AND CHALLENGES

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ABSTRACT

Sustained growth of the power sector is a key parameter to drive economic development. In order to achieve the projected capacity addition of around 1,00,000 MW and build commensurate transmission & distribution capacity, investment of more than INR 11,00,000 Crore would be required in the 12th Five Year Plan. An investment of this proportion is one of the major challenges in the 12th Plan considering limited public financing options available. It is evident that power shortage is a significant impediment to India's ambitious plan to be a global super power having 3rd largest GDP by 2030 and also to have a sustained economic growth of 8-10 percent for at least another decade. Adequate availability of energy would be a fundamental requirement for this objective to materialize. Substantial expansion of coal and gas production as well as exploration of new fossil fuel reserves needs to be expedited. Moreover, large projects in the domain of generation, transmission and distribution are to be executed more efficiently to meet the project schedules. Also, administrative and regulatory measures have to be enforced to harmonize the interest of investors, developers and consumers. In addition to that, more comprehensive policies should be proclaimed for the development of hydro potentials and renewable resources at a faster pace to ensure our commitment towards sustainable development. Overall, the implementation of cost effective technologies along with more emphasis on environment friendly energy resources and proper strategies to mitigate the key challenges for the development of power sector will only ensure India's march towards inclusive growth.

Keywords: Per capita energy consumption, Investment, Economic growth, Legislations, Power sector reforms.

1. INTRODUCTION

Sustained growth of the power sector is a key parameter to drive economic development. Over the years, installed generating capacity in India has increased from a meagre 1713 MW in 1950 [1] to 205456 MW as on 31st July 2012 [2]. Electricity generation has also increased from 5.1 billion kWh in 1950 to 789 billion kWh in 2010-11 [1]. However, per-capita consumption of electricity in India is only 814 kWh in 2011 [1], which is abysmally low compared to world average. As per International Energy Agency (IEA) report (2009), per-capita energy consumption was 15467 kWh for Canada, 8012 kWh for OECD countries, the world average was also 2729 kWh [3]. The 12th Five Year Plan (April 2012 – March 2017) projections made by the Planning Commission indicate that for a sustained Gross Domestic Product (GDP) growth rate of 9 percent per year, energy supply has to grow at around 6.5 percent per year [4]. As per IEA projection, per-capita energy consumption in India will be 1895 kWh by 2030. Hence, the installed capacity should be more than 5,00,000 MW by 2030 along with associated transmission and distribution network. In order to achieve the projected capacity addition of around 1,00,000 MW and build commensurate transmission & distribution capacity, investment of more than INR 11,00,000 Crore would be required in the 12th Five Year Plan [4]. Moreover, for proper functioning of the power system, investments in Generation Vs Transmission Vs Distribution should be in the ratio of 2:1:2.

An investment of this proportion is one of the major challenges in the 12th Plan considering the limited public financing options available.

2. POWER SECTOR TILL ECONOMIC REFORMS

2.1 Pre-Independence Era

The first legislation in the electricity sector was Indian Electricity Act 1887. This law was enacted for the protection of person and property from injury and risks, attendant to the supply and user of electricity for lighting and other purposes. This act was repealed and substituted by Indian Electricity Act 1903, which was the first attempt to regulate the electricity sector broadly in the country. But, this act was ambiguous, as it did not recognize bulk sale of electricity and also jurisdictions of local government and Government of India were not clearly demarcated. This law was replaced by Indian Electricity Act 1910, where power of licensing was the exclusive jurisdiction of local governments and moreover, issuing of license for bulk supply was introduced.

2.2 Post-Independence Era

After independence, Electricity Supply Act (ESA) 1948 was enacted to envisage State Electricity Boards (SEBs) in different states and also to constitute Central Electricity Authority (CEA).

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However, the incorporation of SEBs in different states was delayed a lot due to the reluctance of state governments to give away their direct administrative control of a key infrastructure sector. The main aim to constitute SEBs was to extend electrification across the country, which was limited to major towns and cities till that time. By 1956, SEBs acquired most private licensees upon expiry of their license agreements.

Under Indian Constitution, electricity is enlisted as a concurrent subject in the seventh schedule (Article 246) of the Constitution of India and hence, central as well as state governments both can enact legislation for the same. But, in case any provision of state law is repugnant to central law, central law will prevail, unless the respective state law is reserved for that state with Presidential assent. However, Union Government is mainly accountable to formulate policies and also for statutory and organizational field work, while states are responsible for power generation and supply to consumers. After Industrial Policy Resolution of 1956, generation and distribution of electricity were exclusively reserved for public sectors. However, existing private utilities were allowed to continue, but no new private license was issued.

In 1964, Regional Electricity Boards (REBs) were set-up in five regions in the country for integrated operation and also for inter-state power transfer. To encourage this inter-state power transfer, inter-state transmission lines were considered as central sponsored projects and states were granted interest free loan other than plan outlays. This requirement was necessitated, as generating resources were distributed unevenly; hydel-stations were mainly based at Himalayan foothills and north-east region, whereas coal was reserved in Bihar-Jharkhand-West Bengal region and also in some areas of Andhra Pradesh and Madhya Pradesh. In 1969, Rural Electrification Corporation (REC) was established to ensure the availability of electricity for accelerated growth as a remedy to famines of 1960s and also to improve the quality of life for rural and semi-urban population. In 1975, in order to boost the power generation further, Union Government incorporated National Hydroelectric Power Corporation (NHPC) and National Thermal Power Corporation (NTPC) for executing large hydel and thermal generating stations across the country. The World Bank financed more than US$ 3.5 billion loan [5] to NTPC for executing few large projects. Power Finance Corporation (PFC) was incorporated in 1986 as a dedicated financial institution for the power sector. Power Grid Corporation of India Limited (PGCIL) was set up in 1989 by carving out the transmission assets from various central utilities.

Till that time, the generation and transmission systems in the country were envisaged to achieve regional self-sufficiency and few inter regional transmission lines were executed as a centrally sponsored programme.

2.3 Functioning of State Electricity Boards

ESA 1948 stated that a three percent return per year on net capital would be considered, while calculating the tariff charged by SEBs. Due to this provision, SEBs financial condition was stable during initial few years after incorporation. However, in course of time, SEBs financial health deteriorated due to their poor ways of functioning. SEBs were proposed to be run by competent persons with functional autonomy. But, in most states, SEBs were operational under direct administrative control of the power department of the respective states. Hence, autonomy of SEBs were completely jeopardized. In 1964, Venkataraman Committee noted that a part of the poor return of SEBs were due to the ongoing electrification work in rural and semi-urban areas, where expenditure and losses both were high. In one aspect, rural electrification caused increase in agricultural yields manifold and hence, self-sufficiency in food grain production was achieved. The green revolution accelerated at the cost of SEBs financial health. But, that translated into rural vote banks and therefore, it encouraged politicians to provide free or subsidized electricity for agriculture. Subsidies, which were promised by state governments, were not necessarily paid. Peasants were provided electricity at flat rates depending on pump capacity, rather than proper metering. This was exaggerated further due to the nexus between field staff of SEBs and errant consumers. The World Bank estimated that electricity to agricultural and residential consumers without proper metering caused an annual subsidy burden of about US$ 4.6 billion [5] to the SEBs. Interestingly, the main beneficiaries for this subsidy burden were big and well-off farmers, rather than small peasants.

In course of time, the condition of SEBs worsened further. Instead of yielding expected return of three percent on net capital, SEBs in most of the states incurred huge losses. High commercial losses due to theft were cited as the main reason for poor financial performance of SEBs. Theft can be in the form of direct tapping from distribution lines or by tampered meters. Tariff was mostly determined by political judgment, rather than any economic rationale. It was compounded with political reluctance to increase the tariff due to the fear of loss of vote banks and it caused increasing power subsidies astronomically. As a survival plan of SEBs, cross-subsidy regime was introduced, whereby the industrial and commercial sectors along with railway traction were charged a much higher tariff to compensate the revenue loss caused due to sale of electricity to agricultural and domestic sectors.

But, this cross-subsidy was meagre to compensate the losses, which led to steep increase in electricity price for the industrial sectors further. Moreover, service to potential consumers was poor.

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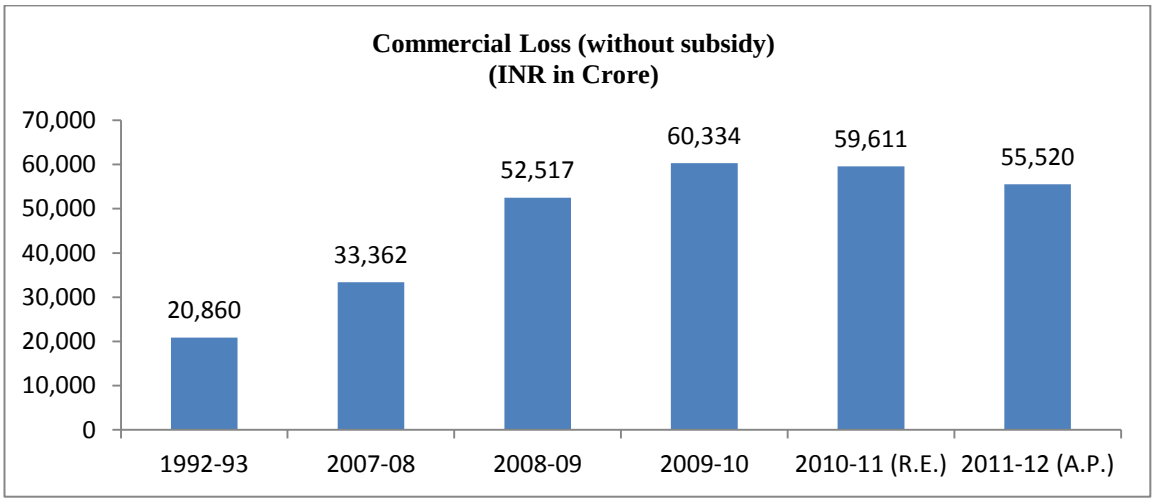
These forced big industries to set up their own captive power plant for better reliability and also to minimize their cost of production. This deteriorated the financial condition of SEBs further.

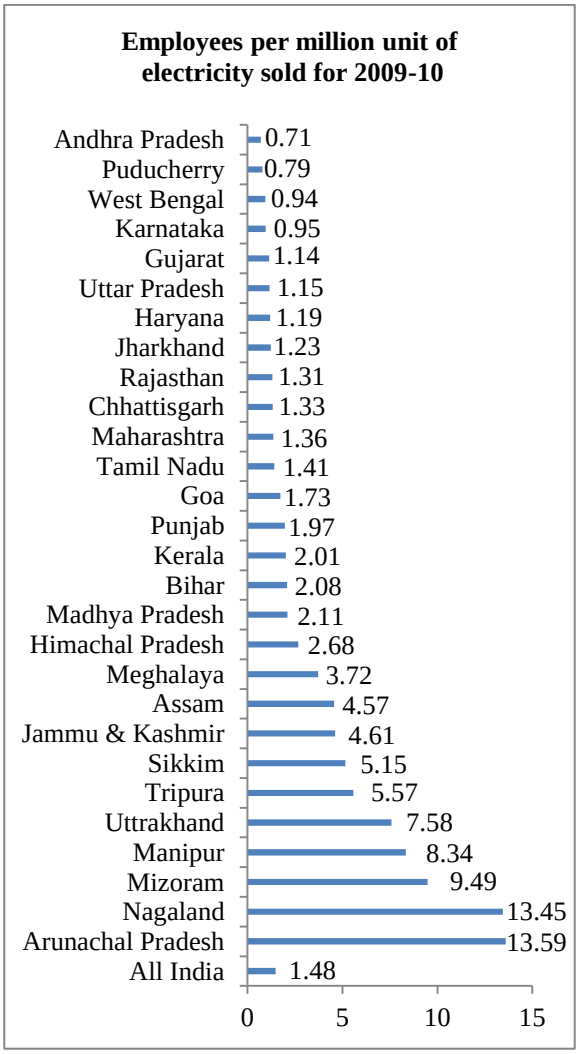
The total commercial losses (without subsidy) for all state utilities are shown in figure 1 [5].

Figure 1: Commercial losses (without subsidies) of state utilities from 1992-93 to 2011-12



Due to this poor financial condition, SEBs were having no internal resources for investments to improve their infrastructure for distribution and also to augment the generation capacity. In addition to inadequate capacity, existing capacity was underutilized due to technical incompetency. Also, SEBs were overstaffed by favouring jobs to people, who are in proximity to power centre. The number of employees per million units of energy sold in India in 1990-91 was about 5, whereas it was about 0.2 in Chile, Norway and USA [5]. Employees per million units of electricity sold across different states for 2009-10 are indicated in figure 2 [5]. Additionally, prolonged restoration time especially for villages in case of outage along with long waiting period for new consumers paralyzed the whole system. Moreover, theft and pilferage of equipment and materials compounded with high rate of corruption made the system completely unsustainable.

Figure 2: Employees per MU electricity sold



3. POWER SECTOR REFORMS IN INDIA

3.1 Initial Phase

Indian power sector reached an absolute dead-end by 1980s. There was no hope of any survival, unless some extensive measures were initiated. Several financial sanctions were imposed on state governments due to poor performance of SEBs. In 1989, The World Bank stated that requests from electricity sector of developing countries summed upto US$ 100 billion, but only about US$ 20 billion was available from multilateral sources [5]. Hence, not much funding was available from World Bank also.

In 1991, Electricity Supply Act was amended to allow private participation into generation sector and also to establish Regional Load Dispatch Centers (RLDCs).

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It coincided with India's worst ever balance-of-payments crisis and the country could have supported only a few days of essential import with existing foreign currency reserves. Government opined that additional investments by private sectors in generation could ease the crisis in power sector. To encourage private investments into generation, several policies were promulgated like:

- A guaranteed 16 percent return on equity with full five years tax holiday [5].
- Debt to equity ratio of 4:1 [5].
- Sovereign guarantees and escrow benefits in case SEBs defaulted [5].

Within a few years, more than a hundred projects were offered by different entities with a proposed investment of over US$ 100 billion [5]. Eight projects were quickly approved as fast-track projects. However, escrow benefits could not be extended to all projects considering the revenue stream of SEBs. But, the Independent Power Producers (IPPs) encountered severe difficulties like coal procurement, wagon availability for coal transportation, litigation in some projects, financial closure, etc. However, the basic reason for this policy failure was poor financial condition of SEBs and that was not addressed. The tariff for the energy generated from these projects was significantly higher compared to that of NTPC and SEB projects due to assured high Plant Load Factor (PLF), high return on equity, higher capital cost of plants, high variable cost due to management fee, insurance charge, etc. Procuring power from projects at such a high tariff multiplied the problem considering near bankruptcy condition of SEBs.

In 1991, a Committee was formed to work out a common minimum agricultural tariff. The issue was further discussed in 1996 during Chief Minister's conference, where a minimum agricultural tariff @ 50 paise per unit was proposed and that was scheduled to be increased to at least 50 percent of the average cost of supply within a period of three years [5]. However, no state implemented that decision, though the main beneficiaries, large farmers were ready for higher tariff with an assurance on better quality of power to achieve higher productivity. In 1998, transmission sector was also opened for private investments subject to approval of PGCIL as Central Transmission Utility (CTU).

3.2 Electricity Reforms in Orissa

During 1980s and 1990s, The World Bank financing was mainly influenced by Washington Consensus. According to that, development processes were hindered more by economic policies, rather than shortage of financial resources. Therefore, as a change in policy, World Bank was insisting for privatization. The World Bank financed various power projects in India after NTPC was incorporated, because those projects were likely to be operated in an efficient manner and hence, their loans would be more secure.

In course of time, World Bank was reluctant to finance coal based thermal power projects due to its environmental impacts and instead interested to assist on restructuring of grid. Orissa was the first state to implement grid restructuring project funded by World Bank. It was the most preferred state for grid restructuring as a model, as its agricultural share of electricity was only 6 percent [5], whereas in some states it was 30-40 percent. Hence, political resistance due to the fear of loss of vote banks was not a predominant factor in Orissa. Orissa Electricity Reform Act 1995 was enacted by Orissa Legislative Assembly and after Presidential assent notified for implementation with effect from 1st April 1996. This act made the provision of separating generation, transmission and distribution and also constitution of Orissa Electricity Regulatory Commission as an independent body to oversee Orissa's electric utilities. Total cost of the project was US$ 997.2 million, out of which World Bank financed US$ 350 million and Overseas Development Agency of UK provided US$ 110 million [5]. In Orissa, generating stations were being operated at 36 percent PLF in 1993-94, transmission & distribution losses were 43 percent and proportion of bills collection was only 17 percent [5]. Thermal generating assets of Orissa State Electricity Board (OSEB) were handed over to NTPC to settle the dues of OSEB with NTPC, whereas hydro generating stations were transferred to Orissa Hydro Power Corporation (OHPC). Transmission infrastructures of OSEB were kept under public ownership with Grid Corporation of Orissa (GRIDCO). However, the distribution sector of OSEB was bifurcated into four regional utilities and later on privatized.

3.3 Electricity Regulatory Commission Act 1998

Orissa became a role model for Indian power sector reforms and 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). All the states, after enacting their law, segregated SEBs into separate generation, transmission and distribution utilities. Delhi also privatized the distribution sector like Orissa, though other states did not follow the same. Government of India also realized the necessity of grid restructuring as a first step for power sector reforms and passed an Ordinance which was later culminated as Electricity Regulatory Commission Act 1998. Under the provision of this act, Central Electricity Regulatory Commission (CERC) was set-up to oversee centrally owned stations and other stations having inter-state function. The same act made the provision to set-up State Electricity Regulatory Commission (SERC) for the respective states, if deemed necessary. The jurisdiction of SERCs was to look after the utilities within their own state only. The primary objective for setting up of the regulatory commissions was to ensure a rational tariff, instead of popular politics with this issue.

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Enactment of Electricity Regulatory Commission Act was the first major step to initiate power sector reforms in India. This was followed by few other steps like introduction of Accelerated Power Development Programme (APDP) in 2000-01, which sanctioned a composite loan/grant for improving the infrastructure of electricity utilities. Later, under the recommendations of Deepak Parikh Committee, APDP scheme was restructured and renamed as Accelerated Power Development and Reforms Programme (APDRP).

Next major step was the constitution of an Expert Committee chaired by Mr. Montek Singh Ahluwalia, then Member (Energy), Planning Commission, to suggest ways for one-time settlement of outstanding dues of all SEBs towards central utilities and also to work out the method for capital restructuring of SEBs. The committee suggested to waive off 50 percent of the surcharge/interest on delayed payments and rest of the dues along with full principal amount aggregating to about INR 33,600 Crore was to be securised by tax-free interest bearing bonds issued by the respective state governments through Reserve Bank of India [5].

3.4 The Electricity Act 2003

Electricity Act (EA) 2003 was a path breaking step in Indian power sector reforms. This act repealed all the existing electricity laws in the country, such as Indian Electricity Act 1910, Electricity Supply Act 1948 and Electricity Regulatory Commission Act 1998, but secured the various reform acts of few states, which were already functional. The preamble of EA 2003 states:

"*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 to all areas, rationalization 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 salient features of the EA 2003 are as follows:

- Creates a liberal and transparent framework for the development of power sector.
- Facilitates investment by creating competitive environment and reforming distribution sectors.
- SEBs have to be unbundled into separate generation, transmission and distribution entities.
- Licensing for generation sector is removed, except techno-economic clearance for hydro projects exceeding a capital cost notified by Central Government.
- Freedom to have captive and group captive generations.
- Establishment of SERCs made mandatory.
- Recognizing trading as an independent activity.
- Open access in transmission facilitating multi buyer and seller model.
- Open access to consumers having demand above one MW within five years from date of enforcement of Electricity (Amendment) Act 2003. Regulators have been mandated to enforce this.
- Envisaging consumer redressal forum and their appellate authority, the Ombudsman.
- 100 percent metering made compulsory.
- Provisions relating to theft of electricity made very stringent.
- For rural and remote areas, stand alone systems for generation and distribution permitted.

EA 2003 is a landmark initiative to restructure and revive Indian power sector. Proper implementation of the act by union as well state governments can only ensure sustained growth of power sector, which is one of the key factors for economic prosperity of the nation. As on 1st July 2011, 29 SERCs have been constituted, out of which 23 have issued their first tariff order [5]. However, till now, state utilities are functional in Bihar, Jharkhand, Kerala, Himachal Pradesh and Tripura as an integrated organization. Though, EA 2003 has mandated a time frame for unbundling their SEBs with a caveat that it can be postponed in consultation with union government, these states have deferred this restructuring innumerable times. Moreover, in some states like Jammu & Kashmir, Puducherry, Goa, Sikkim, Arunachal Pradesh, Manipur, Mizoram and Nagaland, the power sector is functional through a government department. In other states, though SEBs have been restructured into separate generation, transmission and distribution utilities, the distribution continues to be a public sector undertaking except for Delhi and Orissa. However, some private utilities are functional at some areas in few states like Reliance and Tata Power in Mumbai, CESC in Kolkata, Torrent Power in Ahmedabad, and Noida Power in Noida. Though, a few of them are functional in generation, transmission and distribution businesses simultaneously, they are much better managed. Hence, professional and competent operations of the state utilities with functional autonomy and without bureaucratic hurdles are the key requirements to yield the results of power sector reforms.

4. RECENT DEVELOPMENTS AND CHALLENGES

The capacity addition target for Eleventh Five Year Plan (April 2007 - March 2012) was set as 78,700 MW, which was later revised to 62,374 MW during mid-term review [4]. But, only 54,964 MW was added during this period.

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India experienced energy and peak shortage of around 7.5 percent and 10.3 percent respectively during the Financial Year (FY) 2010-11 [5]. Prolonged power cut in different states across the country is a routine phenomenon, which severely affects industrial productivity. Hence, energy deficiency is a key hindrance to sustained economic growth. At the end of 2010-11, 79 percent of the generating stations were owned by central and state utilities [5]. By the end of 12th Plan, the demand for grid power is estimated to grow @ 6 percent per annum [4]. To achieve the ambitious capacity addition target of around 1,00,000 MW [4], significant private investments are required considering limited public financing capabilities. Central and state governments have initiated series of measures to encourage private investments in generation, transmission and distribution. 100 percent Foreign Direct Investment (FDI) is allowed under the automatic route in generation, transmission, distribution and power trading except nuclear generation. In the last five years, different IPPs expressed their interest for investments in generation sectors, especially in thermal and some areas of non-conventional resources. Hence, private share in generation has increased over time. In FY 2010-11, FDI was around US$ 1.5 billion in power sector including non-conventional generations [4]. However, hydel generation and distribution are the areas of reluctance for private investors considering the poor assurance of return. Different power projects initiated by IPPs and public utilities encounter several challenges. Especially, the new entrants having no prior experience in this sectors, face several difficulties like land acquisition, environmental clearance, fuel supply, financial closure, power equipment supply, project execution, human resources constraint, etc.

Land acquisition appears to be an increasingly significant challenge for power projects in India. Delays in acquiring land and obtaining environmental and other requisite clearances cause significant delay in different projects. The new Land Acquisition, Rehabilitation and Resettlement Bill proposes that project developers need to acquire a minimum of 70 percent of the required land. The respective state government may acquire maximum 30 percent area at their discretion. Otherwise, developers need to acquire the entire land for that project. However, the bill continues to face political opposition. It is also reported that even after acquiring the land in the name of public interest with an assurance of direct/indirect employment for the affected people, the project has not been completed after several years due to other delays and hence, credibility of industry and government is eroded. Therefore, it is imperative to meet the project affected persons' expectations in terms of rehabilitation and resettlement.

Several proposals for power project are halted due to supply constraint of fuels. Supply of domestic coal continues to be limited due to lack of development of new mines.

Additional gas supply from KG basin could not ease the problem, as the production is far below expectations. Consequently, government and private utilities have opted for imported coal to bridge the deficit. Some Indian entities have taken the initiative to purchase, develop and operate coal mines in international territories like Indonesia, South Africa, Australia, etc. The main international market for coal supply to India, Indonesia, poses significant geo-political risks due to the change in legal framework to regulate coal export. In the past two years, significant increase in imported coal price has severely affected those power projects in India, which are based on competitive tariff bidding. As the tariff structure does not have the provision to accommodate the escalation in fuel price completely, these projects have become financially unviable. In South Africa, coal transportation from mines is affected due to limited railway capacity and also the facilities at ports are controlled by the existing users making it difficult for new operators to ensure proper evacuation. In FY 2011-12, planned target of domestic coal production was 554 million metric tonnes (MMT), whereas only 539 MMT were achieved [6]. This is due to the slow development of captive coal mines, which were allocated to many developers. Out of 195 coal blocks having storage of 44,230 MMT [4], allocated to different developers, a majority are not yet operational due to land acquisition, permit delays, infrastructure problem and also lack of diligent effort from the developers. In order to meet the requirements of additional coal transportation facility within the country, Indian Railways needs to augment their infrastructures and also freight corridor projects needs to be expedited. Unloading capacity at ports needs to be augmented and if required, developers need to build dedicated unloading bays to manage their own logistics.

Different project proposals are severely affected due to the delay in financial closure. New entrants face difficulties due to lack of prior experiences and hence, their credibility becomes questionable. To augment the generation capacity rapidly, Government of India has initiated to set up a few Ultra Mega Power Projects (UMPP), each having capacity of 4000 MW. Financial closure for such big project, each costing about INR 16,000 Crore [7], is a big constraint. Additionally, considering high financial stakes involved in private investments, delay in payments may cause severe pressure on developers & suppliers to meet the project schedule.

Equipment shortages were a significant reason for India missing its capacity addition targets in 10th Five Year Plan (April 2002 – March 2007). Though, the shortage was primarily in major equipment like boilers, turbines and generators, lack of supply of Balance of Plant (BOP) equipment was also experienced. Due to lack of adequate domestic manufacturing capacities, the country is largely dependent on imported equipment for BTG areas.

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This increases the import bills and hence, the balance-of-payments are severely affected. To boost up the domestic manufacturing capacity, Government of India has initiated for bulk tendering of super-critical units for the projects being developed by NTPC and DVC, with eligibility criterion for the bidders specifying mandatory domestic manufacturing presence as well as a valid technology transfer agreement. Though, in recent days significant augmentation in domestic manufacturing capacity is in progress for BTG equipment, the capacity needs to be increased further to minimize the import bills. In addition to these, there is a shortage of construction equipment also. The Working Group on Power for 11th Plan (April 2007 – March 2012) of the Planning Commission has outlined the requirement of construction equipment for hydro and thermal power projects.

India has historically missed its power sector capacity addition targets in different plans and with tremendous demand growth, power sector continues to be affected by the shortfall on generation and transmission capacities. With present generating capacity of more than 2,00,000 MW, inter-regional transmission capacity at 132 kV and above is only 23,750 MW till December 2011 [8]. The various projects of generation and transmission are in different stages of implementation. However, the power projects in India are affected by various problems for meeting the planned targets, whereas the transmission projects are mostly affected by Right of Way (ROW) issues. Though, the policy makers have defined the various measures to resolve these issues, the corrective actions are not being implemented properly to remove those hurdles at a faster pace. During the 10th Five Year Plan, various reasons have been identified like inadequate preparedness of projects, shortage of equipment supply, financial closure, etc. However, the delay in supply by equipment manufacturer has been identified as a major reason for slippage of targets in 10th Plan.

The shortage of talent pool in the construction industry is a concern since long time and this affects the projects cost and schedule severely. There is a gradual decline of talent pool in construction and power industries as professionals prefer more lucrative career options. The engineering and management institutions are not able to feed the required number of skilled professionals to these industries in various domains like engineering, estimation, contract & project management, erection, testing and commissioning, etc. More collaboration is required between industry, institute and government to attract more talent to these industries to keep the growth momentum. Investment in employees in the form of specialized training as per best international practices is an important factor to have a better career prospects. Also, lucrative salaries can be considered as an option to attract more talent to these industries. The manpower requirements and shortages at supervisory and worker levels for power projects are tabulated in table 1[9].

Table 1: Manpower requirements and shortages at supervisory and worker levels for power projects

Category	**Estimated requirement**	**Available**	**Augmentation required**
Hydro Power Sector			
Senior Level Executives	550	330	220
Middle Level Executives	2000	1200	800
Junior Level Executives	4300	2600	1700
Non Executives	1700	1000	700
Workers	83000	50000	33000
Total	91550	55130	36420
Thermal Power Sector			
Senior Level Executives	1014	660	354
Middle Level Executives	3702	2400	1302
Junior Level Executives	7308	5040	2268
Non Executives	12780	8280	4500
Workers	55090	37736	17354
Total	79894	54116	25778

Significant investments are required in hydro-electric generation to boost up the installed capacity further. As on 31st December 2011, hydro-electric generation installed capacity is 38,748 MW and 15,065 MW is under various stages of construction [4]. Presently, the hydro-electric contribution is less than 20 percent with respect to installed capacity in the country. Considering the daily load curves and also to optimize the cost of generation, the ratio of thermal to hydro should be 65:35. The hydro-electric potential of the country (having installed capacity above 25 MW) is identified as 84,000 MW, which translates to 1,48,700 MW in terms of installed capacity considering 60 percent load factor [10].

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Out of this, Arunachal Pradesh alone has an estimated potential of 57,000 MW and another 1,600 MW for small/mini/micro projects (capacity upto 25 MW) [11]. Moreover, 56 potential pumped storage sites with an aggregate installed capacity of 94,000 MW have also been identified [10]. However, most of the hydro potentials are located in the Himalayan and north-east regions having difficult and mountainous topography, where accessibility to those sites is itself a challenge. Government of India has promulgated a few benefits to encourage more investments in hydro sector like:

- Cost plus tariff regime has been extended for public as well as private sector hydro power projects up to December 2015 [4].
- Mega power projects status for a capacity of 500 MW and above; however, the same threshold is 350 MW for J&K, Sikkim and north-eastern states [10].
- The import of capital equipment would be free from customs duty and deemed export benefits as per EXIM Policy would be extended to developers of Mega Power Projects both in public and private sectors [10].
- Income Tax holiday for a period of 10 years can be claimed by the promoters of a Mega Power Project in any block of 10 years within 10 to 15 years [10].
- The state governments have been requested to exempt supplies made to Mega Power Plant from sale tax and local levies [10].

In spite of these benefits, hydro power projects development does not have the momentum due to the uncertainties of land acquisition, rehabilitation & resettlement issues, environment & forest clearances, inter-state issues and contractual disputes. Moreover, even after best geological investigations, existence of shear zones and water bodies may result in serious time and cost over-runs. Recently, Comptroller and Auditor General (CAG) has stated in its report that the delay in implementing 16 hydro power projects by four central public sector enterprises has led to cost over-runs of INR 14,700 Crore [12]. Serious attention is required in hydro power policies to inculcate more private investments in hydro-electric generations. Also, project execution capabilities need to be augmented considering the shortage of coal supply and environmental degradation caused due to thermal projects.

To mitigate the inadequacy of coal and gas supply, Renewable Energy sources such as wind, small hydro, bio-mass and solar energy are other options. These can be effective ways to address increasing demand of generations. It is having an added advantage of lower gestation periods compared to hydro projects. It will also limit the Green House Gases (GHG) production, which is a step further towards India's commitment on Kyoto Protocol under United Nations Framework Convention on Climate Change (UNFCCC).

The total estimated medium-term potential for power generation from renewable sources in the country is about 1,83,000 MW, whereas only around 25,702 MW has been installed as on 31st July 2012 as per Ministry of New and Renewable Energy (MNRE) report. Estimated medium-term potential (2032) for power generation from renewable sources are tabulated in table 2 [13].

Though, capacity addition of 14660.65 MW during 11th Five Year Plan was impressive to some extent, this sector continues to pose different challenges. Wind energy having lower capital investments per MW for onshore projects, faces shortage of equipment suppliers. Moreover, lack of proper infrastructure for certain potential sites and policy bottlenecks are considered as big challenges. Also, globally offshore wind projects installed capacity is more than 4000 MW [14]. Though, offshore wind project is having more capital investments per MW, it is subjected to higher load factor mainly due to unidirectional wind flow. But, no progress has been noticed for offshore wind project development in India due to lack of government policies. Solar Photo-Voltaic (PV) and Solar Thermal require higher capital investments. In 2008, Government of India has promulgated Jawaharlal Nehru National Solar Mission (JNNSM) with an ambitious target of 20,000 MW grid connected solar power by 2022. Few other states have also declared their Solar Power Policy to encourage more private investments into solar generation. EA 2003 has mandated the state utilities to purchase a minimum percentage of energy from renewable energy sources. However, few states have not yet implemented the same. Though, cost of Solar PV plant has come down significantly in recent days, solar thermal still requires very high capital investments. Moreover, both the solar technologies require plenty of land having high solar insolation. Though, Bio-Power potentials from agro-residues and plantations are estimated to be very high, the progress on the same is minimal. Hence, significant thrust is required in non-conventional generations to achieve India's energy security and also to ensure environmental safeguards.

Table 2: Estimated mid-term potential (2032) from renewable energy sources in MW

Sources/Systems	**Estimated mid-term potential (2032)**
Wind Power	45,000
Bio-Power (Agro residues & plantations)	61,000
Co-generation Baggasse	5,000
Small Hydro (upto 25 MW)	15,000
Waste to Energy	7,000
Solar Photovoltaic	50,000
Total	1,83,000

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In the 12th Five Year Plan, out of the estimated investments of around INR 11,00,000 Crore in power sector, more than INR 6,00,000 Crore are to be invested in transmission & distribution domains. Inter-State Transmission Sector (ISTS) was opened up for private investments through joint venture with PGCIL and by competitive bidding process. Transmission is a licensed domain and PGCIL, as a CTU, will issue the license for ISTS. Ministry of Power has issued the guidelines for development of transmission projects and tariff based competitive bidding process for transmission sector. Different private investors having joint ventures with PGCIL have been issued licenses for the development of transmission projects. Though, various inter-state transmission projects are under different stages of implementation and a few are operational also, significant investments are required in intra-state transmission sector. This issue was pointed out in the Report of the Enquiry Committee on Grid Disturbance in Northern Region on 30th July 2012 and Northern, Eastern & North-Eastern Region on 31st July 2012 [15]. Distribution sector is also an area, where interest of investors is very limited. Aggregate Technical & Commercial (AT&C) losses have been recorded above 25 percent in FY 2009-10 [5]. Though, significant improvement is observed over time since 2001-02, AT&C losses may well be reduced to below 20 percent by proper distribution planning and implementation. Due to the poor investments in distribution sector, power quality and reliability of the system are very poor and also rural electrifications are severely affected. According to census 2001, though 80 percent villages were electrified, only 44 percent of the rural households use electricity [13]. National Electricity Policy (2005) mandated the availability of electricity to all in another five years. Few steps have been initiated in the last decade to achieve 100 percent rural electrification; however, the target is still a distant reality. Moreover, as per rough estimates, about 10,000 villages [13] are located in remote and difficult terrains, where extending power supply to these villages through existing grid power seems to be difficult. Hence, electrification of these villages should be extended through various sources of distributed generation including renewable sources of energy.

5. CONCLUSION

It is evident that power shortage is a significant impediment to India's ambitious plan to be a global super power having 3rd largest GDP by 2030 and also to have a sustained economic growth of 8-10 percent for at least another decade. Adequate availability of energy would be a fundamental requirement for this objective to materialize. Substantial expansion of coal and gas production as well as exploration of new fossil fuel reserves needs to be expedited. Moreover, large projects in the domain of generation, transmission and distribution are to be executed more efficiently to meet the project schedules.

Also, administrative and regulatory measures have to be enforced to harmonize the interest of investors, developers and consumers. In addition to that, more comprehensive policies should be proclaimed for the development of hydro potentials and renewable energy resources at a faster pace to ensure our commitment towards sustainable development. Overall, the implementation of cost effective technologies along with more emphasis on environment friendly energy resources and proper strategies to mitigate the key challenges for the development of power sector will only ensure India's march towards inclusive growth.

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