Birla Institute of Technology & Science, Pilani

Strategies to Meet Manpower Requirements in Power Sector of India up to 2020

A Final report submitted to

NSTMIS, Department of Science and Technology,

Govt. Of India

Economics & Finance Department

***September-
2013(Revised)***

Contents

List of Abbreviations-

Organizations & Institutions

BEE- Bureau of Energy Efficiency

BITS- Birla Institute of Technology & Science

BSES- Bombay Suburban Electric Supply Regards, Yamuna

CEA- Central Electricity Authority

CENPIED- Center for Power Training for Distribution & Transmission

CERC- Central Electricity Regulatory Commission GPCL- GMR Power Corporation Limited

HPPPC- Himachal Pradesh Power Corporation-

IIT- Indian Institute of Technology

ITI- Industrial Training Institute

JG- Jayvee Group-

JPSL -Jindal Power & Steel Limited

LPL - Lanco Power Limited -

L&T -Larsen & Tourbo Power

MOEE- Ministry of Environment & Forest

MBPPL -Moser Baer Projects Power Limited –

NDPL- New Delhi Power Limited

NHPC -National Hydro electric Power Corporation

NPCIL-Nuclear Power Corporation India Limited-

NPTI -National Power Training Institute

NTPC -National Thermal Power Corporation

PMI- Power Management Institute

PGCIL- Power Grid Corporation of India Limited

SJVN Ltd. -Sutlej Jal Vidyut Nigam Limited

TPL -Tata Power Limited

Generic Terminologies

EHV- Extra High Voltage.

EPC- Engineering, Procurement Contract

HV- High Voltage.

NTP- National Training Policy

PSU- Public Sector Undertaking

SEB- State Electricity board.

T&D- Training and Developments

UHV- Ultra High Voltage

UMPP- Ultra Mega Power Projects

Units

BU- Billion Units

GW- Gigawatt

MW- Mega watt

MTOE- Metric tonne of Oil Equivalent consumed

ZJ- Zetta Joules

Executive Summary

India is expected to maintain a robust economic growth rate of over 8% in the coming decade. This implies substantial increase in economic activities and raises the challenge of adding the infrastructure necessary to enable this development. India has ambitious plans of adding over 180,000 MW of generation capacity as well as associated power systems by the end of Twelfth Five Year plan, more than the cumulative capacity addition achieved till date. With such an ambitious target, the power sector requires augmentation of capacity across the value chain including manufacturing, construction, fuel and material supplies, project planning and implementation, financial management and operations and maintenance management.

While large-scale investments have been planned and numerous projects are underway, the lack of competent manpower to execute these projects and subsequently operate and maintain them is already being felt. The scarcity is increasing by the day and unless the Government, industry and all other stakeholders invest in attracting and training the available talent on an urgent basis, it has the potential to become a major bottleneck and derail the rapid growth in the sector that has just begun. This report addresses some of the key human resource challenges in the power sector today and lays out strategies for attracting fresh talent, retaining existing manpower and creating the necessary infrastructure for sustained training and development.

The study attempts to estimate manpower requirements of the power sector in India through scenario building, taking into consideration several factors like- fuel mix, technological changes, environmental concerns & growth. This uniqueness of this study on Indian power sector lies in its focus on manpower requirement at different levels including manpower requirements for environmental protection that would be required for meeting power requirements through alternate sources. The estimated manpower requirement for operations and maintenance pertaining to generation of power was estimated to be between 3.30 lakh and 4.79 lakh by the end of 2017 and between 4.10 lakh and 6.02 lakh by the end of 2020, depending upon the fuel mix, technology and growth in the power sector. This manpower would be required at different levels for achieving power generation installed capacity to the tune of 350 GW by 2017 and 440 GW by 2020 respectively. However, it may be noteworthy that the available manpower far exceeds than the required manpower for the future. This clearly shows that availability of manpower will not be an issue; however critical issue would be quality of human resources in terms of required skills at different levels in the power sector to effectively and efficiently use the available capacities in the power sector. The study therefore attempted to evaluate training facilities and infrastructure available and required through a questionnaire survey, involving various employee categories across all major power utilities. The results indicate that, not much emphasis goes in training for lower level management, as they are generally outsourced and are considered out of the mainstream employees. In addition it was observed that engineers, supervisors and workmen lack basically technical, human and knowledge skills respectively, and there is a significant difference between the perceptions of employees across different levels regarding the effectiveness of training and development programs, wherein employees at higher levels perceive the programs as effective and on the other hand employees at lower level perceive it as ineffective. Program **design and commitment** of the top management was identified as the two most important factors contributing towards the effectiveness of training & development programs.

The study highlights major problems faced by the power sector, through an expert opinion poll and proposes certain key strategies such as - attract talent by showcasing opportunities, improving brand image and changing the work environment, expand training to cover behavioral and attitudinal changes, strengthen ITIs and other vocational skill development centers, standardize curriculum and develop certification standards, expand existing training facilities and create new infrastructure, ensure proper utilization of funds through direct payments, introduce electives at graduate engineering programs and specialized programs at post-graduate level, create awareness on energy efficiency among all stakeholders and incorporate mandatory training for personnel involved in energy intensive processes, and increased investment for creation of modern training infrastructure. In addition, the study also highlights the need for developing a comprehensive training program, development of inter and intra departmental informal training networks, training emphasis on human resource management and finance, developing training programs for contractual labor, disaster management courses, developing more simulator programs for imparting practical knowledge & developing collaborative programs with colleges and universities.

CHAPTER-I

INTRODUCTION

Background

Accelerating economic growth and achieving higher standards of living depend upon the availability of adequate and reliable power at an affordable price. Unlike other commodities, electricity cannot be stored for future use. In other words, its generation and consumption have to be simultaneous and instantaneous. It is noteworthy that within a fraction of a second of clicking the power switch, the consumer puts into motion an intricate transaction involving a power generation company (like NTPC), a power transmission company (like POWERGRID), and a bulk power purchaser and retail distributor (like DVB). The unique features of power as a commodity or service make the dynamics of its supply and demand difficult to manage. Installing power generation, transmission and distribution capacity is a complex, time consuming and expensive process. Power is among the most capital-intensive infrastructure sectors.

Electricity was first introduced in 1880's in US and Europe. Today, with the use of electricity, man has transformed the world. Electricity goes through three stages before finally being available for consumption i.e. **Generation, Transmission and Distribution**. Generation is typically done through large scale power plants and transmission and distribution is done through extensive network of grid lines at affordable price to the end consumers. India has 200 Gigawatts (GW) of installed electric generation capacity and electricity generation has increased from 119.26 billion kilowatt-hours in 1980 to 920 billion kilowatt hours in 2012. The Compound Annual Growth Rate (CAGR) of power sector (Generation) in India is 5.17%, compared to Gross Domestic Product (GDP) rate of 7.4 % during the period 1999-2011, indicating a scarcity in terms of power generation to fulfill the requirements of a growing economy. According to World Resources Institute (WRI), India's electricity grid has the highest transmission and distribution losses in the world – a whopping 24.5% in 2010. Some of these losses are attributed to technical losses (grid's inefficiencies) and theft. In addition more than 40% of Indian households are not electrified. In contrast certain countries have a much more competitive power sector. For example in China, apparently losses are just 8% by way of transmission and distribution of total power generation and in OECD countries' transmission and distribution losses are just 7%. India is gearing up for additional 180 GW as well as associated power systems in the Eleventh & Twelfth Five Year Plan, more than the cumulative capacity addition achieved till date. With such an ambitious target, the power sector requires augmentation of capacity across the value chain including manufacturing, construction, fuel and material supplies, project planning and implementation, financial management and operations and maintenance management.

While large-scale investments have been planned and numerous projects are underway, the lack of competent manpower to execute these projects and subsequently operate and maintain them continues to be the critical factor in the power sector. The scarcity of requisite manpower is increasing and unless the Government, industry and all other stakeholders invest in attracting and training the available talent on an urgent basis, it has the potential to become a major bottleneck and derail the rapid growth in the sector that has just begun. This study addresses some of the key human resource challenges in the power sector today and lays out strategies for attracting fresh talent, retaining existing manpower and creating the necessary infrastructure for sustained training and development.

The total manpower in the power sector at the end of Tenth Five Year Plan was approximately 9.5 lakhs as per the report of the Planning Commission's Working Group on Power for Eleventh Five Year Plan. Even in a scenario where employee productivity is projected to increase leading to decreasing Man/MW ratio, it is estimated that over five lakh technical manpower and 1.5 lakh non-technical manpower need to be inducted into the sector in the 11th and 12th Five Year Plan periods. In addition to the technical manpower, tens of thousands of highly skilled managers will be required in areas such as project planning and management, project monitoring project finance, contracts and materials management experts, human resources management personnel etc. Further, with increasing focus on energy efficiency and renewable energy, there is an opportunity to productively engage millions of people to participate in harnessing small hydro, bio-mass & bio-fuels, solar and wind resources, provided they have the appropriate specialized knowledge. Moreover, demand side management, power trading, carbon credits, smart grids etc. will also require manpower with specialized knowledge, skills and training.

Sources of Electric Power

There are different sources of electricity supply in India these are hydro, thermal, nuclear, wind and solar.

Hydro power

Hydro power is another source of renewable energy that converts the potential energy or kinetic energy of water into mechanical energy in the form of watermills, textile machines etc., or as electrical energy (i.e. hydroelectricity generation). These are of various types such as –

- Hydroelectricity
- Tidal Energy
- Wave Energy
- Waterwheels

India has an install capacity of 40 GW in the year 2012, which is only 26% of the 150 GW hydro-electric potential in the country that has been harnessed so far. (NHPC 2011-12)

Thermal power

Thermal power which is generated by coal and oil has always been the major source of electric power in India. In 1950-51 installed capacity of thermal power was 1150 Mw (MoP 2011-12) and gradually the share of thermal power had increased from 67% in 1965 to 71% 2010. The inputs used in thermal power generation plants are non-renewable and exhaustible resources.

- At 51% (of total energy generation), Coal is the single-largest source of energy at the disposal of the power sector. (TERI 2011)
- By 2011– 12, demand for coal is expected to increase to 730 MMT p.a., creating a supply shortage of over 50 MMT (MoC 2011-12).
- India has the fourth largest proven coal reserves in the world, pegged at 96 billion tones, creating an investment opportunity of US$ 10 billion– 15 billion over the next 5 years. (Investment Commission of India)

Nuclear power

Nuclear power is of recent origin and its supply accounts for only 2.7 % of the total installed capacity of electricity. This source has the potential to supply large amount of electricity, however it has its associated risk factors. As per the ongoing policy perspective of government of India, attempts are being made to increase its share to take care of increasing power requirements.

Some of the critical issues related to nuclear energy-

- **Improper land acquisition** – Most of the land, which government has allocated for installation of Nuclear Park, isn't fit for the above mentioned purpose. Currently India has 21 nuclear reactors in all, with the capacity of generation 5000 MW in total, which is deemed to be manageable, as the number doesn't have the potential to create a major havoc to the nearby environment, but as per the coming plan, India plans to install bigger nuclear reactors of the capacity to produce 10,000 MW, which has a serious threat of causing a major damage to nearby areas, in larger magnitudes , moreover most of the places acquired for the purpose has a large number of habitation .

- **Untested technology**- India plan to install, French based technology of European Pressurized Reactors (EPR), which hasn't been properly tested and is not considered to be reliable. Although various sources claim, the safety of these reactors, but it hasn't been approved by IAEA (International Atomic Energy Agency). Moreover, even US have delayed the construction of these projects for the time being, due to safety reasons.

- **Poor Regulation**- 17 out of 21 reactors do not comply with the minimum basic safety standards set aside by IAEA. As per minimum compliance report of IAEA submitted to DAE (Department of Atomic Energy, India), the current safety set-up cannot survive the Fukushima disaster of 2010 in Japan.

- **Economically unviable** – Currently installation of thermal based power projects costs something like Rs 5-6 crores per MW. India plan to install EPR of the capacity of 1,650 MW for US$ 7 billion, which would come out to be Rs 21 crore per MW, much higher than thermal based power plants

.

- **Poor rehabilitation of people** - Some of the areas like Hasipur (West Bengal), Jaitpur (Jharkhand), Kondakulam (Tamil Nadu) which have been identified for development of Nuclear parks, have witnessed strong resistance from local people as they haven't been properly remunerated for the loss of land and displacement of work force caused by the acquisition of their land. The government in various places has offered from Rs 2.60 per square foot to Rs 3.70 per square foot to land owners in these places, over and above Rs 10-14 Lakhs as fixed lump sum for cultivatable land. More than 50 % of the farmers claim that the compensation is very low, and they haven't realized their claims yet.

- **Dangers of radiation** - Nuclear fission emit invisible radiation which act like slow poison, the places near nuclear reactors are most vulnerable to radiation , and once India install, bigger nuclear reactors the extent of these radiations is unimaginable.

- **Fuel shortage** - India doesn't have sufficient Uranium reserves, on the contrary India is rich in thorium, for which it hasn't made sufficient efforts to harness it. India would be dependent on US for uranium supply, which can expose India's energy security needs.

Wind Power

Wind power is the conversion of wind energy into a useful form, such as electricity, using wind turbines. Wind power is generally converted to the form of electricity; large-scale wind farms are connected to electrical grids to supply energy. Individual turbines can provide electricity to isolated locations. In windmills, wind energy may also be used directly as mechanical energy for pumping water or grinding grain. Wind energy is available freely, is renewable and clean and produces no greenhouse gas emissions.

- India is the 4th largest country in the world in terms of installed wind energy. (MNRE 2012)
- India's potential of wind power is pegged at 45,000 MW while its current capacity stands at only 8,450 MW. (IREDA 2012)

Solar Power

Solar energy is the utilization of the radiant energy from the Sun. Earth receives 174 petawatts (PW) of incoming solar radiation at the upper atmosphere, of which, around 30% is reflected back to space while the rest is absorbed by the atmosphere, oceans and land. The total solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately 3,850 zettajoules (ZJ) per year.

- India's installed solar – based capacity stands at a mere 100 MW compared to its present potential of 50,000 MW.
- Under Jawaharlal Nehru National Solar Mission (JNNSM), GoI has planned an addition of 20000 MW solar power by 2022.
- Based on the substantial investment opportunities that exist in this sector, it is estimated that by 203- 32, solar power would be the single largest source of energy, contributing 1,200 MTOE (1 metric tonne of oil equivalent (MTOE) = 10 × 106 Kcal) i.e. more than 30% of our total expected requirements. (India Brand Equity Foundation)

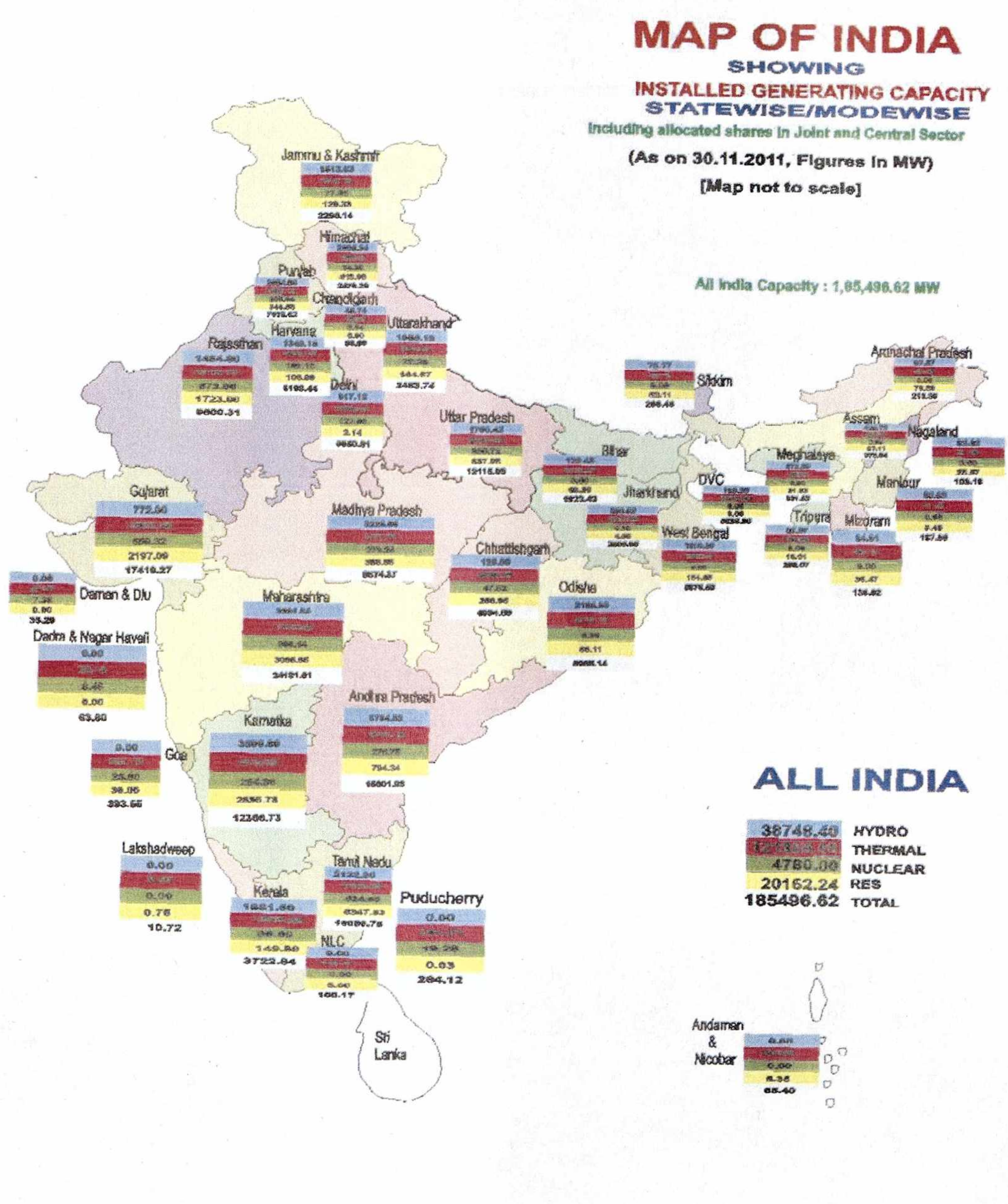
Biomass/Bio-fuels

These biomass/bio-fuel plants use photo-synthesis to grow and produce biomass. Also known as bio-matter, bio-mass can be used directly as fuel or to produce liquid bio-fuel. Agriculturally produced bio-mass fuels, such as bio-diesel, ethanol and bagasse (often a by-product of sugar cane cultivation) can be burned in internal combustion engines or boilers. Typically bio-fuel is burned to release its stored chemical energy. Research into more efficient methods of converting bio-fuels and other fuels into electricity, utilizing fuel cells, is an area of very active work.

The Map 1 of India shows the installed generating capacity of electricity across different states in which three main sources of generation of electric power have been shown. The major source of electricity generation in India is thermal power, because country possesses large coal deposits.

Hydro-electric power is another major renewable resource used in electricity generation. In 1950-51 installed capacity of hydro power was 560 MW. It has increased to 38748 MW in 2010-11.

Map 1: Different Sources of Power Generation in India



Source: *Ministry of Power*

This was because of the greater growth of thermal power since 1951. Nuclear energy constitutes only 2.7 % of the total installed capacity of electricity. As on 31st July 2012, power sector in India had a total installed capacity of 206456 MW. As a whole power sector in India is predominantly controlled by Government as evident from having around 42% of installed capacity in State sector and around 32% in Central sector. Private sector had a share in total installed capacity to the tune of 26% (Source: CEA). However, the private sector investment is also catching up fast, which would change the whole complexion of the industry. As regards fuel-mix wise share in the installed capacity of power, the largest share continues to be thermal with 66.5% share followed by hydro power at 19.0%, renewable including small hydro project, bio-mass gasifier, bio-mass power, urban and industrial waste power, wind energy etc at 12.1% and remaining from nuclear power.

Some of the important problems faced by power sector in India are as under:

- *Lack of optimum utilization of the existing generation capacity*
- *Inadequate intra-regional transmission links*
- *Inadequate and ageing sub-transmission & distribution*
- *Network leading to power cuts and local failures/faults*
- *Large scale theft and skewed tariff structure*
- *Slow pace of rural electrification*
- *Inefficient use of electricity by the end consumer*

One of the critical factors behind above mentioned problems continues to be non-availability of adequate manpower with desired knowledge and skills. Thus, human resources i.e. right number of people with requisite knowledge and skills comprising of skilled engineers, supervisors, artisans, managers etc. would be the critical input to cater to building capacity for meeting emerging future power requirements. Keeping this in the backdrop, the study on ***Strategies to Meet Manpower Requirements for Power Sector up to 2020*** is proposed to be undertaken.

Literature review

Power sector and its effect on economy

Tongia describes the political economy of Indian power sector reforms (Tongia 2003). It shows that per capita consumption of electricity in India is only 350 Kwh per annum which is very low when compared to world average of 2000 Kwh in 2003. Although the per capita consumption of electricity has increased to 778 Kwh, but still it is very low as compared to world average consumption of 2275 Kwh in 2011(WRI). Bodger and Mohamed (2006) in their study show the relationship between electricity consumption and economic growth from the period 1980 to 2005 for both developing and industrialized countries using key factors such as electricity intensity, electricity intensity factors and electricity intensity curve. They recommend that economic performance and energy demand is strongly influenced by the stage of the development and the standard of living in a country. Another study examines the cost of unreliable power in US as well as changing customer reliability needs on 43 identified industries. The study highlights the way the structure of electric utilities is undergoing a dramatic change as new and expanded service options are added. The concepts of unbundling the electric service and offering customers a range of new services that more closely track actual costs are expanding the options open to customers (Eto.et.al 2001).

Chontanawat and others (2001), tested for causality between energy and GDP using a consistent data set and methodology for 30 OECD and 78 Non-OECD countries. Causal relation between aggregate energy consumption and GDP and between GDP to energy consumption is found to be more prevalent in the developed OECD countries compared to the developing Non-OECD countries.

In a similar study (Squalli and Wilson 2006) presented the electricity consumption-income hypothesis for six member countries of Gulf Coast Countries (GCC) - Bahrain, Kuwait, Oman, Qatar, KSA. and UAE. This paper finds evidence of a long-run relationship between electricity consumption and economic growth for all GCC. It also finds support for the efficacy of energy conservation measures in five of the six countries except Qatar. Chang (2007) described a set of explicit functional relationship that link energy and the economy using data for 16 OECD countries from 1980-2001. The methodology used is period-by-period regression, pooled regression and cross-sectional tests. Results show that energy price is a macro-economic instrument that offers trade-off between energy efficiency and economic well being.

Another study proposed a semi-parametric model for detecting multi-scale causality between consumption and growth in emerging economies from 1968 to 2002 and found that in the short run there is a feedback relationship between GNP and energy consumption. The magnitude of the wavelet correlation changes based on time-scales for GNP and energy consumption indicates that Value Added (VA) and Energy Consumption (EC) are fundamentally different in long run (Ho.et.al 2006).

Henderson (2007) found structural change in the Korea's electricity consumption during 1991-2007 periods. The results show that there exists a strong relationship between the electricity consumption and industrial production over the sample period. Mishra and others (2007) indicated that energy consumption per capita in approximately 60% of country is stationary (using panel stationary test developed by Silvestre) and that energy consumption per capita for the panel of 13 countries as a whole is stationary. The study offered several suggestions for modeling energy consumption and policy making in the pacific islands.

Nondo and Kahsai (2009) investigated the long-run relationship between energy consumption and GDP for a panel of 19 African countries based on annual data for the period 1980-2005. The results show that GDP and energy consumption move together in the long-run. Currie (1996) measured the relationship between energy consumption and GDP in Fiji during1981-1990. During this period energy intensity declined by 1.9 Tera Joules per F $m of GDP (at factor prices for 1990). The petroleum and electricity intensities indicate that the economy become less dependent on imported petroleum products for its energy requirements and more dependent on electricity for energy consumption during 1980's. Reddy (1996) examined the pattern of energy consumption and growth in Fiji. The period was different for different fuel types for the purpose of study. The results revealed that Fiji's energy dependency over the last two decades will impose significant impact on import bill; if efforts are not made either to increase conservation and efficiency of energy use.

Vaden (2002) employed a unique data set of approximately 2500 large and medium enterprises in China for the year 1997-1999 to identify the factors driving the fall in total energy use and energy intensity. The results indicate that energy prices and research and development activities are important contributors to the decline in firm-level energy intensity according to Divisia calculations. Further, the paper also found that changes in the share of output by region, ownership type and industry contribute to decline in measured energy intensity.

An empirical investigation about energy intensity evolution both for developing and developed countries (Martin and Cerda 2003) tests the hypothesis of de-linking economic growth and energy use. While UK is decreasing its intensity, both Turkey and Brazil are increasing their energy intensity. So the evolution of energy intensity cannot be explained only by the process of economic growth, as various internal causes in each country may explain the behavior. As per the study by Gupta and Jaswal (2006), India witnessed a decline in its energy intensity between 1990 and 2003, reducing at the rate of 1.1% on an average annual basis due to relatively higher growth in the service sector and better energy management in the industrial sector. However on the other hand China is highly energy intensive country. At the same time the Chinese economy has undergone a significant decline in its energy intensity, falling at an average of 5.5% p.a., primarily attributed to multifaceted energy conservation efforts in comparison with India `s decline of 1.1%. Chima (2011) computed the intensity of energy use in USA during the period 1949-2003. His paper tries to understand the nature of interaction between energy consumption and GDP. The results show that energy consumption is very sensitive to energy prices, which in turn impacts the GDP. The IEU (Income earned per unit of energy consumption) has declined in the USA for the period covered in study. The Kuznets environmental curve was used in developing a model that depicts downward sloping segment for the IEU. The results indicated that energy conservation policies are desirable.

As per the study by Ray & Reddy (2007) energy intensity in the manufacturing sector has declined during 1992-2002 in India. It was mainly due to fuel substitution away from coal in some of the sectors, especially in cement industry. Further decomposition analysis found that most of the intensity reductions are driven purely by structural effect rather than energy intensity.

The estimated trends for China computed in the study by Sheehan and Sun (2007) show rapid growth in energy intensive industries particularly after their entry to WTO in 2001. China has reverted to the normal developing economy case of an elasticity of over one, based on a simple projection model. They concluded that China's energy use and carbon dioxide emissions from fuel combustion are likely to grow by more than 6% pa over 2005-30. The study suggested a sustained policy process involving use of the full range of instruments that could reduce China's energy use and carbon dioxide emission by 35 - 40% by 2030. The study found low elasticity of energy use with respect to GDP over 1980-2001, and concluded that low elasticity was primarily due to technological up-gradation and energy conservation, stimulated by energy rationing in a command economy with limited energy supplies and high initial usage levels.

Training & Development (T&D) of Manpower

Training is needed to improve ability, to learn new techniques and to stimulate involvement of employees in the goals and objectives of the firm (Luzon.M & Morono.D 1993). It is indeed one of the most essential components of organizational growth (Chien 2004). The business environment is ever changing and dynamic; therefore in order to keep pace with the change, the firms must evolve appropriate training modules for the same (Lim & Johnson 2002).

Training, as an activity has been directly linked with employees' efficiency and productivity (Vail 1996). In yester years T&D was considered a mere sub set of personnel management, but in the modern era it has gained a lot of importance and has come across as a full fledged and specialized field (Harvey 1991). The range and scope of the training programs differ from firm to firm. It is based on many factors such as organizational size, training budget, type of industry, competition, work force composition etc. (Rove, Christopher 1992). Usually, training & development programs are developed as per need based requirements to harness appropriate skills for the prescribed job (Jackson, David 1994). Therefore it is very difficult to club these programs under a single roof. Most of the companies have failed to pay attention to both screening and selection of employees for appropriate training programs (Arther, Bennart 1995), (Edens & Bell 2008; Birke & Day 2009). Moreover, the fresher's who are graduating from the educational system are deficient in appropriate skills set requirements as per industrial standards (Sarka & Banker 2011; Erich 1993). In this backdrop, it becomes very important to have a proper design of the training programmes that is subordinated to the needs, goals and objectives of training (Hilal 2012; Akoojee 2012). Training enables employees to acquire work-related knowledge (Muenhout et.al 2012). The training design process helps in formulating proper means of knowledge, attitudes and skills transfer to the employees (Allais 2012; King 2012). It is an important factor as it influences motivation and also helps in improving self- efficacy of employees (Holton 2000). The programmes design relates to the performance of the staff and the firm as a whole (Kirwan, Birchall 2006). In most of the organizations, the employers evaluate the performance of their subordinates and accordingly give recommendations for the training requirements of these employees (Velanda 2007). Moreover, training interventions also help in reducing labor turnover, as it bridges the gap between employee expectations and perception towards the effectiveness of training programs (Soltani & Liao 2009). Some of the modern training methods call for engagement of the trainees in the training process (Mirhie 2011). This also helps in improving the morale of the employees as they feel an integral part of the orgainsation (Deshmukh 2006). Most organization follow a top down approach, for assessing training needs and its evaluation, primarily this approach is followed in most of the organizations including power utilities. Sometimes such a practice fails to take in to account the focus, pedagogy, curriculum design, infrastructure layout etc. (Kotnour et.al 2011; Schein1999), while the orgainsations tend to focus more on employees attitude and behavior which are directly related to their job effectiveness (Crine et.al2012; Pillai et.al 2011). Keeping in view the importance of training and development in improving the effectiveness and efficiency of human resources, this study attempts to understand the perception of the participants undergoing training and development programs to identify factors that contribute the most towards the effectiveness of these programs in Indian power sector.

Chapterisation

Chapter 1 of the study is introductory in nature and gives an overview of Indian power sector as a whole in terms of generation, consumption, power deficit. It also highlights various sources of power generation in the country and touches upon some of the relevant issues and challenges being faced by power sector. Chapter 2 is on objectives and methodology of the study and focuses on need for the research, objectives of study, scope of study and framework used for manpower estimation in power sector in India. It covers aspects related to sample size and sampling unit. It also deals with the data sources and their applicability towards this research. Chapter 3 on data analyses uses both primary and secondary data to arrive at alternative scenarios for demand for power up to 2020. It also presents manpower projections based on man-mega watt ratio, for various sources of power generation under alternative scenarios up to 2020. Chapter 4 on training needs requirements and assessment deals with an overview of the quality of training and development programs conducted in power sector in India. Moreover it also tries to identify perceived skill set requirements for various levels and various key factors influencing the effectiveness of these programs. Chapter 5 gives conclusion and recommendations of the study. It attempts in the backdrop of objectives of the study to come out with strategies to meet future manpower requirements of the power sector in India. The chapter also highlights some important recommendations emanating as an outcome of the study that would be useful for the policy planners.

CHAPTER-II

DATA SOURCE AND METHODOLOGY

This chapter explains the research design, sample size, sources of primary and secondary data used and the methodology used for analyzing and interpreting data.

Need for Research

Power generation is one of the key inputs for growth and development and would continue to be critical input in times to come. Power sector of India has always been faced with some serious challenges, and one of those challenges is mapping manpower requirements for the future. There is a serious need for the estimation of skill set requirements in the light of technological advancements, environmental sensitivity, fuel consumption etc. This study attempts to identify various skills set requirements that would help training utilities to design and develop training programs to effectively meet the future manpower requirements.

Objectives of Research

- To estimate the capacity requirements in power sector up to 2020.
- To estimate manpower requirements in power sector for the above mentioned period.
- To propose requisite strategies and suggest a framework for meeting the manpower requirements for future.

Scope of the Study and Sample Size

The proposed research work was completed in the following stages:

Phase I Extensive literature survey was carried out to fully understand the core issues affecting the power sector in India.

Phase II i) Collection and analysis of primary data through structured questionnaire from employees/executives of various power utilities across the value chain.

ii) Expert opinion survey to elicit challenges, emerging scenario in power sector and strategies to meet future manpower requirements was undertaken.

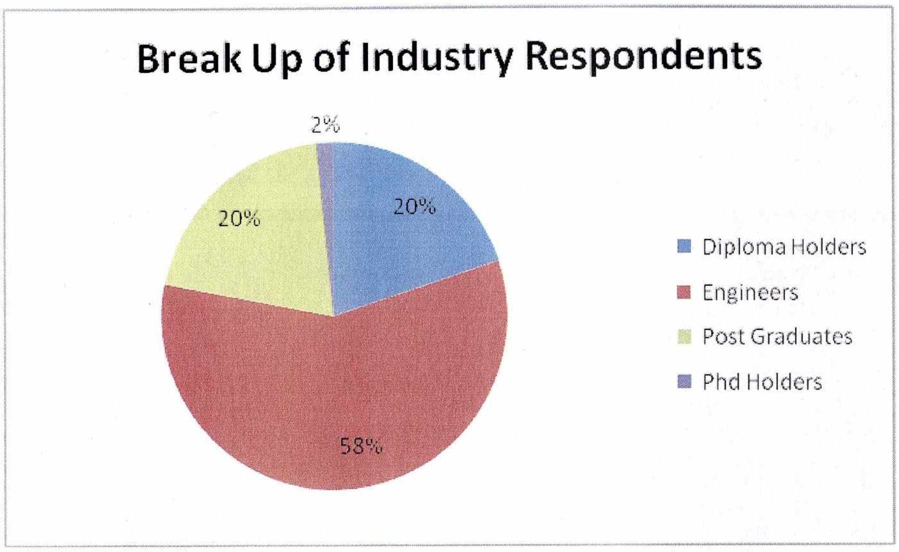
Phase III Analysis of data to suggest various strategies for meeting future human resource requirement for Indian power sector and its overall competitiveness.

The data for research was collected from both primary and secondary sources. The secondary sources comprised of publications by Indian Power Sector Organizations viz: Economic Survey, Ministry of Power, The Energy Resource Institute, Central Electricity Authority, Websites of Power Sector Utilities & Ministry of Power, Planning Commission etc. Primary data was collected from power utilities operating in thermal, hydro, and renewable energy areas through a detailed questionnaire as well as by expert opinion survey.

Sampling Unit: We visited various power utilities viz. National Thermal Power Corporation, National Hydro Power Corporation, Jindal Power Corporation, Tata Power, GMR Power, and Jaypee Power, distribution agencies viz. Power Grid Corporation of Indi a Ltd., North Delhi Power Limited and Power training institutes viz. Power Management Institute, National Thermal Power Institute, and Center for Power Efficiency in Distribution (CENPEID) for primary data collection .

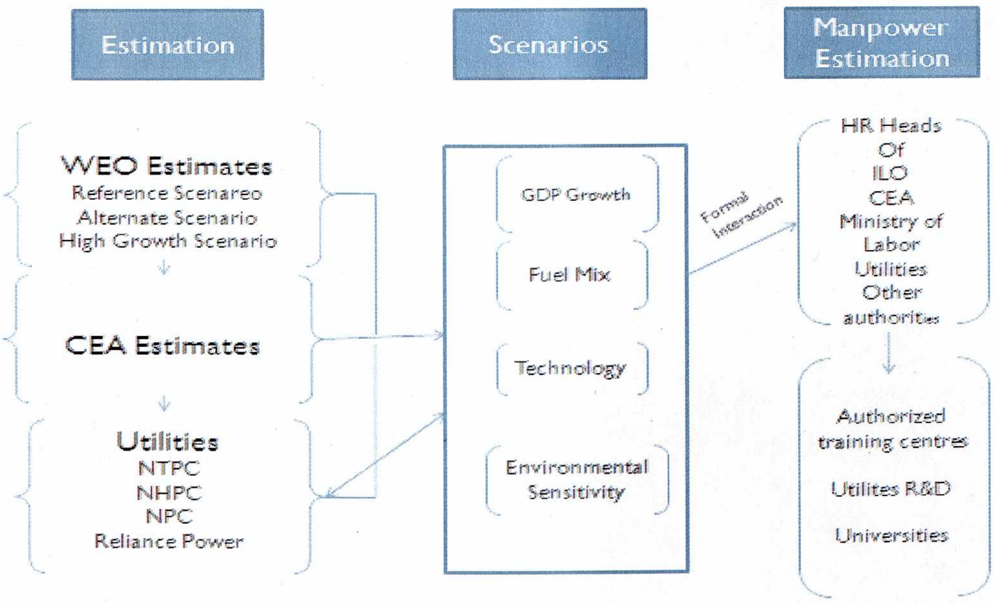
Sampling Element and Sample Size: Data from 845 respondents across various utilities and for different levels was collected through a structured questionnaire (APPENDIX I). The respondents include employees from all grades (A -D), educational background (SSC, Graduate, Post Graduate & PhD) and across all levels (plant, maintenance, project & others). The sample size was selected through quota sampling method, based upon the prescribed norm laid down by CEA for the percentage of employees at various levels. The employees were asked to rate various skills required for their job, on a scale of 10, wherein 1- was least important and 10 was most important. Expert opinion survey was undertaken to identify key challenges faced by power sector in India , their views on demand for power and power mix, category wise requirement of manpower and the competencies required and infrastructural constraints and how to overcome them (APPENDIX II).

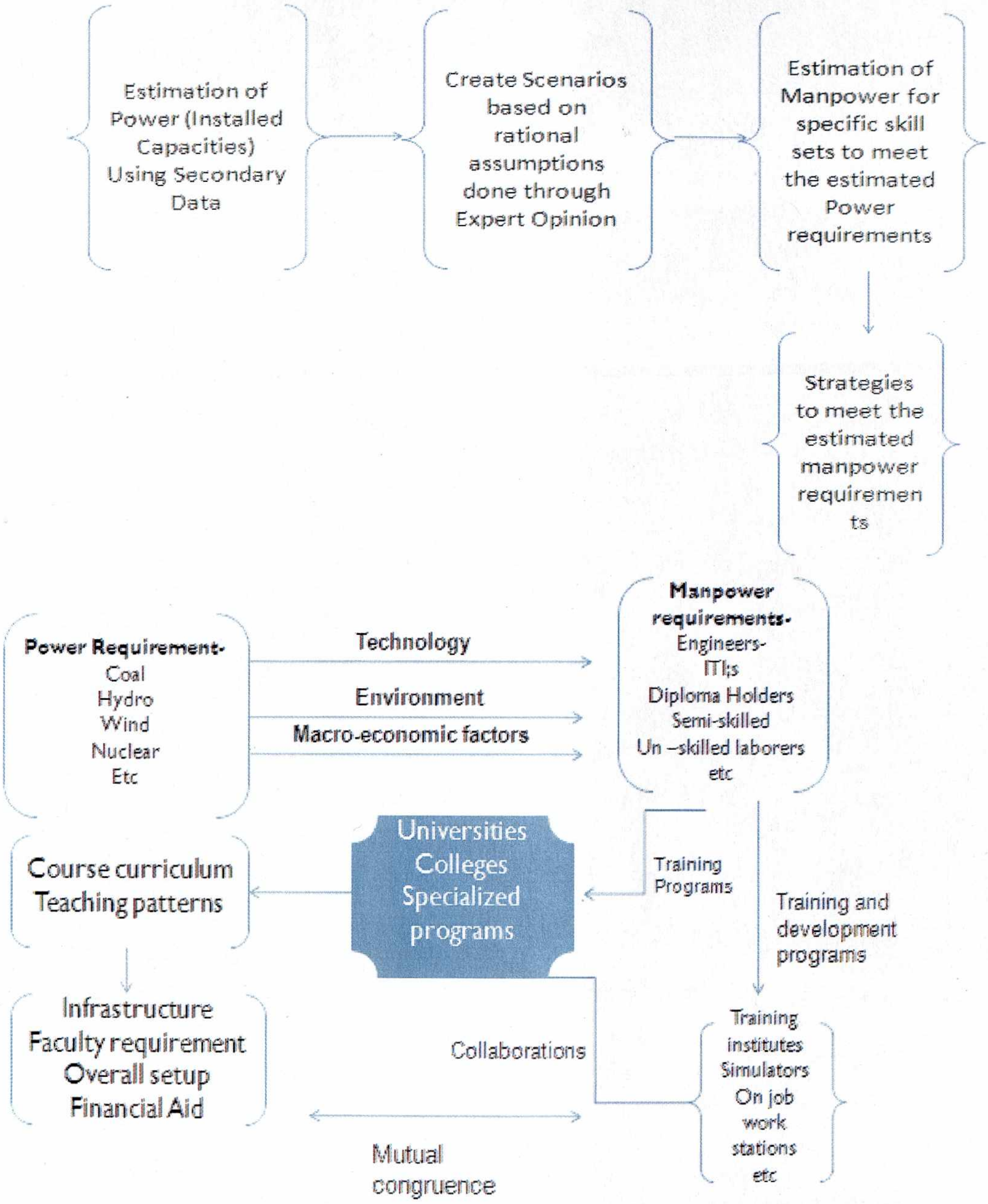
Fig- 2.1- Sample Size Break Up



Framework for Manpower Estimation

Suggested Framework for Manpower Estimation





Statistical Tools used for Research

Measure of central tendency - Measure of central tendency depict the point about which items have a tendency to cluster. Such a measure is considered as the most representative figure for the entire mass of data. Measure of central tendency is also known as statistical average mean also known as arithmetic average; it is the most common measure of central tendency and may be defined as the value which got by dividing the total measure of the values of various given items in a series by the total number of items.

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{1}{n}(x_1 + \cdots + x_n).$$

$\bar{x}$= the symbol we use for mean

x_i= value of ith item

n= total number of item

Measure of dispersion - An average can represent a series only as best as a single figure can, but it certainly cannot reveal the entire story of any phenomenon under study. Specifically it fails to give any idea about the scattered nature of the values beamed in the series. It also does not reflect the degree of variation in the given data set. So many at times averages can be far from the real picture. That is why measure of dispersion has been used to formulate the degree of variation from the true mean to evaluate the data in a much better form.

Autoregressive (AR) model has been utilized as technique to estimate power requirements under different scenarios. This technique is a representation of a type of random process; as such, it describes certain time-varying processes in nature, economics, etc. The autoregressive model specifies that the output variable depends linearly on its own previous values. It is a special case of the more general Auto Regressive Moving Averages(ARMA) model of time series.

The notation AR(*p*) indicates an autoregressive model of order *p*. The AR(*p*) model is defined as

$$X_t = c + \sum_{i=1}^{p} \varphi_i X_{t-i} + \varepsilon_t$$

where $\varphi_1, \ldots, \varphi_p$ are the ***parameters*** of the model, $c$is a constant, and ε_t is white noise. This can be equivalently written using the backshift operator *B* as

$$X_t = c + \sum_{i=1}^{p} \varphi_i B^i X_t + \varepsilon_t$$

so that, moving the summation term to the left side and using polynomial notation, we have

$$\phi(B)X_t = c + \varepsilon_t \, .$$

An autoregressive model can thus be viewed as the output of an all-pole infinite impulse response filter whose input is white noise.

Some constraints are necessary on the values of the parameters of this model in order that the model remains wide-sense stationary. For example, processes in the AR(1) model with $|\varphi_1| \geq 1$ are not stationary. More generally, for an AR(p) model to be wide-sense stationary, the roots of the polynomial $z^p - \sum_{i=1}^{p} \varphi_i z^{p-i}$ must lie within the unit circle, i.e., each root z_i must satisfy $|z_i| < 1$

Factor Analysis - has been used to identify critical factors which affect effectiveness of training and development programs. This technique is used to establish certain central factors from group of other factors which are affecting and controlling the given data set. Factor is an underlying dimension that account for several observed variables. There can be one or more factors, depending upon the nature of the study and the number of variables involved in it.

Factor loading - These are those values which explain how closely the variables are related to each other. They are also known as Factor variable correlations. They work as a key to understand the factor mean. **Eigen Value** is the sum of squared values of factor loadings relating to a factor which is referred as Eigen value or latent root. These values indicate the relative importance of each factor in accounting for the particular set of variable analysis.

Conclusion

In this chapter we have explained various statistical tools and techniques which have been used for our data analysis and interpretation. Moreover it also explains the methodology, blue print and research design used for the research.

CHAPTER-III

DATA ANALYSIS: POWER & MANPOWER ESTIMATION

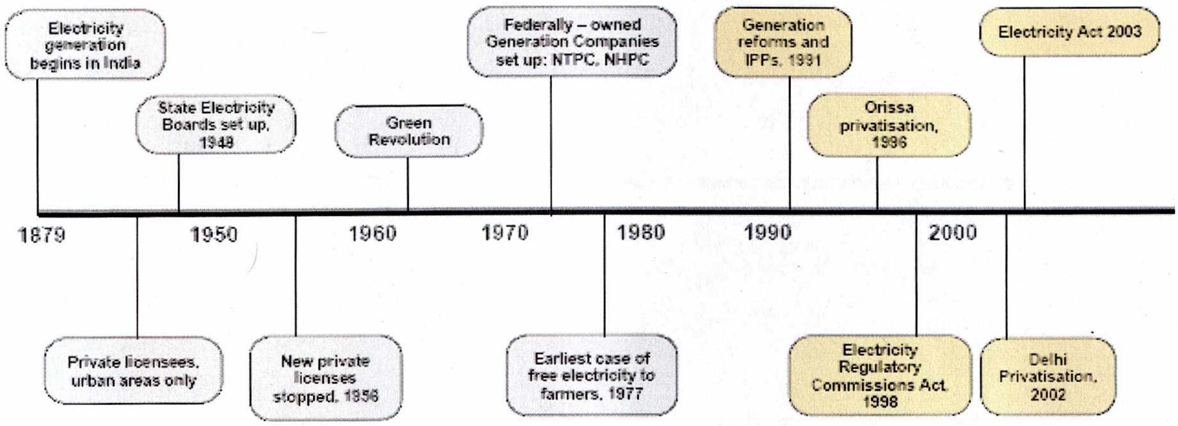
This chapter analyses data from both primary and secondary sources, and creates various scenarios for power projections till 2020. Similarly it also presents manpower projections based on man mega watt ratio, for various sources of power generation for the above mentioned time zone.

Power Sector in India

The electricity generation in India began in India in 1879. The power industry was in the private sector at the time of independence (1947) and the total commissioned capacity of the power generation in the country was about 1350 MW. There was no power industry in rural India.

In 1948, the very next year of the independence, the Electricity Supply Act 1948 came into existence which modified the 1910 Act. Barring a few licensees in some urban areas, e.g. The Tata Power Company Ltd. in Mumbai, Calcutta Electric Supply Corporation Limited (CESC) in Calcutta, Bombay Suburban Electric Supply Company (BSES) in Mumbai, Ahmadabad Electricity Company (AECO) in Ahmadabad etc. The entire power sector is mostly owned by State Governments and is largely managed by vertically integrated power utilities through State Electricity Boards (SEBs). Figure 3.1 presents the various reforms introduced in power sector between 1879 and 2003.

Fig 3.1 A Timeline of Reforms



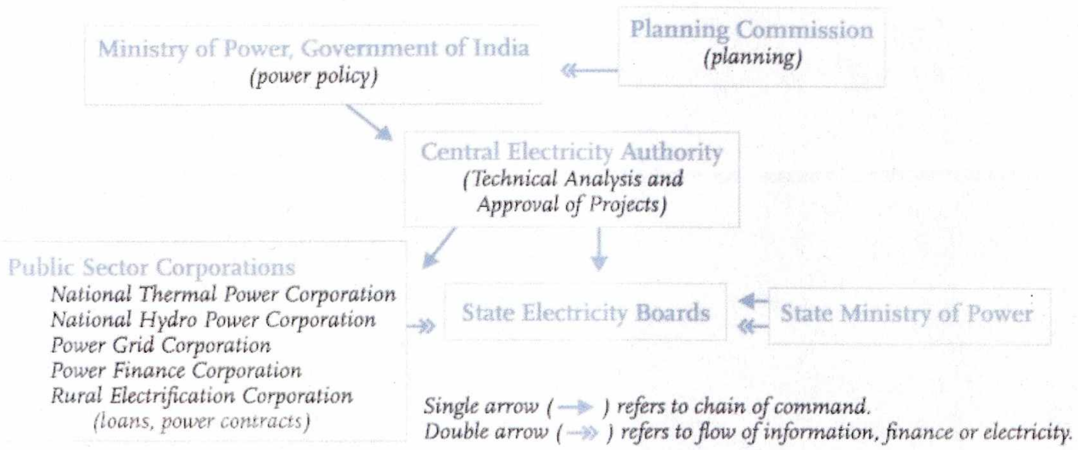
Source: *Sen, 2009*

Subsequent to 2003, the **Electricity (Amendment) Act, 2007** has been announced to amend certain provisions of the Electricity Act, 2003. The main features of the amendment Act are as under:

- Central Government, jointly with State Governments, to endeavour to provide access to electricity to all areas including villages and hamlets through rural electricity infrastructure and electrification of households.
- No license required for sale from captive units.
- Deletions of the provisions for elimination of cross subsidies. The provisions for reduction of cross subsidies would continue.
- Definition of theft expanded to cover use of tampered meters and use for unauthorized purpose. Theft made explicitly cognisable and non-bailable

The structure of power sector prior to 1991 is given in Fig. 3.2.

Fig 3.2 Structure of Electricity Sector before (1991)



Source: *Tongia, 2003*

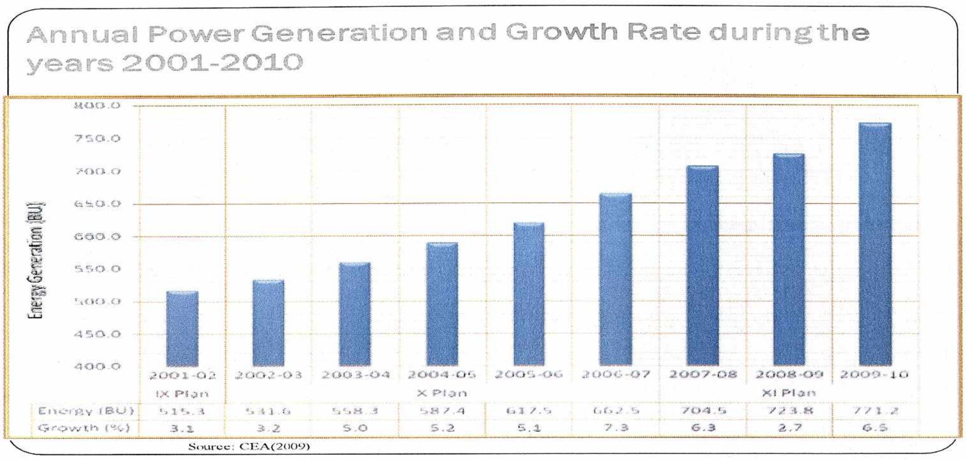
SEBs were mainly financed through state government loans and were run as extensions to state energy ministries. As a result, SEBs were "indebted in perpetuity," and were forced to continue in a relationship of financial and administrative dependence to energy ministries. Nonetheless, SEBs were the backbone of the electricity infrastructure, and by 1991 controlled 70% of electricity generation and almost all distribution (World Bank, 1991).

Under the Indian constitution, the power sector is a "concurrent" subject, allowing both the central and state governments some authority in the sector. SEBs are under the control of state governments, which also controlled the critical tariff-setting function. The central government was responsible for electricity policy, long-term planning, technical analysis, and project approvals through the Power Ministry, Planning Commission, and Central Electricity Authority.(Fig.3.2).

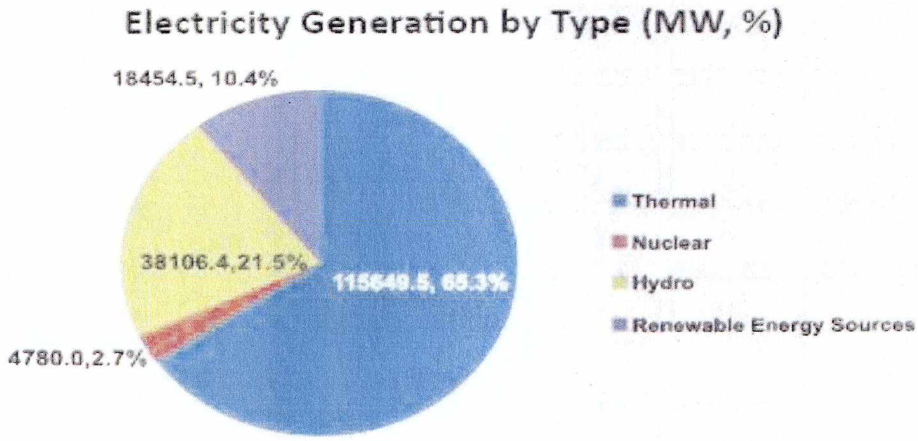
India's Power Sector- Generation

At the time of independence, the country's power generation only stood at 1362 MW, while at present it is around 180 GW. The power sector has been witnessing progressive developments, after the implementation of Electricity Act of 2003, and its amendment in 2007; there has been resurgence in the power sector through competitive bidding policies and private investments.

Fig 3.3 Annual Power Generation & Growth Rate during 2001-2010



Source: CEA(2009)



Power Ministry 2011-12

The power generation in India over the last decade, has increased at 5.17 % pa between 2001-02 and 2009-10. It increased from around 515 Bu (Billion Units) in 2001 to 771 Bu in 2010 (Table 1.1). As regards fuel mix of power generation in India, it is evident that the major source continues to be thermal based constituting 65.3% of total power generation in 2011-12; followed by hydro (21.5%) and then others.

Power Generation Projections

The projected installed capacity of power generation from various energy sources, based on growth rates of 6%, 8% and on auto-regression model assumed in our study is given below. The overall estimated installed capacity of power is expected to range between 295 GW and 350 GW by the end of 2017 and 352 GW and 440 GW in 2020 respectively (Table 3.1).

Table 3.1 Projected Power Generations from Different Sources 2012-2020

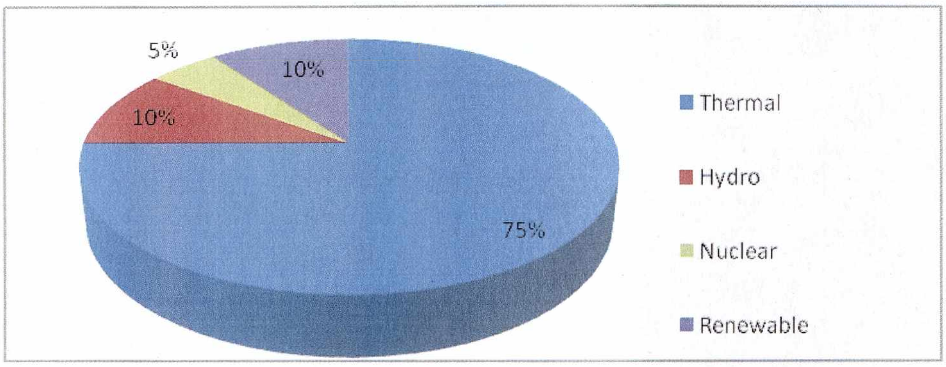
Source	2012			2017			2020		
All figures in 000's MW	6% Growth	8% Growth	Auto – Regressive Model	6% Growth	8% Growth	Auto – Regressive Model	6% Growth	8% Growth	Auto – Regressive Model
Thermal	135.0	145.0	145.0	180.0	214.0	144.0	215.0	270.0	159.5
Hydro	45.5	50.0	51.0	62.0	73.0	47.1	74.0	92.0	49.4
Nuclear	5.5	5.5	5.5	6.2	8.1	4.9	9.0	10.0	5.8
Renewable	34.0	36.5	36.5	46.8	54.9	37.0	54.0	68.0	37.3
Total	220	237	238	295	350	233	352	440	252

Through our study we have tried to create different scenarios, based upon the projected figures for power generation in India up to 2020. The demand for manpower in this sector will usually depend upon the operational power projects and technologies set up in the coming years. Therefore our extrapolations are strictly based on the extension of "supply of power" rather than "demand of power". The rationale for adopting this approach has been the continuous demand and supply mismatch, which according to CEA (2007) report on power sector claims to be having peak shortages to the tune of 8.5% and 10.3% respectively during 2010 and 2011. The ongoing RGGVY (Rajiv Gandhi Gram Vidyuthikaran Yojana) envisages access to electricity to households in rural areas; 56% of which do not have access to electricity.

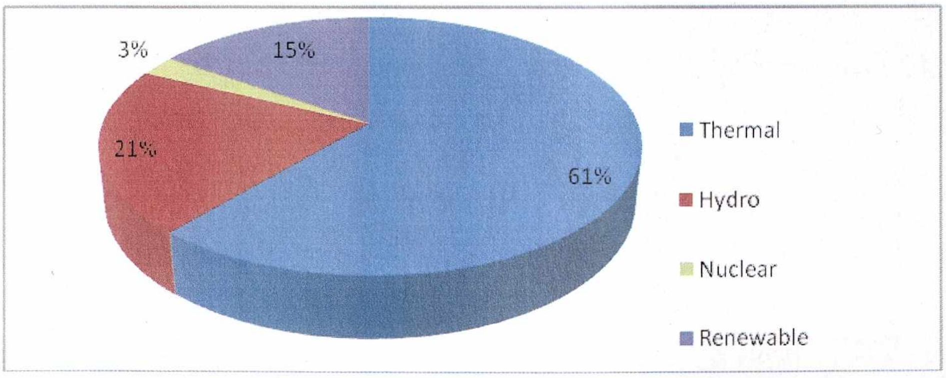
Alternate Scenarios for Power Generation under Changing Fuel Mix

In our study, we have assumed certain technological changes, which would affect the fuel generation mix in the coming years. Over the years, world's power requirements have been fueled through fossil fuels, primarily coal. As these are non-renewable and their usage is harmful to the environment, therefore, there is greater pressure to explore alternate sources of energy that are cleaner and equally efficient. The three scenarios of power-mix that have been used in our study are based on expert opinion using Delphi method.

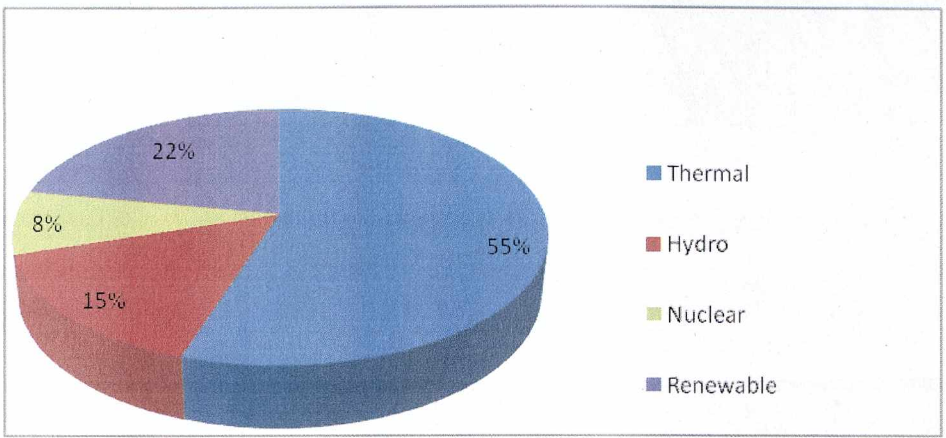
Figure 3.4-These are given below as **Scenario 1, Scenario 2 and Scenario 3.**



Scenario-1



Scenario-2



Scenario-3

Power Projections under Growth and Fuel –Mix Scenarios

Power projections under different growth and fuel–mix scenarios for 2012, 2017 and 2020 have been worked out and given in Tables 3.2, 3.3 and 3.4 below.

Table 3.2- Power Generation mix under various scenarios for 2012

	2012								
Source	6% Growth			8% Growth			Auto Regression		
All figures in 000's MW	S1	S2	S3	S1	S2	S3	S1	S2	S3
Thermal	135.00	165.00	121.00	145.00	177.80	130.40	145.00	178.50	130.90
Hydro	46.00	22.00	33.00	50.00	23.70	35.60	51.00	23.80	35.70
Nuclear	5.50	11.00	17.60	5.50	11.00	19.00	5.50	11.90	19.10
Renewable	34.00	22.00	48.40	36.00	23.70	52.00	36.50	23.80	52.30
Total		220			237			238	

Table 3.3 - Power Generation mix under various scenarios for 2017

	2017								
Source	6% Growth			8% Growth			Auto Regression		
All figures in MW 000's	S1	S2	S3	S1	S2	S3	S1	S2	S3
Thermal	180.00	221.25	162.25	214.00	262.50	192.50	139.00	174.75	128.15
Hydro	62.00	29.50	44.25	73.00	35.00	52.50	46.50	23.30	34.95
Nuclear	6.20	14.75	23.60	8.10	17.50	28.00	4.90	11.65	18.64
Renewable	45.00	29.50	64.90	54.00	35.00	77.00	37.00	23.3	51.26
Total		295			350			233	

Table 3.4 - Power Generation mix under various scenarios for 2020

	2020								
Source	6% Growth			8% Growth			Auto Regression		
All figures in MW 000's	S1	S2	S3	S1	S2	S3	S1	S2	S3
Thermal	215.00	264.00	193.60	270.00	330.00	242.00	145.00	189.00	138.60
Hydro	74.00	35.20	52.80	92.00	44.00	66.00	50.00	25.20	37.80
Nuclear	7.90	17.60	28.16	10.30	22.00	35.20	5.10	12.60	20.160
Renewable	54.00	35.20	77.44	68.00	44.00	96.80	38.00	25.20	55.44
Total		352			440			252	

Human Resource Requirements

The Power sector is a capital and technology intensive sector requiring large number of engineers, technicians and other skilled workers. Power projects require specialized technical manpower during the project construction phase as well as the Operation and Maintenance (O&M) phases. Due to the technology intensive nature of the business, technical and managerial competency is critical in ensuring timely implementation of projects and optimum performance upon commissioning.

As discussed in the previous section, the country is poised to build more power generation capacity as well as support existing power systems in the next 10 years as compared to the previous 60 years. This necessitates induction of significant manpower in the sector. Even though the country produces a large number of fresh engineers every year, it is not possible to directly deploy them in the work force without proper training due to the technology intensive nature of the industry. The induction programs currently specified by the CEA range in duration between six to twelve months for engineers, operators, supervisors and technicians based on the technology area. Further, experienced professionals are required for critical activities and it is difficult to augment the number of such professionals in a short period of time. Hence adequate capacity building measures need to be undertaken to ensure the ready availability of manpower required for achieving the plan targets. Further, continuous training should be provided to the current manpower to ensure up-to-date technical skills, higher motivation and productivity.

The total manpower in the power sector at the end of Tenth Five Year Plan (2002-07) was around 9.5 lakhs as per the Planning Commission's Working Group on Power. The following are the requirements for additional manpower for the Eleventh Plan (2007-12) assuming addition of 68,869 MW of generation capacity, 100,000 ckt.Kms of HV, EHV and UHV transmission lines and 16 crore distribution consumers. It should be noted that the generation capacity addition target was revised to 78,700 MW which further increases the manpower requirement.

Table 3.5-Additional Manpower requirements for Eleventh Five Year Plan in 000's.

Area	Technical	Non-Technical	Total
Thermal	**31.4**	**12.3**	**43.7**
Hydro	**25.3**	**7.1**	**32.5**
Nuclear	**3.9**	**1.6**	**5.5**
Power System	**202.1**	**60.6**	**262.7**
Total	**262.7**	**81.7**	**344.4**

Source: Report of Sub-group – 9 of Working Group on Power for 12th & 13th Plan on Human Resources Development and Capacity Building, August 2011

Table 3.6 Additional Manpower required for Twelfth Five Year Plan in 000'

Area	Technical	Non-Technical	Total
Thermal	26.9	10.0	36.9
Hydro	37.5	6.3	43.8
Nuclear	13.2	5.6	18.8
Power System	148.4	45.1	193.4
Total	226.0	67.0	293.0

Source: Report of Sub-group – 9 of Working Group on Power for 12th & 13th Plan on Human Resources Development and Capacity Building, August 2011

As per the Planning Commission estimates, the total additional manpower requirements in power sector for the Twelfth Five Year Plan is around about 2,93,000 employees across all categories of operations and maintenance i.e. generation, transmission and distribution. The difference in 11th and 12th plan estimation is attributed to technological advancements.

Table 3.7 CEA estimates for total manpower requirements in power sector for Twelfth Five Year Plan.

Category	Construction	Operations & Maintenance	Total
Engineers	64,000	48,000	1,12,000
Supervisors	85,000	89,000	1,74,000
Skilled	4,03,000	1,49,000	5,52,000
Semi-Skilled	3,81,000	89,000	4,70,000
Non-Tech	2,12,000	1,44,000	3,56,000
Total	11,45,000	5,19,000	16,64,000

Source: Report of Sub-group – 9 of Working Group on Power for 12th & 13th Plan on Human Resources Development and Capacity Building, August 2011

As per the CEA estimates the total manpower requirements in power sector is around 16,64,000 employees, at the end of 12^{th} plan.

All the above projections are based on category-wise man: megawatt ratio, established by CEA for various levels. The manpower hierarchical structure has been set up by the HRD Ministry and Ministry of Power, Government of India. Such a structure defines the entire manpower force in basic four categories' namely A to D.

A- This has nine sub levels of various employees classified as "Executive" & above. The basic educational qualifications consist of Engineers, Lawyers, Management Graduates, Charted Accountants, etc. Employees from "B" category can also be promoted to this category, for which they have to be part of the organization for at least 10 years out of which 3 years must be served at "W10-12" level.

B- This level has primarily five sub levels classified as "Supervisor". These employees generally have minimum of five years of experience at lower levels and promoted through a structured performance appraisal system. The education level varies from ITI pass outs, diploma holders, Bachelor of Arts, bachelor of commerce etc.

C- This level consists of six sub levels classified as " Junior Supervisor", "Typists"," Steno" etc. These employees have similar educational qualification as the B category people, but most of them are taken in as freshers or with less than 5 years of experience.

D- This level consists of mainly "Skilled" & Semi-skilled" workers.

E- Employees involved for Environmental concerns. This category has been additionally proposed since environmental concerns are going to increase in coming years and hence requirement of personnel with requisite expertise would be critical.

Manpower Projections under Growth, Fuel-Mix and Technology Scenarios

Two technology scenarios have been assumed regarding productivity of manpower at different levels based on existing technology and improved technology in future as given in Table 3.8. The scenario T1 – Man/MW ratio has been approximated using empirical data from leading utilities in thermal, hydro and nuclear fueled power utilities, while as the future technology scenario T2 Man/MW ratio has been projected using secondary data from CEA. Linear extrapolation has been used to derive man megawatt ratio for 2020 based on man megawatt ratio benchmark set by CEA for 11th & 12th plan.

It is evident from that T2 figures are much lower than the T1, mainly because in future man-megawatt ratio is expected to come down due to technology advancements; except for renewable power sources wherein there is an uncertainty regarding technology advancements in terms of scale.

Table 3.8

Technology Mix(Man Megawatt Ratio)				
		T1		
Man/MW				
	Thermal	Hydro	Renew	Nuclear
A(E1-E9)	0.430	0.610	0.520	0.805
B(W8-W12)	0.130	0.270	0.300	1.050
C(W3-W7,S1)	0.210	1.300	0.330	0.741
D(W0-W2)	0.050	0	0.570	0
		T2		
Man/MW				
	Thermal	Hydro	Renew	Nuclear
A(E1-E9)	0.373	0.403	0.520	0.505
B(W8-W12)	0.112	0.178	0.300	0.659
C(W3-W7,S1)	0.182	0.858	0.330	0.465
D(W0-W2)	0.043	0	0.570	0

Manpower Projections

Considering technology scenarios T1 and T2; fifty four (3 growth X 3 fuel-mix X 2 technology X 3 years) alternate manpower projection scenarios under growth, fuel-mix and technology have been worked out. For easy reference and indexing a master Table 3.9 has also been provided below.

Table 3.9 Master Table index-(table numbers)

Year Technology Growth

Year	Technology	6%			8%			Auto Regress		
		S1	S2	S3	S1	S2	S2	S1	S2	S3
2012	T1	A.1	A.2	A.3	A.4	A.5	A.6	A.7	A.8	A.9
	T2	A.28	A.29	A.30	A.31	A.32	A.33	A.34	A.35	A.36
2017	T1	A.10	A.11	A.12	A.14	A.15	A.16	A.17	A.17	A.18
	T2	A.37	A.38	A.39	A.40	A.41	A.42	A.43	A.44	A.45
2020	T1	A.19	A.20	A.21	A.22	A.23	A.24	A.25	A.26	A.27
	T2	A.46	A.47	A.48	A.49	A.50	A.51	A.52	A.53	A.54

Table 3.9.1- Manpower Requirements in Thermal based plants

All figures in 000's		2012	
Thermal	Max	Min	Range
A(E1-E9)	76.76	45.18	31.58
B(W8-W12)	23.21	13.66	9.55
C(W3-W7,S1)	37.49	22.06	15.43
D(W0-W2)	8.93	5.25	3.68
		2017	
A(E1-E9)	112.90	54.14	58.76
B(W8-W12)	34.13	16.37	17.76
C(W3-W7,S1)	55.13	26.44	28.69
D(W0-W2)	13.13	6.30	6.83

		2020	
A(E1-E9)	141.9	51.75	90.1515
B(W8-W12)	42.9	15.64	27.2551
C(W3-W7,S1)	69.3	25.27	44.0275
D(W0-W2)	16.5	6.017	10.4827

Table 3.9.2- Manpower Requirements in Hydro based plants

All figures in 000's		2012	
Hydro	Max	Min	Range
A(E1-E9)	30.5	8.8572	21.6428
B(W8-W12)	13.5	3.9204	9.5796
C(W3-W7,S1)	65	18.876	46.124
D(W0-W2)	0	0	0
		2017	
A(E1-E9)	32.025	11.8767	20.1483
B(W8-W12)	14.175	5.2569	8.9181
C(W3-W7,S1)	68.25	25.311	42.939
D(W0-W2)	0	0	0
		2020	
A(E1-E9)	56.12	17.714	38.4056
B(W8-W12)	24.84	4.4906	20.3494
C(W3-W7,S1)	119.6	7.6346	111.9654
D(W0-W2)	0	0	0

Table 3.9.3 - Manpower Requirements in Nuclear based plants

All figures in 000's		**2012**	
Nuclear	**Max**	**Min**	**Range**
A(E1-E9)	**15.3407**	**2.2757**	**13.0649**
B(W8-W12)	**19.9920**	**5.5628**	**14.4292**
C(W3-W7,S1)	**14.1130**	**2.5588**	**11.5542**
D(W0-W2)	**0**	**0**	**0**
		2017	
A(E1-E9)	**22.5597**	**7.4592**	**15.1004**
B(W8-W12)	**29.4**	**9.7210**	**19.6790**
C(W3-W7,S1)	**20.7544**	**6.8623**	**13.8921**
D(W0-W2)	**0**	**0**	**0**
		2020	
A(E1-E9)	**28.3607**	**6.3719**	**21.9888**
B(W8-W12)	**36.96**	**8.3040**	**28.6560**
C(W3-W7,S1)	**26.0912**	**5.8621**	**20.2292**
D(W0-W2)	**0**	**0**	**0**

Table 3.9.4 - Manpower Requirements for Renewable Power

All figures in 000's		**2012**	
Renewable	**Max**	**Min**	**Range**
A(E1-E9)	**27.2272**	**11.44**	**15.7872**
B(W8-W12)	**15.7080**	**6.6**	**9.1080**
C(W3-W7,S1)	**17.2788**	**7.26**	**10.0188**
D(W0-W2)	**29.8452**	**12.54**	**17.3052**

	2017		
A(E1-E9)	33.748	12.116	21.632
B(W8-W12)	19.47	6.99	12.48
C(W3-W7,S1)	21.417	7.689	13.728
D(W0-W2)	36.993	13.281	23.712
	2020		
A(E1-E9)	40.2688	13.104	27.1648
B(W8-W12)	23.232	7.56	15.672
C(W3-W7,S1)	25.5552	8.316	17.2392
D(W0-W2)	44.1408	14.364	29.7768

Table 3.10-Total Manpower Estimation for Operations & Maintenance – Generation

(All Figures in 000)

Year	**Technology**	**Growth**								
		6%			**8%**			**Auto Regress**		
		S1	**S2**	**S3**	**S1**	**S2**	**S2**	**S1**	**S2**	**S3**
2012	**T1**	285.0	250.3	301.3	305.5	269.7	324.5	255.56	270.8	325.9
	T2	230.1	205.1	246.1	246.4	221.0	265.1	206.82	221.9	266.2
2017	**T1**	394.1	374	***465.2***	***451.1***	***443.7***	***479.3***	280.29	295.4	319.1
	T2	305.3	275.1	***329.9***	***342.7***	***351.3***	***406.6***	305.74	234.9	270.7
2020	**T1**	453.0	400.5	***482.0***	***568.2***	***500.7***	***602.5***	307.88	286.7	345.1
	T2	432.5	400.5	***482.0***	***459.0***	***410.2***	***492.1***	249.23	235	281.8

Table 3.10 shows the total manpower estimation for operations & maintenance (O&M) for power sector pertaining to **generation** up to 2020. The details estimates of manpower in the year 2012, 2017 and 2020 with levels , fuel mix, technology and growth are given in APPENDIX III It is observed from the estimated manpower that auto regression estimates are not realistic and therefore were not found to be tenable. Similarly estimates arrived at by considering 6% growth

assumption and fuel mix under S1 and S2 were also found to be unrealistic, particularly in view of the projected growth in GDP that Indian economy is aspiring for in the coming years. The manpower estimates highlighted in italics (red) are the most likely scenario that would emerge in the future. Although the growth rate for power sector was around 4% to 4.5% till 2010, it is expected to grow at 8% in the near future, and moreover with an expected change in fuel mix scenario due to environmental concern and technological advancements the overall manpower requirement for operations and maintenance pertaining to power **generation** is likely to be around 343,000- 4,80,000 till 2017 & 410,000 - 6,00,000 till 2020. Moreover these figures are not directly comparable with Planning Commission estimates for eleventh and twelfth plan as these include total additional requirement for power sector including construction, generation and transmission and distribution. While CEA estimates although highlight separately total manpower requirements for construction and O&M, however their O&M figures include transmission and distribution. Further their projections are based on higher power requirements.
The total availability of engineering and management graduates required for 'A' category of employees in the power sector is 15.45 lakh in 2012 as per working Group on Power for 12th & 13th Plan which will go up to 77.25 lakh in 2017 and further to 123.60 lakh in 2020. The availability of category 'A' employees is plotted against best and worst case scenario in Fig. 3.2.1 to 3.2.3. It is evident that the availability in quantitative terms far exceeds the projected requirements. The same holds true for category 'B' and category 'C' as well.

Figure 3.2.1

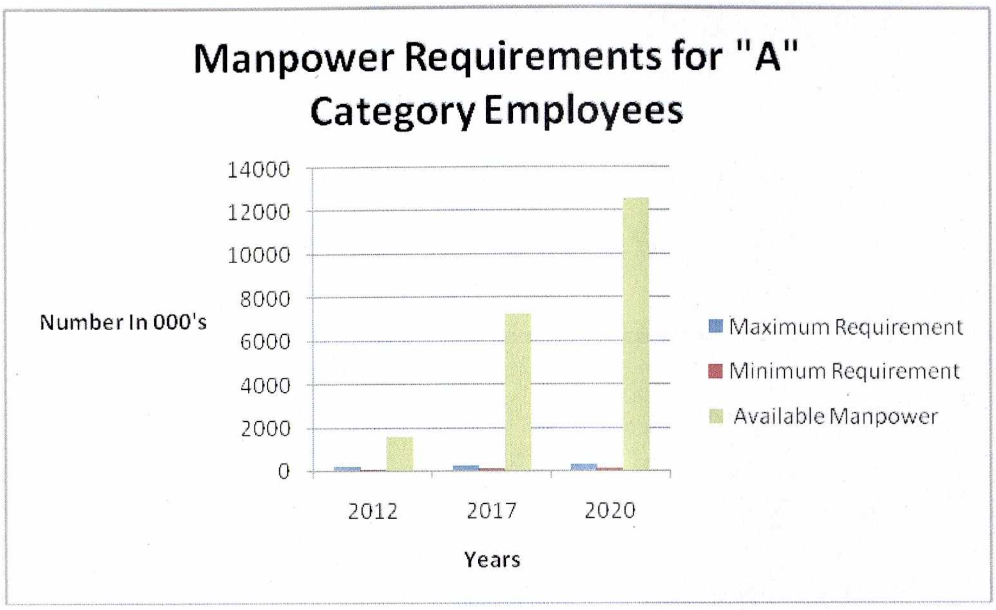


Figure 3.2.2

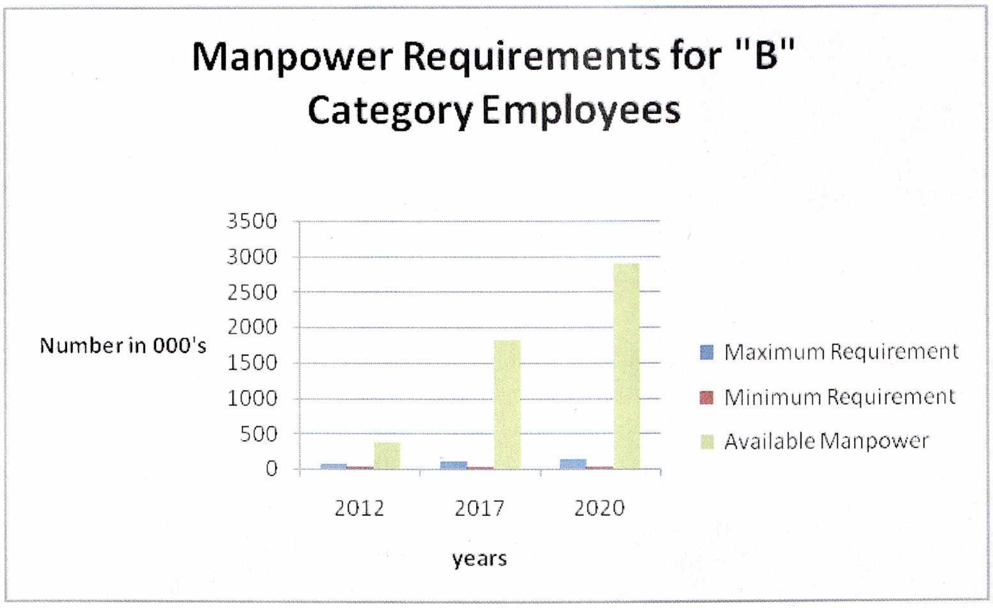
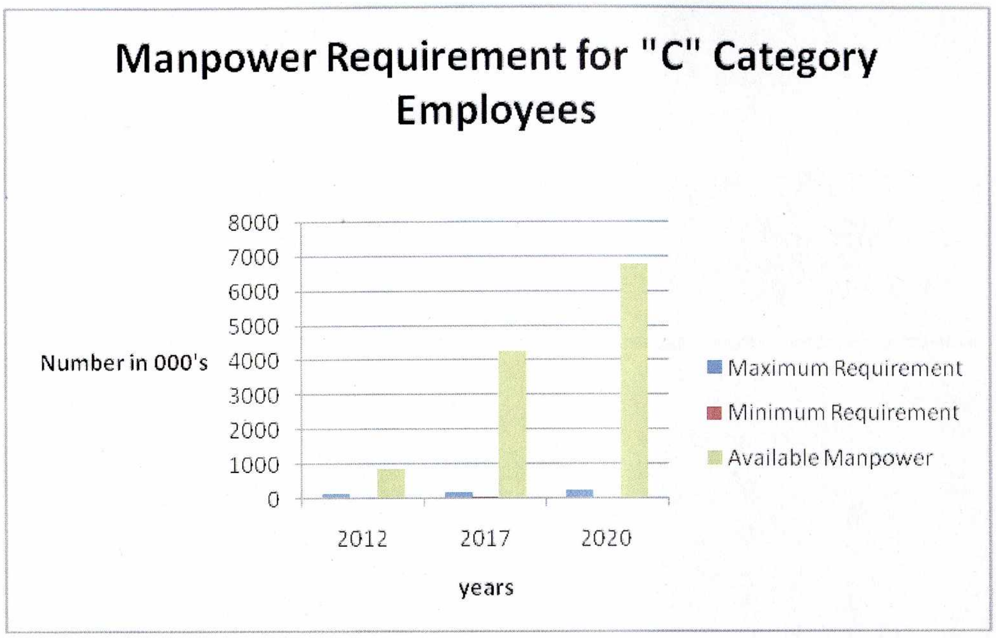


Figure 3.2.3



Our manpower projections are based upon the consultation with policy makers, industry experts and the projections set across by the major power utilities across the country as regards basic assumptions on technology, fuel mix and growth .

According to our study, the power industry would be requiring close to 410,000 - 600,000 employees in O&M for generation sector alone by 2020. The onus would be based on mainly two categories that are "A" & "C", which would be requiring overall manpower between 2,80,000 - 3,80,000 at both levels. Both "B" and "D" category employees would only have an overall requirement demand of 80,000 - 1,40,000 and 50,000 - 80,000 respectively. Generally people aren't recruited at B level; they come through promotions as explained earlier. Regarding D category people are not part of O&M setup, they are mostly used in construction and grid management set up. That explains for their low demand in future. Moreover with the advent and onset of Super Critical technologies, there would be a need for more skilled and educated personnel with updated in recent technologies.

Table 3.11 Manpower Availability vs. Requirement

Courses	Colleges	Annual Intake (Lakhs)	Total (5yrs) (Lakhs)	Manpower requirements for 12th Plan (Lakhs)
Engineering	3617	11.30	56.50	0.58
Management	4058	4.15	20.75	-
Polytechnics	540	0.93	4.65	0.56
ITIs	8039	11.15	55.75	1.99
Total	16254	27.53	137.65	3.13

Source: Report of Sub-group – 9 of Working Group on Power for 12th & 13th Plan on Human Resources Development and Capacity Building, August 2011

Human Resource Position at Various Power Utilities

NTPC- Currently NTPC has around 25,000 employees out of which around 45% are at "A" level. The input that we got from their HR team is that the company has already set up a recruitment plan for 2017 projections wherein they plan to almost double their current capacity of production. Over the past couple of years NTPC has been recruiting around 1,000 employees at all levels, out of which 600-750 of them are "A" category employees, most of them being graduate engineers. NTPC currently has a 0.8 Man-Mega watt ratio, which they want to bring down to 0.6 by 2017. This company has an advantage of being a Maharatna "PSU" and has been recently awarded as top employer by the HRD ministry. This makes it as a top choice for ambitious employees. As per NTPC- HR team they receive over 100 applications per job which is considered a good number to build a talent pool. Moreover this organization has an attrition rate of less than one percent.

NHPC- Being a Hydro based utility; this organization has an extremely high man-megawatt ratio of 2.2, which is very high in comparison with some of the other utilities. Currently NHPC has around 11,000 employees, which are well spread at all levels. This organization has a plan to recruit around 5,000 additional employees at all levels by 2019.

Over the last few years they have been employing around 500 employees across all levels annually. The attrition rate of NHPC is close to three percent.

TATA Power & Other Private Players- Except TATA Power, all other private players have a very less man-megawatt ratio. TATA Power alone has a 2.53 man-megawatt ratio, whereas most other utilities have man-megawatt ratio of less than 0.3 in other private sector power utilities. This is so because, other utilities such as JPL, LANCO, RNRL, GMR maintain cross-sectional teams, and their C & D category people are mostly outsourced. Such an alarming difference between man-megawatt ratio of private and PSU utilities was justified by the HR team by stating that they follow Western based model, and have tried to replicate similar technologies which are employed in West, where the man-megawatt ratio in O&M sector moves between 0.25-0.4. JPL, LANCO, RNRL & GMR haven't come out by any detailed manpower recruitment plan, but have given out that they would maintain man-megawatt ratio at around 0.4 -0.6, which can be applied to their additional power capacity plans.

Conclusion

The overall requirement for additional manpower for O&M generation for power utilities will be in the region of 410,000 - 600,000 till 2020. On the other hand it is clear that there is no shortage of supply of manpower for power sector. Moreover most of the prominent power utilities have well settled recruitment plans for the future. In addition due to technological advancements this sector is going to observe a radical fall in Man-Mega Watt ratio.

Thus basic issue in manpower planning for the power sector in the coming years will not be availability of numbers but the quality of manpower pertaining to the skill set & competency requirement at various levels.

CHAPTER-IV

TRAINING NEEDS REQUIREMENTS AND ASSESSMENTS

This chapter gives an overview of the quality of training and development programs conducted for power sector in India. Moreover it also tries to identify perceived skill set requirements for various levels and various key factors influencing the effectiveness of these programs.

Skill Set Required at Different Level of Employees – An Empirical Survey

This study attempts to map the perceptual gap of employees about the skill set requirements of employees working at their level as well as at other levels. The skill-set was broken into three primary categories viz. **Technical skills** (dealing with all the technical know-how of the particular job), **Knowledge skills** (dealing with requisite knowledge domain for the job) and **Human skills** (dealing with mainly soft skills, such as interpersonal, communication skills). The purpose of the study was to know the viewpoint of the recipients of the training and development programs conducted by various power utilities that could then provide an insight to the designers for improvement of such training and development programs. The data was collected through a questionnaire and personal interview method from the employees of major power utilities in India viz. National Thermal Power Corporation, National Hydro-electric Power Corporation, Jindal Power Corporation, Tata Power, GMR Power, and JAYPEE Power.

In India not many studies have been conducted in this area at the national level for power sector. Most of the utilities take clue from the technology providers and in-house research for further development of these programs. Through our personal interaction with the program architects at Power Management Institute (PMI) which is an apex training center of National Thermal Power Corporation (NTPC) and National Power Training Institute (NPTI), a training university under the Power Ministry, Government of India, we came to know that programs are designed solely through the inputs provided by the technology providers and a pool of senior officials. For further improvisation, the productivity of employees is considered as a measuring yardstick.

Here again, the perception of the employees and their feedback, who are actually undergoing these programs isn't taken in to account.

We wanted to understand the perception of employees and their opinions on the type of skills required at various levels. The employees who are performing the assigned jobs have a far better idea in gauging the set of skills required to do the job in a much better way. They understand their follies and short comings, which must be given due weightage for improving the structure of training and development programs. Through our study we have tried to capture the perception of various employees at different levels regarding the same.

Skills are not just educational qualifications but rather an employee's comprehension and understanding of the organizational requirements (Grugulis & Macmillan 2007). Firms which sustain in the longer run ensure to upgrade employee skill set as per the need of the time. Business environment is quite dynamic and ever changing, therefore in order to meet these challenges, the respective firms have to upgrade staff core competencies (Blancaro, Boroski& Dyer 1996). Skills are of varied types, but in order to have a broader understanding we have divided them into three major categories viz. **human, technical and knowledge skills**. It has been observed that human, knowledge and technical skills are more important for managers, senior managers and lower level managers, in that order, respectively (Kay & Moncarz, 2004) .

The western countries have reached a saturation point in terms of economic growth, and now the focus for fostering world economy has shifted to Asia Pacific region. The recent studies conducted in this region reveal that there is a severe shortage of technical and knowledge skills in this region (Cedant 2001; Yuksel2011). In such a scenario, it's the job of human resources departments to manage the skills set requirement of employees for their respective firms, as they are considered to be best agents of change (Ulrich, Brockbank, Yeung & Lake 1995). While small-scale firms face a problem of employee retention because they fail to match the expectations of employees (Peters 2005), in such cases managing skill set is a huge challenge. The bigger firms like power utilities face a threat of creating 'black holes' because of poor management of skills, resulting in higher attrition rate (Goodwin 2004).

The key factors in the smooth functioning of any sector are primarily technology, investment, raw materials and manpower. The core differentiator among the utility companies in this era of globalization and easy access to technology, capital and raw material is the efficiency and effectiveness of their manpower (Kastava & Condrey 2005). Through efficient personnel management these companies can cut down on losses and help in improving the overall productivity of the utility, and hence contribute towards shortening the gap between the demand and supply of power requirements.

Katz (1955) in a classic article in the *Harvard Business Review* titled, "The Skills of the Administrator," divided good management skills into three general areas: human relations, technical, and conceptual. We divided the major skill set in three primary categories as **Technical skills**, **Knowledge skills and** Human skills to identify the importance of these skills based on employees' perception for their job/level and also rate the importance of these skills for other levels.

Analysis & Interpretation

The responses were differentiated category wise based on the respondent's educational qualification whether he/she is holding a diploma, graduation, post graduation, or doctoral degree. The reason being that minimum eligibility conditions for different levels in power utilities were mostly based on educational qualifications and various power utilities have different training programmes for different levels. Hence categorization as per different educational qualifications broadly means categorization as per different levels of employees.

We calculated the mean of the responses given by an employee belonging to a particular category. Mean analysis gave us some insight about the perception of these employees regarding the type of skill set adequacy/inadequacy after which we conducted Analysis of Variance (ANOVA) to deduct whether the difference in perception levels of different categories of employees was statistically significant.

Table-4.1.1 Importance of Different Skills at Different Levels.

Qualification		**(a) Technical Skills**	**(b) Human Skills**	**(c) Knowledge Skills**
Diploma holder	**Mean**	**8.67**	**6.61**	**7.54**
	Std. Deviation	**1.099**	**2.748**	**2.650**
Graduate	**Mean**	**7.95**	**7.98**	**8.33**
	Std. Deviation	**1.546**	**1.385**	**1.263**

Post Graduate	**Mean**	**7.07**	**7.94**	**<u>8.38</u>**
	Std. Deviation	**2.238**	**1.245**	**1.356**
Doctorate	**Mean**	**5.90**	**<u>7.70</u>**	**6.90**
	Std. Deviation	**1.449**	**.483**	**1.449**
Overall	**Mean**	**7.88**	**7.69**	**<u>8.16</u>**
	Std. Deviation	**1.730**	**1.793**	**1.687**

The respondents were asked to rate the skills (technical, human, and knowledge) relevant at their level on a scale of 1-10 (1-least important & 10-most important). Employees with ITI/diploma qualification feel that ***technical*** and ***knowledge*** skills are more important as compared to *human* skills. On the other hand graduates and post-graduates feel ***knowledge*** kills are the more important skills in comparison with other skills. However PhD's feel the importance of *human* skills.

This data clearly shows that according to the employees the skills set requirement varies at different levels. For floor level employees, *technical* skills become most relevant, while for the other employees' *knowledge* skills and *human* skills seem to be more relevant.

Further, we set up our null hypothesis that there is no difference in perception of type of skills required across different employee levels as per perception of employees and tested the hypothesis using F-test.

Table- 4.1.2 Difference in Perception of Type of Skills Required Across Different Employee Levels

Type of Skills			Sum of Squares	df	Mean Square	F	Sig.
(a) Technical skills	**Between Groups**	**(Combined)**	**200.795**	**3**	**66.932**	**24.934**	**.000**
	Within Groups		**1661.604**	**842**	**2.684**		
	Total		**1862.399**	**845**			
(b) human skills	**Between Groups**	**(Combined)**	**182.196**	**3**	**60.732**	**20.672**	**.000**
	Within Groups		**1818.521**	**842**	**2.938**		
	Total		**2000.717**	**845**			
© Knowledge skills	**Between Groups**	**(Combined)**	**80.485**	**3**	**26.828**	**9.825**	**.000**

Within Groups	1690.273	842	2.731
Total	1770.759	845	

As the results show, the difference in perception of type of skills required across different employee levels skill is significant and hence we do not reject the null hypothesis.

Employees at different levels were asked to rate the importance of upgrading different type of skills for different categories of employees viz. engineers, supervisors and non-technical (work man) people for improving their job effectiveness on a scale of 1-10 (where 1 is least desirable and 10 are most desirable). The Table 4.1.2 shows the rated mean of the skill set up gradation required by engineer, supervisor and workmen levels, as perceived by various employees.

Table 4.2.1 Perception Rating of Different Levels about Skills Up-gradation Required at Various Types of Positions

Qualification		Engineer			Supervisor			Workmen		
		Technical	Human	Knowledge	Technical	Human	Knowledge	Technical	Human	Knowledge
Diploma holder	Mean	8.62	7.21	7.89	9.02	7.57	8.76	6.67	7.75	7.36
	Std. Deviation	1.482	2.665	2.605	.936	2.253	1.232	2.338	1.485	2.138
Graduate	Mean	8.66	8.13	8.56	8.23	7.92	7.65	6.43	7.93	7.25
	Std. Deviation	1.249	1.494	1.245	1.382	1.773	1.523	2.318	1.549	1.733
Post Graduate	Mean	8.64	7.63	8.59	7.84	7.54	7.72	6.50	7.30	7.15
	Std. Deviation	1.204	1.197	1.162	1.352	1.005	1.418	1.751	1.653	1.998
Doctorate	Mean	7.60	8.00	8.60	7.70	8.80	8.40	2.90	9.00	7.70
	Std. Deviat	.966	.000	.966	.483	1.932	.966	1.449	.000	.483

	ion									
Over all	Mean	8.63	7.84	8.43	8.30	7.79	7.90	6.44	7.78	7.26
	Std. Deviation	1.290	1.768	1.614	1.345	1.770	1.503	2.250	1.570	1.862

Higher Mean values in the ratings column that have been underlined indicate that ITI/diploma holders, graduate engineers and post-graduates feel that upgrading *Technical* skills is more important at engineer and supervisor levels, whereas *Human* skills upgrading is more important at workmen level. On the other hand doctorates feel that appropriate *Knowledge* skills are missing at engineer level, whereas appropriate *Human* skills are deficient at supervisory and workmen level.

Surprisingly not only do ITI's and diploma holders feel that the training and development programs for engineers should be more focused towards upgrading technical skills rather than others skills, but they themselves i.e. graduate engineers and post-graduates too feel that skill-set enhancement area for their own category is that of technical skills. Overall ratings indicate necessity of enhancement of technical skills at the engineer and supervisor levels and human skills at the workmen level.

Further we set up our null hypothesis that there is no difference in perception of type of skills enhancement required across different employee levels (engineer, supervisor and workmen) as per perception of different categories of employees (ITI/diploma holders, graduates, post-graduates and doctorates), and tested that hypothesis using F-test (ANOVA) (Refer Table 4.1.1 & 4.1.2)

From Table 4.1.2 & 4.2.1, we find that there is significant difference in the responses of the various categories of employees in terms of skill enhancement required in the area of technical skills for engineers; in the area of human skills for the supervisors; and in the area of knowledge for workmen.

To put it in other words, as per the perception of different categories of employees in this empirical study (that had a sample size of 845 respondents representing Indian power sector both in private and public sector), the various levels of employees in this sector needed enhancement of skills of different types. The engineers, supervisors and workmen lack in technical, human and knowledge skills respectively and hence the training programs in future should focus on these skill areas.

Table 4.2.2 Difference in Perception Rating for Different Levels about Skills Up-gradation Required at Levels

ANOVA Table						
		Sum of Squares	df	Mean Square	F	Sig.
Engineer Technical skills	Between Groups(Combined)	10.882	3	3.627	2.192	.088
	Within Groups	1024.219	842	1.655		
	Total	1035.101	845			
Engineer Human skills	Between Groups(Combined)	84.132	3	28.044	9.335	.000
	Within Groups	1859.601	842	3.004		
	Total	1943.733	845			
Engineer Knowledge skills	Between Groups(Combined)	46.526	3	15.509	6.103	.000
	Within Groups	1573.091	842	2.541		
	Total	1619.617	845			
Supervisor Technical skills	Between Groups(Combined)	95.725	3	31.908	19.183	.000
	Within Groups	1029.622	842	1.663		
	Total	1125.346	845			
Supervisor Human skills	Between Groups(Combined)	29.807	3	9.936	3.203	.023
	Within Groups	1919.908	842	3.102		
	Total	1949.715	845			
Supervisor Knowledge skills	Between Groups(Combined)	119.497	3	39.832	19.168	.000
	Within Groups	1286.333	842	2.078		
	Total	1405.830	845			
Workmen Technical skills	Between Groups(Combined)	132.310	3	44.103	9.047	.000
	Within Groups	3017.435	842	4.875		
	Total	3149.746	845			

Workmen Human skills	Between Groups(Combined)	51.971	3	17.324	7.239	.000
	Within Groups	1481.302	842	2.393		
	Total	1533.273	845			
Workmen Knowledge skills	Between Groups(Combined)	4.712	3	1.571	.452	.716
	Within Groups	2151.716	842	3.476		
	Total	2156.428	845			

Table 4.2.3
Identification of Significant Skill set at Different Levels

	Factors								
Education Qualification	**Engineer**			**Supervisor**			**Workmen**		
Types of skills	Technical skills	Human skills	Knowledge skills	Technical skills	Knowledge skills	Human skills	Technical skills	Human skills	Knowledge skills
Significance	**Significant**	Not significant	Not significant	Not significant	Not significant	**Significant**	Not significant	Not significant	**Significant**

Table 4.2.4

Primary Skill Set Required and Inadequate Skill Set at Different Levels

Work Designation	Primary Skill Set requirements	In-Adequate skills Sets
Engineers	**Knowledge skills**	**Technical skills**
Supervisors	**Technical Skills**	**Human skills**
Workmen	**Human skills**	**Knowledge skills**

Above Table 4.2.4. is based on inferences derived by analysis of survey data given in the Table 4.2.2 and 4.2.3. It may be concluded from above Table- 4.2.4 that engineers employed in power sector require knowledge skills to perform their job, but are lacking in technical skills; in the case of supervisors, technical skills become the primary prerequisites, but they are deficient in Human skills, although perception mapping of workmen is slightly out of domain of our study, because they are not classified within bare minimum educational qualifications, moreover they come under semi-skilled or unskilled category employees therefore the only skill set they bring to the work is Human skills and as per the perception of other category employees, the workmen severely lack knowledge skills.

There is a need to identify specific on-the-job training programs to meet the requirements of engineers joining the power sector. Although there is an overall satisfaction about the kind of knowledge being imparted to the graduates, more emphasis must be given to honing their specialized technical skills for the particular job.

Supervisors are generally picked through various Industrial Training Institutes, primarily categorized as diploma holders. Since their job role is designed for on-site jobs requiring certain specialized skills that require a level of precision therefore they cannot afford any laxity towards the training needs for Technical skills. These employees aren't exposed to Management Development Programs, hence they lack Human skills. These set of skills are also required by them because they have to manage the team of workmen under them. Training for soft skills will help them communicate better with their subordinates and superiors.

Workmen are primarily employed for unskilled jobs, wherein people are absorbed having virtually no educational qualification; however to perform any job, these employee must have at least some basic knowledge for attaining efficient results. It's been observed that, in the current times, utilities aren't hiring these employees but are better off outsourcing it. The utilities or the outsourcing agencies must take care of basic training requirements of these employees.

Factors Influencing the Training & Development Programs in Power Sector

The employees were asked to rate eight variables namely - appropriate selection of the participants, duration of the program, infrastructure and resources, quality of the program, pedagogy, curriculum design, impact measurement, and commitment of the top management (given in the questionnaire under question 10) on a scale of 10, wherein 1- was least important and 10 was most important, to identify critical factors that contribute to the effectiveness of training and development programmes. The emphasis of such analysis was to consolidate these variables into certain important factors, which employees felt had more influence than the other on improving the overall efficiency of the training and developmental programs. In this pursuit, we used **Factor analysis** technique for data reduction, and clubbing these variables to highlight the core factors.

Table 4.3.1 Identification of Critical Factors Contributing to Training Effectiveness

S. No.	Factor Name	Eigen value	% of variance	Items	Item loading	Mean	Std Dev
1	Program Design, Quality & Execution	3.968	49.600	i. Infrastructure	.753	7.84	1.901
				ii. Quality of the program	.752	8.63	1.435
				iii. Pedagogy	.755	7.67	1.874
				iv. Curriculum Design	.801	8.22	1.818
				v. Impact measurement	.706	7.80	1.740
2	Program Commitment & Intent	1.143	14.962	i. Selecting participants	.875	7.94	1.930
				ii. Duration of the program	.683	7.72	2.027
				iii. Commitment of the top management	.748	8.35	1.740
				Total variance explained these two factors = 63.892%			

Based on this analysis the two major factors which affect the Training & Development programs are, **Program Design, Quality & Execution and Program Commitment & Intent (Table 4.3.1)**.

- **Program Design, Quality & Execution** deals with developing & designing the entire training module in accordance with the needs based upon infrastructural requirements (class room set-up, well equipped – up-to date faculty, training simulators and other learning aids.), curriculum design, pedagogy & its impact measurement. It also elaborates the entire structuring of the program in a detailed manner. Moreover this factor explains more than 49.6% variance, which makes it the most important factor in contributing towards efficiency of the training and development program.

- **Program Commitment & Intent** tells us about the actual intent and commitment of the program organizers towards the smooth functioning of the program. Sometimes despite having a sound blueprint for the training module it might fail to deliver desired results because of sheer lack of intent on the part of its organizers. Such instances will tend to occur, if right candidates aren't chosen for the program, or the duration of the program is ill-timed, that may be because of it being too long or short or if it is too early or late for its recipients. In many cases it may also reflect upon that the top management isn't committed or motivated towards the same. Therefore not only proper designing but also proper execution and intent from all the parties is required for making training and development programs relevant and effective. This factor explains 14.962% variance.

Training and development, as the name suggests, is one of the most key elements in enhancing productivity and efficiency of every employee. Moreover it also helps in morale boosting, confidence building and motivation of the employees (Feldman, 1989). It has been emphasized by many famous management gurus and laureates that what matter is quality not quantity. Hence taking a cue from this we wanted to focus upon the effectiveness and the efficiency of training and development practices and programs followed by various power utilities for each and every employee across different levels.

For this purpose our research team personally visited different power utilities and interviewed the training and development heads. In addition we also took information from various employees in the form of a close-ended questionnaire, which primarily focused upon gauging the effectiveness of training and development on various parameters such as employee development, skill enhancement & focus on job role. Moreover, it also focused on the understanding of various factors which contributed to an effective training module.

Employee Perception towards Effectiveness of Training Interventions

In an ever changing dynamic environment, which is continuously exposed to technological changes, it becomes almost imperative to familarise employees with all the facilities in order to keep up pace with the same. The Indian Power Sector is no different which has going through a complete overhaul over the past few decades. It has seen a growth rate of 3.05 % (CAGR) for last 8 years (CEA 2011). As this sector is technology intensive, the emphasis on developing efficient manpower becomes a key challenge. Human Development interventions is an integral part of manpower development as they help in enhancing employee knowledge, skill & abilities (Birdi,2005) and (Nafukho,2006). It not only helps in improving employee's performance (Arthur et.al, 2003) but also helps in enhancing their job involvement and satisfaction (Neumann et. al, 1989). These interventions are designed to accomplish clearly defined, explicit organizational goals (Hesketh & Ivancic, 2002) & (Salas and Cannon-Bowers, 2001), which have explicit and implicit implications (Ordonez de Peblos, 2004).

The idea behind such a study is to understand employee's perception towards the efficiency of the training and development programs, being conducted by various power utilities both in house and through professional training centers. Unfortunately not many such studies have been conducted in this area especially in power sector of India. In India we have many power utilities, which conduct training programs for all categories of employees, right from A-D (norm prescribed by the HRD ministry), but the efficiency of these programs isn't properly gauged. Power Management Institute (NTPC's apex Training Center) & National Power Training Institute (Ministry of Power's Training Center) alone conduct some 2,500 Human Development programmes every year for all levels. The management in most of these utilities considers the productivity of the unit, as a measuring yard stick for gauging the effectiveness of the training and development programs deployed for the particular category of employees, but in actual terms this cannot be the only measuring yard stick.

The modus operandi of training and development activity is to match employee capacity with its capability. As capability is an unknown factor (non-quantifiable), the management often gets swayed with a marginal increase in productivity. Although researchers have developed models to gauge the effectiveness of development interventions (Kraiger et.al, 1993) that focus on cognitive and behavioral and affective outcomes, through our study we want to have a deeper understanding of the gap between capability and capacity.

Our study consisted of interacting with the employees of power utilities as mentioned earlier, for understanding this gap between Capacity and Capability.

Data from 845 respondents across various utilities and for all levels, these responses include employees from all grade (A, -D), educational background (SSC, Graduate, Post Graduate &

PhD) and across all levels (Plant, Maintenance, Project &others).The sample size was selected through stratified sampling method, based upon the prescribed norm laid down by CEA for the percentage of employees at various levels.

Questionnaire designed by our team was to capture the perception of the employees undergoing these programs, regarding overall efficiency of training and development activities viz-a-viz competency building (skill enhancing activity) (McClelland 1973), focus on job role (equipping with skills required for the undersigned job) & improving productivity (improving efficiency) . According to our analysis, the best person, to judge the capability factor is one self. Therefore, our methodology is woven around the perception of the employees and their analysis of the above mentioned programs.

As we have taken the data through a structured questionnaire, our responses were taken on a Likert scale, where in each employee had to rate the training and development programs on the basis of above mentioned factors(ranging from Strongly agree-Agree-Cant say-Disagree-Strongly Disagree). All these responses were later quantified (5-Stongly Agree & 1-Stongly Disagree).

These responses were later on categorized based on employee category and their educational qualifications. The reason of doing this was, various power utilities conduct different programs for various levels, and people at these levels are chosen according to their educational qualifications. We calculated the means of the responses mentioned by the employee based on above mentioned educational qualifications. Means analysis, gave us some insight about the perception of these employees regarding the training and development programs after which we conducted Analysis of Variance (ANOVA) to understand the difference of the perception level, of these employees based on their qualifications and levels.

Training and development, as the name suggests is one of the key elements in enhancing productivity and efficiency of employees. Moreover it also helps in moral boosting, confidence building and motivation of these employees (Feldman, 1989). What matter is quality not quantity? Hence taking a cue from this we wanted to focus upon the effectiveness and the efficiency of training and development practices and programs followed by various power utilities for employee across different levels.

For this endeavor our research team personally visited some of above mentioned utilities and interviewed the training and development heads in addition we also took information from various employees in form of a structured questionnaire, which primarily focused upon gauging the effectiveness of training and development on various parameters such as employee development, skill enhancement and focus on job role. Furthermore we set our null hypothesis that there are no perceptual differences between employees belonging to various educational backgrounds regarding the effectiveness of training and development programs for competency building, productivity and focus towards job role.

Table-4.4.1 Efficiency of training programs in Competency building, Productivity & Focus towards job role.

Qualification		Competency building	Productivity	Focus
ITI	Mean	4.17	4.34	3.94
	Std. Deviation	1.130	.764	1.293
	Grouped Median	4.22	4.41	4.26
Graduate	Mean	4.23	4.10	4.09
	Std. Deviation	.620	.605	.667
	Grouped Median	4.08	4.13	4.12
Post Graduate	Mean	4.35	4.17	4.20
	Std. Deviation	.480	.721	.647
	Grouped Median	4.35	4.22	4.25
PhD	Mean	4.70	4.00	3.30
	Std. Deviation	.483	.000	.483
	Grouped Median	4.70	4.00	3.30
Overall	Mean	4.25	4.16	4.07
	Std. Deviation	.730	.664	.833

Grouped Median	4.11	4.20	4.16

Table 4.4.2 Analysis of Variance between category of Employees in terms of effectiveness of training and development programs regarding Competency building, Productivity & Focus for job role

			Sum of Squares	df	Mean Square	F	Sig.
Competency building	Between Groups	(Combined)	4.453	3	1.484	2.811	.039
		Linearity	3.639	1	3.639	6.890	.009
		Deviation from Linearity	.815	2	.407	.771	.463
	Within Groups		326.902	842	.528		
	Total		331.355	845			
Productivity	Between Groups	(Combined)	5.313	3	1.771	4.071	.007
		Linearity	2.108	1	2.108	4.844	.028
		Deviation from Linearity	3.206	2	1.603	3.684	.026
	Within Groups		269.313	842	.435		
	Total		274.626	845			
Focus	Between Groups	(Combined)	10.682	3	3.561	5.234	.001
		Linearity	1.159	1	1.159	1.704	.192
		Deviation from Linearity	9.523	2	4.761	7.000	.001
	Within Groups		421.068	842	.680		
	Total		431.750	845			

The respondents were asked to rate (on a scale of 1-5, where 1 is least effective and 5 is most effective) the training and development programs on the basis of their effectiveness towards competency building, improving productivity and focus towards job role respectively. Employees across all levels felt that training and development help them in competency building, although it was regarded as most effective by post graduate employees (4.35) and least effective by ITI diploma holders (4.17). In improving productivity, the training programs are better suited for ITI and diploma holders (mean 4.34) and least suited for PhD holders with a mean of 4 (On a scale of 5). In addition, regarding job role, the training programs are best suited for the post graduate category of employees (4.20) and it is least suited for PhD holders (3.30) (Table 6.2) .

Table of Significance

Table 4.4.3 Perceptual Differences in Effectiveness of Training Programmes by Educational Qualifications.

Factors	Competency building	Productivity	Focus on Job role
Education Qualification	Significant	Not Significant	Not Significant

There was significant statistical difference in perception of various categories of employees regarding competency building only (Table 4.4.2 and 4.4.3).

Table 4.4.4 Analysis of Variance between responses towards Effectiveness of Training and Development programmes regarding Competency building, Productivity & Focus for job role

Qualifications	Sum of Squares	df	Mean Square	F	Sig.
ITI's /Diploma Holders (Between groups Within Groups Total)	10.158 434.329 444.487	2 369 371	5.079 1.177	4.315	.014
Graduates (Between groups Within groups Total)	3.885 431.494 435.379	2 1083 1085	1.943 .398	4.876	.008
Post Graduates (Between groups Within groups Total)	2.525 147.260 149.785	2 378 380	1.262 .390	3.241	.040
Doctorates (Between groups Within groups Total)	9.800 147.260 149.785	2 27 29	4.900 .156	31.500	.000

Table 4.4.5 Perceptual Differences in Effectiveness of Training Programmes amongst Employees with different Educational Qualifications.

Variables	ITIs	Graduates	Post Graduates	Doctorates
Competency Building, Productivity & Focus towards Job Roles	Significant	Not Significant	Significant	Not Significant

There is a significant difference in the perception of employees towards the effectiveness of training and development programs regarding competency building, improving productivity and its focus towards job role, in the case of ITI diploma holders & post-graduates, but it's not so in the case of graduates and doctorates (Table 4.4.4 and Table 4.4.5) .

This implies that ITI's and post graduates perceive that training interventions conducted for them lack coherence and focus for integrating all the three dimensions for improving their overall performance. This may also imply that most of the training and developmental interventions for employees are general in nature and are not specifically designed for meeting their requirements of specialised job roles. This substantiates the common perception that training programmes are not systematically designed based on identification of training needs. Even there is mismatch between the training programmes and the target group.

Training interventions help in coping with the challenges faced on the job front (Tannenbaum, 1991). It further helps in improving employee's commitment towards the organization (Brown, 1996). Keeping this in view, it becomes important for the training designers to take employee's perspective into cognizance. We observed that, as per employee perception the training programs lack focus for the particular job, but the variation in perception was statistically significant only for ITI diploma holders and post graduates. This phenomenon can be explained through the continuous technological changes which the sector is exposed to and training systems inability to cope with it. Earlier we had sub-critical thermal power stations and now we are moving to Ultra-mega power projects in the form of super-critical and ultra super-critical thermal power stations. Training employees on newer technologies has always been a big challenge, because even training centers require complete over hauling in the form infrastructure and updation of faculty. National Thermal Power Corporation is the biggest player in this industry for India and it has detailed training modules for almost all level of employees, but in contrast many private players use matrix sort of organizational structure, which makes is difficult to design job specific programs.

National Thermal Power Corporation's Power Management Institute (PMI) is the only training center in India which has training facility for super-critical technologies. In this regard even power ministry's NTPI seems to be lagging far behind the industry requirements.

Interaction with experts from the industry also revealed that most of the present utilities are concentrating more on recruitment and development of engineers (graduates). Therefore, there is a greater focus on development of specific programs for the engineers. However other categories of employees are exposed mainly to general programs. For example, NTPC has a 52 long weeks induction program for fresher's (engineers) whereas for other categories training interventions are reduced to a mere 7 days training module, that to fulfill certain statutory norms.

Further, we understand that most of the training interventions are designed, keeping in view present scenario in mind and lacks due emphasis on identification of training needs for future. Therefore training utilities must plan training interventions keeping future needs in mind.

Need for Improvement in Training Programs

In order to improve the quality of the training programs for power sector in India, the program designers must work closely with employees and consider their inputs. Commitment of the top management is essential towards the successful delivery of the program. Study reveals that in most of the power utilities, the training modules are organized on designation basis rather than on role/need basis. The management must be firm towards its intent for the successful implementation of its training programs. Moreover, these utilities do not pay much attention to the lower levels of employees, simply because they are unable to see much value in their contribution. It is perceived that, people at lower level generally require lesser skills and hence their training needs often remain confined to the statutory norms of the state.

Curriculum design should be regularly reviewed and updated as per changes in environment. Over the past few years, the thermal power plants have seen radical changes from sub-critical to critical and now super-critical technology. In future power utilities will have to focus on Ultra Mega Power Projects (UMPP). We need to incorporate latest technology in the curriculum of training programs for improving employee productivity.

Management Development Programs may be sometimes considered as break from routine and thus as a leisure activity rather than a skill enhancer, because more often than not, the employees are sent abroad or to some scenic location for attending these programs. These results in inappropriate selection of participants based on their position rather than on their training requirements. The top management must show firm intent and re-iterate the ideology and essence of the training modules to improve effectiveness of training interventions.

We require a great deal of investment in terms of upgrading the infrastructure in terms of equipping the training centers with better class rooms, modern simulators, competent faculty and other facilities.

Validation based on the feedback received from the respondents-

The researchers interacted with participants of the training programs to gather further insight into the factors responsible for ineffectivenss of existing training programs as also to validate the above findings as arrived based on statistical analysis. Some of the observations given by respondents on the existing training programmes are as under:

Induction Level – Employees feel that existing programs are theoretical in nature, and hence they are unable to connect these programs with their assigned job role. Most of them even consider these as a "sluggish" extension of their respective qualifying degree.

Supervisors & Lower Level - The Training programmes are not delivered by clear identification of needs. These are meant mainly to fulfill the statutory norms laid down by Government of India. Moreover these programs are usually "open for all" and are general in nature.

Engineer - Engineers were of the view that training programmes are focused on their job role, but due to a frequent job rotation policy, they are unable to properly utilize their learning from these training programs for the assigned job. Although the programs are designed to meet technical requirements in terms of knowledge and skills gap, but pedagogy used is not able to deliver the expected outcomes. Moreover there is a greater need, for knowledge sharing, especially for handling typical and unique cases which lacks in operationalisation of training programmes at present. They further perceive that the best form of learning is through greater emphasis on practical experience and therefore on the job learning in a guided and well structured way can help more in improving the effectiveness of training programs.

Senior Level Employees - Management Development Programs have more to do with exposure and networking. The exposure to such programs is not based on merit, but more so, on the basis of seniority.

Semi- Skilled and Un-Skilled Laborers - Practically semi-skilled and un-skilled employees are not part of formal training programs, as they are mostly outsourced. Therefore technically the hiring utility isn't bound for providing even the mandatory minimum man days of training. Lack of training emphasis at this level does affect overall productivity and efficiency of power sector.

The above mentioned observations of employees at different levels substantiate our findings that Management Commitment and Intent coupled with Programs Design, Quality and Execution complements effectiveness of training programmes at different levels. Unless and until both these dimensions are used to administer training and development functions seriously in Indian Power Sector, training interventions would not deliver desired results.

CHAPTER-V

CONCLUSIONS & RECCOMENDATIONS

This chapter brings about various issues and challenges affecting power sector of India and brings about some of the key challenges to be faced by Human Resource Management (Power Sector). Moreover it recommends certain strategies in order to meet manpower requirements for the future.

Issues affecting Power Sector – An Expert Opinion Survey

To identify the key challenges faced by power sector in India expert opinions were sought through personal interviews. Experts from human resource domain as well as technology domain from power utilities and training institutes viz. NTPC, NHPC, Lanco, L&T, Jindal, Moser Bayer, NPTI, PMI, PFC, Himachal Power Corporation and SJVN Limited etc. were interviewed. Expert opinion was elicited in the domain of:

- ✓ Pressing Challenges faced by power utilities.
- ✓ Critical skills required at project design, project execution and project operations and maintenance stages.
- ✓ Strategies adopted to meet the manpower requirements.
- ✓ Evolving Specialized training/academic programmes in power industry.

Some of the key critical issues faced by power sector as identified, based on opinions of experts, are as under:

Transmission & Distribution Losses and Poor Infrastructure - In India, maximum loss of electricity and its pilferage is at this stage. Overall, these losses are to the tune of 28%, out of which around 5-10% losses are at the transmission stage and rest of it at the distribution stage. Transmission of electric current is primarily managed by the National Power Grids. Over the last few years power sector has been successful in reducing the transmission losses through grid unification and deployment of heavy duty transmission lines. At present India's electric transmission system is divided into two grids and, it's planned to have only one grid for the whole country by the end of 2013, which will further improve the efficiency of the transmission of electricity in India.

Theft and poor maintenance constitute the major components of losses at the distribution stage. Every year around about 15-17% of electricity generated is stolen and goes unaccounted for, moreover this problem get aggravated because of faulty meters and low tension wiring, which can be easily tampered for drawing electricity through jumpers and hooks. In addition more than 10% of the electrified region in India is unmetered. Recovery of unpaid bills is also a major problem in many states of the country. Still, the authorities have failed to take any action against the defaulters and many such cases are still getting uninterrupted electricity.

Coupled with ageing transmission and faulty distribution system, which results in high power losses; transmission capacities have almost saturated and would require major investments to meet future requirements. India at present has a total installed capacity to produce 200 GW of electricity, but in contrast our transmission system can only manage a peak load of 136 GW. In addition, the problem of load shedding in many parts of the country is not always due to shortage of production, but due to poor infrastructural set-up at the distribution end, in the form of old transformers, poor quality wiring, lack of alternate networks etc. This aggravates in peak summer season, when we have the maximum demand of electricity, because the poor infrastructure cannot take the additional load. It would necessitate capacity building in terms of training employees, once comprehensive reforms in transmission and distribution are effected

Fuel Shortages and Coal Linkages- Around 60% of the electricity produced is coal based and it is going to continue as a major source of electricity production in India in near future. Although India has sufficient number of coal mines, the quality of coal extracted and produced isn't up to the industry standards. As most of these mines are located in far-flung areas, where there is considerable influence of mafia and naxalite movements that hampers coal production and distribution. In order to cope up with this problem, many power utilities have bought mines in other countries like Australia, Indonesia, South Africa etc. But importing coal, cannot be a long term solution as it is much more expensive.

Viability and Tariff Issues (Power Purchase Agreements Need to be Relooked) - In India the electricity tariffs, both for domestic and industrial consumers, are regulated by respective state governments. Despite ever increasing costs in the form of fuel prices, inflation, infrastructural overheads etc, the electricity tariff plans continue to be subsidized. For years we have seen a marginal increase in the tariff plans, as a result of which the excess burden has to be borne by various power utilities. Many power utilities are on the verge of collapse, if proper steps are not taken to relook into power purchase agreements. Some of these power plants in private sector will become non-viable and may get closed.

Land Acquisition and Environmental Hazards - Power projects usually require huge area of land for their establishment. Acquiring land often leads to lot of deforestation, which affect the flora & fauna of nearby areas as well. There are various ills associated with deforestation such as extinction of endangered animal species and causing imbalance in food value chain. The Ministry of Environment & Forests, Government of India has adopted a very strict policy towards issuance of clearance of land for almost all types of industrial establishments. Therefore acquiring land for power projects will become a huge challenge in the coming times. Further, land acquisition challenges get multiplied because of difficulty in acquisition of land owned by farmers, in spite of policy initiative requiring investment on rehabilitation measures for land owners to be undertaken by power plants.

Most of Indian power projects are based on fossil fuels, as more than 65% of India's energy needs are fulfilled through fossil fuels such as coal and petroleum products. The usage of fossil fuels is quite harmful to the environment, as they release some harmful gases in the atmosphere which aggravate the problem of global warming. There is a lot of research going on for tapping renewable sources of energy which aren't that harmful for the environment. However in the coming years there would be maximum dependence on fossil fuels, which is very harmful for the ecological environment.

For example Ministry of Environment and Forests (MoEF) has recently prohibited mining in a number of areas where coal blocks have been already allotted to private power companies. This has impacted around 55 projects amounting to 50,000 MW including two ultra-mega projects (Sarguja UMPP in Chhattisgarh and Bedabahal UMPP in Orissa). Such issues like 'coalgate' are likely to multiply in years to come and need to be suitably handled by having a long term policy in place.

This issue requires human talent in terms of specialized skills and domain expertise for getting clearances as also negotiation skills and ensuring necessary compliances regarding environmental pollution as also rehabilitation affected population.

Capital and Funding Issues – Power plants require substantial investments with long-term gestation period for repayment of loans. Therefore inherent risk associated with lending to power sector increases. The risk further increases because of regulatory measures applicable to this sector. Banks and financial institutions have already extended assistance to their limits to this sector, which poses challenges to get capital and funding from banks and financial institutions. There is a need for coming out with innovative solutions to meet future funding requirements of this sector. This will necessitate attracting experienced and qualified manpower with finance background suitable to this sector.

Quality Engineering Procurement Contracts (EPC's) not Available - There are constraints pertaining to availability of quality suppliers for power equipment as also the availability of quality EPC players to cater to the requirements arising as a result of demand-supply gap. There has been increasing dependence on Chinese equipment and manpower by private players that has posed inherent threats to this sector. Despite the continuing emphasis on domestic capacity addition in plant and equipment industry, the reliance on equipment imports is likely to continue in the years to come. Thus lack of competitiveness of domestic power equipment industry and availability of quality EPC players will continue to pose a challenge in timely implementation of power projects. This would require an increase in research and development capability as well as operational effectiveness of domestic equipment suppliers.

Lack of Open Access to Power and Intra State Open Access Issues - It has been earlier observed that maximum losses in power sector occur at the distribution stage. Therefore, there have been proposals for directly providing power to the consumer from the generation stage. In this light Ministry of Power, in year 2007, brought out legislation for allowing consumers of 1 MW of capacity of power or more, open access to electricity, which wouldn't be regulated by respective state electricity boards. Inspite of having this legislation, state electricity boards haven't made efforts for providing free access to the respective consumers.

Open access transaction has been mainly utilized by State Electricity Boards/distribution licensees to sell surpluses or to meet the short-term power requirements in their respective regions. The industrial customers still face problems pertaining to accessing their choice of suppliers due to the restrictions (such as invoking Section 11/108 of Electricity Act 2003) imposed by several state governments/State Load Dispatch Center (SLDCs) citing shortages or non-availability of transmission infrastructure. According to Central Electricity Regulatory Commission (CERC), up to May 2010 applications seeking open access for over 18000 MW had been submitted, but implementation has been quite low at about 2,000 MW (mainly for captive power).

While the inter-state open access market has progressed due to regulatory initiatives taken by the CERC, the intra state open access continues to face constraints on account of delays in implementation of policies.

Challenges Related to Human Resource Management

Employee availability v/s Employability- There is absolutely no doubt that this sector has any problem relating to employee availability because of problem of unemployment and number of technical personnel passing out of technical institutions, but the available applicants are just not fit to take on the challenges of ever-changing dynamics of this sector. With the induction of super critical technology, this problem is going to get worse. An HR director head of one of the major power utility even mentioned that, they receive some 500 applications for one job opening, and many of the times they have to re-advertise for the job opening as none of the applicants were employable.

Intra Sectoral Poaching v/s Inter Sectoral Poaching- Usually the trend which has been observed over the years is that employees make a move to other firms in the same industry but in this sector employees move to other sectors, just after their initial training period in the company. Once they are industry ready, being well equipped with the base level knowledge they often make a change over to the IT sector, or other lucrative sectors, which turns out to be a huge drain on training investments. Some senior official's of a reputed power utilities mentioned that, as per the recent trend observed in their utility, the cream trainees shift to some big giants in telecommunication and IT sector just after the completion of their induction level training module.

Matching Employee Expectations- The cream or the real talent does not want to take up engineering jobs; rather they are focused for taking up corporate jobs, the common consensus from most of the utilities was that talented people shrug taking up field jobs in sub stations, or climbing up towers, as their main interest lies in developing Management Information System (MIS) systems on computer in head or regional offices. HR-Director of a power utility mentioned an interesting case, wherein a recent recruit came up to him and looked at his posh car and asked him, "how long will it take for him to own such a car?" With the rising pay packages across all major sectors, it is becoming very difficult to match up to these expectations.

Difficult job environment- Certain jobs are to be performed in difficult environmental conditions such as in far flung areas at plant location or at sub-stations which are built around unglamorous locales, where the employees not only remain virtually cut-off from the rest of the world but also have to stay away from their families. In such cases retaining and motivating employees becomes a tough challenge. One of the senior official mentioned that 50-60% of the applicants whom he had interviewed in last few years, gave more emphasis to the location of the job rather than any other factor, many of them even rejected higher incentives given at project sites as against getting placed in well connected metropolitan cities.

Critical Skills/Knowledge Domains Required – Expert View

The critical skills domain that need special emphasis to make the sector more effective and efficient as identified based on experts views from the industry, are as under:

- Project Management
- Project Finance
- Power Purchase Agreements and Regulations
- Super-critical Technology Expertise
- Leadership in the Pipeline
- Planning Capability
- Systems Integration
- Engineering and Design Capability
- Application of Information Technology (IT)
- Quality availability of Welders, Fitters, Plumbers, Masons etc.

As per experts on following strategies have been used to meet increasing quality manpower requirements of the power sector:

- Catching employees, mainly professionals, at young age and grooming them in the organization, so as to get their long-term commitment for the organization.
- Outsourcing of employees at non-technical and semi-skilled levels and training them to get better out-put from them.
- Coaching and mentoring of employees at different tiers.
- Job rotation to create pool of multi-skilled employees.
- Adoption of ITI/engineering colleges to prepare a professional pool of employees directly suited to job roles
- Collaboration with educational institutions with mutual benefits for human resource development of employees.
- Establishing simulators and advance technology driven training labs to train employees.
- Good balance between structured training on the job and training in training centers.
- HR interventions for low attrition rates by furthering employee engagements.

- Deputing employees to joint venture partners and technology suppliers.
- In-house training policies

Based on the experts opinions the industry needs to standardize and diffuse these practices throughout the industry by sharing at greater rate through workshops, conferences, training programs, seminars etc.

Proposed Strategies for Developing Human Capital

Attract talent by showcasing opportunities, improving brand image and changing the work environment

The power sector is unable to attract the best available talent despite the fact that this is a sector that offers good salary and benefit packages, has relatively structured training & development programs, has several organizations with good employer reputation and, most importantly, with immense opportunities for a meaningful career. The power industry needs to showcase these and create awareness among the young talent pool. Industry groups as well as large companies in the sector need to work on creating a positive brand image for the industry in order to attract fresh talent. Further, companies should work on changing the work environment through better human resource practices, soft skills training, reducing hierarchical barriers and creating career development maps for the personnel. Experienced HR managers from other sectors should be inducted to incorporate best practices from other sectors.

Expand training to cover behavioral & attitudinal changes

The training interventions, education up-gradation plans and management development programs designed for personnel should ensure holistic all-round development of the personnel. One of the comprehensive models for training, the 360° Training Model, provides a platform not just for functional skill development but incorporating behavioral and attitudinal orientation while creating an appreciation of the commercial aspects of the business. While utilities and apex training institutions are generally able to effectively bridge the knowledge gaps by offering core functional training, behavioral and attitudinal training expertise need to be given the much needed impetus. Hence, companies should seek to ensure that the training is not limited to narrow functional role perspectives but overall organizational and social perspectives as well. The importance of this has clearly emerged from analysis of data on the training needs at different tiers of power utilities.

Strengthen ITIs and other vocational skill development centers

Given the current requirement for a large number of manpower for project construction, ITIs can be strengthened and better utilized for the development of skilled construction workers as well as O&M personnel with the help of the existing players in the industry. The "**Adopt-an-ITI**" scheme has been launched to address the issue of skilled and trained manpower and around 56 ITIs have been currently adopted by both public and private sector utilities. NTPC has adopted maximum number of it is (25) followed by NHPC (11), DVC (9), PGCIL (4) and 1 or 2 each by NEEPCO, SJVNL, THDC, and NHDC. Adoption of ITIs close to large project sites would allow the companies to both recruit local manpower and also create goodwill by providing employment opportunities to the project affected people. Given the large requirements, at least 200 ITIs can be adopted in the medium term by the power sector.

Following are the benefits that can be derived by adopting ITIs.

- Skilled workers from near the project sites were more likely to remain with projects.
- Would contribute significantly towards relief and rehabilitation aspirations of project affected people.

The Government can also consider collaborating with specialist training service providers for operating the ITIs.

Standardize curriculum and develop certification standards

It is important to standardize the curriculum for training of skilled and semi-skilled workers in order to effectively train a large number of workers. Certification standards have to be developed and implemented in order to ensure consistency in quality. In addition, having standard certified programs will allow multiple specialist training service providers to offer these courses to a wider cross-section as employment- oriented programs and prepare a steady pool of qualified manpower taking the burden off the limited available infrastructure.

Expand existing training facilities and create new infrastructure

While the National Power Training Institute (NPTI) and the training centers of NTPC and some of the state utilities cater exclusively to the training needs of the Power sector, they are not sufficient to meet the training needs of the sector. New training infrastructure needs to be created urgently in order to avoid a manpower crisis that is already looming large. This can be done by

- Providing incentives to existing training institutions in both the public and private sectors to conduct specific programs.
- Encouraging the private sector to set up new training infrastructure with attractive incentives such as land at concessional rates, grants and loans etc.
- Creating centers of excellence which can act as resource centers for other institutions.
- Introducing new applied programs at existing academic and industrial institutions.

Ensure proper utilization of funds through direct payments

A major cause of lack in development of training infrastructure is the mindset that training facilities are cost centers and are non-critical. With most of the utilities in the past being loss making, training budgets were usually curtailed. It is precisely for this reason that the NTP mandated a minimum allocation of 1.5% of salary expenses towards training which is to be raised to a level of 5%. Investment in training can be increased through directed measures like the following:

- Part reimbursement of training expenses directly provided to training institutes by the Central Government
- Apportioning of training budgets to a special Training & Development fund by the regulators and direct reimbursement to the training institutes in order to ensure proper utilization of these funds

Introduce electives at graduate engineering programs and specialized programs at post-graduate level

- Introducing electives at graduate level would help generate interest in the Power sector as well as provide sound theoretical base for the engineers seeking to enter it.

- Degrees in renewable energy, environment management, and energy efficiency should be provided in universities and leading academic institutions like BITS and IITs, at post-graduate level.
- R&D centers should be established in academic institutions to develop knowledge base in emerging areas like solar energy, smart grids, etc.

Create awareness on energy efficiency among all stakeholders and incorporate mandatory training for personnel involved in energy intensive processes

While energy auditors and mangers are certified by the Bureau of Energy Efficiency (BEE), awareness on energy efficiency needs to be propagated to all stakeholders from retail consumers to managements of firms. Awareness on energy efficiency across the value chain is critical for preserving scarce resources, reducing pollution as well as increasing profitability for businesses. The measures to improve awareness should include:

- Orientation programs for key decision makers.
- Mass awareness campaigns reaching out to different consumer groups.
- Mandatory training for operators of energy intensive processes.
- Incorporating energy conservation measures in school and college curriculum.

Increased Training Investment

Training investments need to be enhanced to reach to a level of 5% of salary budget by 2020 as per policy framework by not only encouraging in-house training facilities, but also establishment of 'stand-alone' profit centers which specifically train employees on various aspects including emerging areas and challenges. Such institutions may be modeled on the lines of part funding from private players that can allow training of professionals coming from different organizations. It is important even from the perspective of some of the new private players who may not be able to afford building such training institutions on 'stand-alone' basis for their organizations per se.

In-house research on training effectiveness and impact

Training modules and programmes need to be geared up to specifically identified training needs at different tiers for each organization which differ because of their unique business models and operational plans and local factors. Therefore, training programmes need to **evolve dynamically for each organization** which can be partly met by general programmes and partly by specifically devised programmes. This would also call for research in evaluation of training effectiveness of training modules in terms of investments made. Thus, to meet training deficit would require, at organizational level, to work with most effective strategy that would be suited to specific employee mix keeping in mind the cultural and attitudinal factors that are organisational specific. The impact studies of training evaluation have not only to focus on improvement in operations and productivity aspects but also on impact on customer relationships that plays a vital role in power utilities.

Developing a Comprehensive Training Plan

A comprehensive training plan needs to be prepared with short, medium and long term perspectives by each organization. The plan should cover all aspects of personnel training, including behavioural and managerial skills that have been found to be of great importance in technology intensive power utilities. This would inter-alia require preparation of a comprehensive training plan by creating an index of all parameters that need to be measured to make a statement about the holistic nature of training programme. It would be desirable for power utilities to move away from legacy models for training, which are archaic in nature, and adopt new best industry practices in training and recruitment systems globally. This would require structured and purposive interactions of professionals by deputing them to power utilities abroad and international conventions to make them acquire best of international practices. Further, there is a need for instituting outreach programmes for collaboration amongst different institutes, training affiliates, universities and power sector majors to share their research results on human resource development.

Need for Training Policy

Each power utility needs to have a concrete training policy in place that should be guided by standard documentation guidelines for power utilities to ensure uniform reporting and documentation. The training policy need to be synchronized with expansion of technical education plans. There is a need for greater emphasis on skills and attitudinal training. Above all, training systems need to be ahead of rapid changes in the technology - distribution and generation to meet man power requirements. (Refer Appendix 1V-VI)

Development of Training Management Information System

There is an urgent need to implement training Management Information System (MIS) uniformly across training facilities attached to utilities to do away with procedures which lead to faulty and misplaced allocation of resources or overlook real issues. MIS can help organizations to keep track of appropriate selection of employees for training programmes, monitoring performance of individuals prior to training and post-training, processing of collective performance of trainees on the job, linking post-training performance with incentives and performance appraisal etc. Analysis of data will also enable training managers to identify weaker links in their training programmes and systems so as to introduce necessary changes to improve the overall effectiveness.

Development of Inter and Intra departmental informal training networks

Informal learning from peer groups in an organization is a powerful concept of unstructured experiential learning that needs to be inculcated as a supplement to formal training structures in the power utilities. This form of learning allows diverse experiences to be shared and disseminated amongst employees that not only contributes to powerful learning mechanism but also develops bondage amongst employees that permeates beyond work and helps in creating a cohesive organization culture.

Training Emphasis on Human Resources Management and Finance

Power sector is fast undergoing a change in its character from being a state owned monopoly concern to a competitive market with increasing penetration by the private players to attract market share in both generation and distribution of power. This structural change in the nature of the industry has brought with it the concomitant challenges in training to equip the existing manpower with skills relevant to free market utilities. The erstwhile training modules had little emphasis on human resource management and financial robustness of operation primarily because of lack of competition at operational as well as supply and procurement level of resources. The greater problem lies in lack of appropriate faculty members to take care of emerging training needs in the areas of human resources and finance related issues. Power utilities need to prepare a pool of dedicated faculty members who can provide the much needed leadership to train employees in emerging areas that are far more relevant.

Training Programmes for Contract Labour

Contract labour plays a crucial role in construction phase of power projects as also in maintenance phase. They constitute around 22% of the total workforce in power sector in low skill category and 10% in non-technical category. Their skill enhancement and development is vital for the improvement of Man/MW ratio in power plants. Informal or ad-hoc training to contract labour before deploying them on work site is fraught with associated risks of injury and permanent debilitation to workers as also unwanted delays on account of damage to the equipments and machinery. A suitable training programmes in the area of technical skills and IT for them helps in not only deriving higher productivity but also preparing them to gradually promote them to permanency and avoid additional search costs for suitable contract employers.

Disaster Management Courses

Grid failure, shut-downs due to power theft and accidental short-circuiting are emergency situations that staff at all levels encounter during their service. The promptness and alertness with which such emergency situations can be dealt with would go a long way in mitigating the losses to infrastructure and restore normalcy in supply to the consumers. Weather turbulence and anti-social elements sabotage, requires contingency plans to ensure uninterrupted power supply to vital industrial locations and consumers. Disaster management courses prepare employees to respond to such challenges effectively. Power sector lacks due competence to respond to such eventualities. This would require not only giving due importance to disaster management programmes but also organizing periodic simulation drills for all categories of employees by creating conditions during an emergency shut-down and practicing the action plan for such contingencies. Further, contingency and back-up options for power supply in case of a grid failure need to be regularly run and tested to ensure their functionality in the event of a failure.

Simulator Training

Simulator training is a module that allows fresh recruits and technicians to understand, control and manipulate the functions of a real simulation of a power plant to impart training about its working. Total number of simulators in the training system as a whole is around 35 which are being used for training of employees of their own organization and outside organizations. There is a need for adding additional simulators to enhance the e-learning by suitably gearing up investment policies to ensure training for all and instituting peer review and feedback mechanism.

Collaborative programmes with Higher Educational Institutions

Although educational institutions do produce more than sufficient number of graduates/postgraduates and PhDs required by the power sector but out-put of educational sectors lacks relevance to the industry. Therefore, power utilities through joint collaboration with educational institutions should help them in devising need-based programmes and curriculum which could be delivered jointly by industry and educational institutions inside class and on the job training to meet the requirements and optimize on investment in training. Further, power utilities can operationalise certain higher education programmes for up-gradation of their human resources by asking educational institutions to develop specific programmes which could have a balance between broad knowledge input and input specifically required for accepting higher responsibilities in the organizations. These programs can be integrated with work of employees and can be operationalised on-site without disturbing the employee's professional commitments. Power utilities can encourage their employees to pursue higher education by putting policies in place to support such employees financially as also to extend career enhancement benefits to those who successfully complete such programmes. An affiliate programme, where certain distinguished universities run programme of studies that are tailor made to requirements of the human development plans of the organization needs to be replicated in other utilities such as NTPC (BS Power Engineering programme) with three year durations by BITS Pilani for diploma holders/BSc for NTPC, Tata Power, Essar Power JSW Energy etc. More and more such tailor-made programmes for catering to the specific needs of the industry need to be introduced along with desired changes in curriculum to take care of specific specialized courses that can cater to power sector.

Government Support for Power Sector Reforms and Top Management for Human Resources Development

Power sector in India is going through major reforms and wide-ranging disruptive technologies are going to be introduced in coming years which would require political will of government and continuous support of top management in implementation. With power sector reforms expected to bring in an unprecedented change in the skills set mix required for the human capital, it becomes necessary to motivate and train existing people in the organization. Specially designed programmes on power sector reforms for senior management personnel will help executives to grasp the rationale and circumstances that have necessitated these reforms and simultaneously create a common vision for effective implementation of reforms. It is necessary that policy interventions like Bills, Acts and changes in CEA regulations in power sector at both industry and firm level be thoroughly debated by policy makers as well as executives to arrive at an n understanding and perspective acceptable to both the sides.

Based on our analysis as given earlier in this report, two major factors that affect the effectiveness of training and development programs are, **Program Design, Quality & Execution and Program Commitment & Intent.** Though the former is a necessary condition for the effectiveness of training and development programs, the later ensures its sufficiency

Appendix I - Questionnaire Utilized for Identification of Training Needs and Effectiveness

Questionnaire

Name________________________________

Designation__________________________

Placement

Position	**Place**	**From-----------**	**To---------------**

Q1. Specify your date of joining? ____________

Q2. Please specify your education qualification?

(a) Senior Secondary (b) ITI/diploma holder (c) graduate tech/non tech(d) post graduate tech/non-tech (d) PhD

Q3. In which of the following functional areas have you worked?

(a) Plant floor level (b) Maintenance level (c) Administration level (d) Project level

(e) Other______

Q4.What all training programs have you attended in the last 3 years? (Please mention, column 2-3 and tick in column 4-5)

Training Types(1)	Title(2)	Duration(3)	In- House(4)		External(5)	
		Man days	On-Job	Training Centre	Training Institutes	Abroad
Induction						
Refresher						
Management Development program						
Education up gradation	ITI/Diploma					
	BS/BE					
	MS/ME/MBA					
	Others					

Q5. The training and development programs attended by me have benefitted considerably towards competency building?

(a) Strongly Agree (b) Agree (c) Can't Say (d) Disagree (e) Highly Disagree

Q6. Training and development programs have helped in improving my productivity at my job?
(a) Strongly Agree (b) Agree (c) Can't Say (d) Disagree (e) Highly Disagree

Q7. The training programs selected for me were well focused for my job role?
(a) Strongly Agree (b) Agree (c) Can't Say (d) Disagree (e) Highly Disagree

Q8. Rate the following Skill sets, on the basis of their relevance for your job? (Please rate each on the scale of 10, with 1 as least important and 10 as most important).

(a) Technical skills [ ]

(b) Human skills [ ]
(c) Knowledge skills. [ ]

Q9. Rate the importance of upgrading the following skills for the indicated categories of employees for improving their job effectiveness? (Please rate each on the scale of 10, with 1 as Least Important and 10 as most important).

	Engineers	Supervisors	Non -Tech
(a) Technical skills			
(b) Human Skills			
(c) Knowledge Skills			

Q10What are the important factors contributing towards the effectiveness of training and development programs? (Please rate the following factors on the scale of 10 where, 1 is least important and 10 is the most important)
(a)Appropriate selection of the participants [ ]
(b) Duration of the program [ ]
(c) Infrastructure & resources [ ]
(d) Quality of the program [ ]
(e) Pedagogy [ ]
(f) Curriculum design [ ]
(g) Impact measurement [ ]
(h) Commitment of the top management [ ]

Q12. Suggestions to improve training and manpower development in future?

____
____
____
____

Appendix II – Questionnaire Used for Expert Opinions

<u>Project titled - Strategies to Meet Manpower Requirements in Power Sector of India by 2020</u>

I. Your assessment about Demand Supply gap between 2011 to 2020 for India.

II. In terms of generation of power (%)

	Present	2015	2020
Conventional			
Non- conventional			

III. In terms of generation of power (%)

	Present	2015	2020
Conventional			
Thermal			
Hydro			
Nuclear			
Non- conventional			
Wind			
Solar			
Bio-mass			
Others			

IV Kindly tells us your estimate of the category-wise requirement of manpower to meet the proposed estimated generation of capacity for power generation up to 2020.
(Please answer in context to your company)

1. Proportion of manpower	Present	2015	2020

ITI/workman
Diploma
Engineers
Administrative

2. Shortfall in Availability of manpower

Proportion of manpower	Present	2015	2020
ITI/workman			
Diploma			
Engineers			
Administrative			

V. Kindly identify concrete profile of knowledge and skills base of manpower category-wise required for power sector – at the project design, execution, and running and maintenance levels of the projects.

1. Your views on critical knowledge and skills required and their availability

% Availability

Project Design

I)
ii)
iii)

Project Execution

I)
ii)
iii)

Project Operations & Maintenance

I)
ii)
iii)

2. Kindly tell us your views on how to bridge the gap in infrastructure required – institutions, faculty, programme of studies – course curriculum, laboratory etc. to meet the manpower requirements in the most effective manner.

VI. Kindly indicate three policy steps that center and state governments need to take for responding to the challenge of meeting manpower requirements of the power sector.

	Present	Future
i)		

ii)
iii)

VII. Kindly mention three key strategies with which your organization proposes to meet critical future manpower requirements

VIII. Do you find any major difference between manpower requirement, its mix (ITI, diploma holders, engineers and post-graduates) and quality of manpower per mega watt of power production in India vis-à-vis developed countries?

Appendix III manpower Projections Under Alternative Scenarios

Table A.1

2012	6% growth, Scenario-2 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
(E1-E9)	70.950	13.420	8.863	11.440
B(S8-S12)	21.450	5.940	11.550	6.600
C(W3-W7,S1)	34.650	28.600	8.153	7.260
D(W0-W2)	8.250	0	0	12.54
Total	135.30	48.400	28.567	38.06
Environment	0.760	0.336	0.125	

Table A.2

2012	6% growth, Scenario-1 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	58.050	28.060	4.431	17.680
B(S8-S12)	17.550	12.420	5.775	10.200
C(W3-W7,S1)	28.350	59.800	4.076	11.220
(W0-W2)	6.750	0	0	19.380
Total	110.70	101.20	14.283	58.820
Environment	0.621	0.701	0.0620	

Table A.3

2012	6% growth, Scenario-3 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	52.030	20.130	14.181	25.168
B(S8-S12)	15.730	8.910	18.481	14.520
C(W3-W7,S1)	25.410	42.900	13.046	15.972
D(W0-W2)	6.050	0	0	27.588
Total	99.220	72.600	45.705	83.732
Environment	0.557	0.501	0.198	

TableA.4

2012	8% growth, Scenario-1 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	62.350	30.500	4.431	18.720
B(S8-S12)	18.850	13.500	5.775	10.800
C(W3-W7,S1)	30.450	65.000	4.076	11.880
D(W0-W2)	7.250	0	0	20.520
Total	118.900	110.000	14.283	62.280
Environment	0.667	0.7625	0.062	

Table-A.5

2012	8% growth, Scenario-2 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	76.432	14.457	9.547	12.324

B(S8-S12)	23.107	6.399	12.442	7.110
C(W3-W7,S1)	37.327	30.810	8.783	7.821
D(W0-W2)	8.887	0	0	13.509
Total	145.755	52.140	30.773	41.001
Environment	0.81782	0.361	0.133	

Table A.6

2012	8% growth, Scenario-3 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	56.050	21.685	15.276	27.112
B(S8-S12)	16.945	9.598	19.908	15.642
C(W3-W7,S1)	27.373	46.217	14.053	17.206
D(W0-W2)	6.517	0	0	29.719
Total	106.881	78.211	49.238	90.202
Environment	0.599	0.5421	0.213	

Table-A.7

2012	Auto –Regression growth, Scenario-1 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	52.460	25.010	3.625	16.120
B(S8-S12)	15.860	11.070	4.725	9.300
C(W3-W7,S1)	25.620	53.300	3.336	10.230
D(W0-W2)	6.100	0	0	17.670
Total	100.040	90.200	11.686	53.630
Environment	0.561	0.6252	0.050	

Table-A.8

2012	Auto –Regression growth, Scenario-2 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	76.755	14.518	9.587	12.376
B(S8-S12)	23.205	6.426	12.495	7.140
C(W3-W7,S1)	37.485	30.940	8.820	7.854
D(W0-W2)	8.925	0	0	13.566
Total	146.37	52.360	30.903	41.174
Environment	0.821	0.362	0.134	

Table-A.9

2012	Auto –Regression growth, Scenario-3 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	56.287	21.777	15.340	27.228
B(S8-S12)	17.017	9.639	19.992	15.708
C(W3-W7,S1)	27.489	46.41	14.112	17.278
D(W0-W2)	6.545	0	0	29.845
Total	107.338	78.54	49.445	90.582
Environment	0.602	0.5445	0.214	

Table A.10

2017	6% growth, Scenario-1 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	77.400	37.820	4.995	23.400
B(S8-S12)	23.400	16.74	6.510	13.500
C(W3-W7,S1)	37.800	80.6	4.595	14.850
D(W0-W2)	9.000	0	16.101	25.650
Total	147.600	136.400	0	77.850

Environment	1.138	0.9265	0.069	

Table A.11

2017	6% growth, Scenario-2 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	95.138	17.995	11.884	15.340
B(S8-S12)	28.763	7.965	15.487	8.850
C(W3-W7,S1)	46.462	38.350	10.933	9.735
D(W0-W2)	11.063	0	38.305	16.815
Total	181.425	64.9	0	51.035
Environment	1.399	0.441	0.167	

Table A.12

2017	6% growth, Scenario-3 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	69.767	26.993	19.014	33.748
B(S8-S12)	21.092	11.947	24.780	19.470
C(W3-W7,S1)	34.072	57.525	17.492	21.417
D(W0-W2)	8.1125	0	61.287	36.993
Total	133.045	97.350	0	112.277
Environment	1.025	0.661	0.266	

Table A.13

2017	8% growth, Scenario-1 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	62.350	26.992	19.014	33.748

B(S8-S12)	18.850	11.947	24.780	19.470
C(W3-W7,S1)	30.450	57.525	17.492	21.417
D(W0-W2)	7.250	0	61.287	36.993
Total	118.900	97.350	0	112.277
Environment	0.916	0.661	0.266	

Table A.14

2017	8% growth, Scenario-2 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	112.875	21.350	14.099	18.200
B(S8-S12)	34.125	9.450	18.375	10.500
C(W3-W7,S1)	55.125	45.500	12.971	11.550
D(W0-W2)	13.125	0	45.446	19.950
Total	215.25	77.000	0	60.550
Environment	1.659	0.523075	0.197	

Table A.15

2017	8% growth, Scenario-3 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	82.775	32.025	22.559	40.040
B(S8-S12)	25.025	14.175	29.400	23.100
C(W3-W7,S1)	40.425	68.250	20.754	25.410
D(W0-W2)	9.625	0	0	43.890
Total	157.850	115.500	72.714	133.210
Environment	1.216	0.784	0.315	

Table A.16

2017	Auto- Regression growth, Scenario-1 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	59.770	28.365	3.947	19.240
B(S8-S12)	18.070	12.555	5.145	11.100
C(W3-W7,S1)	29.190	60.450	3.632	12.210
D(W0-W2)	6.950	0	12.725	21.090
Total	113.980	102.300	0	64.010
Environment	0.878	0.694	0.055	

Table A.17

2017	Auto- Regression growth, Scenario-2 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	75.142	14.213	9.386	12.116
B(S8-S12)	22.717	6.291	12.233	6.990
C(W3-W7,S1)	36.697	30.290	8.635	7.689
D(W0-W2)	8.737	0	30.254	13.281
Total	143.295	51.260	0	40.309
Environment	1.104	0.348	0.131	

Table A.18

2017	Auto- Regression growth, Scenario-3 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	55.104	21.319	15.018	26.655
B(S8-S12)	16.659	9.436	19.572	15.378
C(W3-W7,S1)	26.911	45.435	13.816	16.915
D(W0-W2)	6.4075	0	0	29.218
Total	105.08	76.89	48.406	88.679
Environment	0.810	0.522	0.210	

Table A.19

2020	6% growth, Scenario-1 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	92.450	45.140	6.365	28.080
B(S8-S12)	27.950	19.980	8.295	16.200
C(W3-W7,S1)	45.150	96.200	5.855	17.820
D(W0-W2)	10.750	0	0	30.780
Total	176.300	162.800	20.515	93.420
Environment	1.359	1.105	0.089	

Table A.20

2020	6% growth, Scenario-2 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	113.520	21.472	14.180	18.304
B(S8-S12)	34.320	9.504	18.480	10.560
C(W3-W7,S1)	55.440	45.760	13.0456	11.616
D(W0-W2)	13.200	0	0	20.064
Total	216.480	77.440	45.705	60.896
Environment	1.668	0.526	0.198	

Table A.21

2020	6% growth, Scenario-3 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	83.248	32.208	22.688	40.268
B(S8-S12)	25.168	14.256	29.568	23.232
C(W3-W7,S1)	40.656	68.64	20.872	25.555
D(W0-W2)	9.68	0	0	44.140
Total	158.752	116.160	73.129	133.971
Environment	1.223	0.789	0.317	

Table A.22

2020	8% growth, Scenario-1 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	116.100	56.120	8.298	35.360
B(S8-S12)	35.100	24.840	10.815	20.400
C(W3-W7,S1)	56.700	119.600	7.634	22.440
D(W0-W2)	13.500	0	0	38.760
Total	221.400	202.400	26.748	117.640
Environment	1.706	1.374	0.116	

Table A.23

2020	8% growth, Scenario-2 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	141.900	26.840	17.725	22.880
B(S8-S12)	42.900	11.880	23.100	13.200
C(W3-W7,S1)	69.300	57.200	16.307	14.520
D(W0-W2)	16.500	0	0	25.080
Total	270.600	96.800	57.132	76.120
Environment	2.085	0.657	0.248	

Table A.24

2020	8% growth, Scenario-3 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	104.060	40.260	28.360	50.336
B(S8-S12)	31.460	17.820	36.960	29.040
C(W3-W7,S1)	50.820	85.800	26.091	31.944
D(W0-W2)	12.100	0	0	55.176
Total	198.440	145.200	91.411	167.464
Environment	1.529	0.986	0.397	

Table A.25

2020	Auto- Regression growth, Scenario-1 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	62.350	30.500	4.109	19.760
B(S8-S12)	18.850	13.500	5.355	11.400
C(W3-W7,S1)	30.450	65.000	3.780	12.540
D(W0-W2)	7.250	0	0	21.660
Total	118.900	110.000	13.244	65.740
Environment	0.916	0.747	0.0575	

Table A.26

2020	Auto- Regression growth, Scenario-2 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	81.270	15.372	10.151	13.104
B(S8-S12)	24.570	6.804	13.230	7.560
C(W3-W7,S1)	39.690	32.760	9.339	8.316
D(W0-W2)	9.450	0	0	14.364
Total	154.980	55.440	32.721	43.596
Environment				

Table A.27

2020	Auto- Regression growth, Scenario-3 of fuel mix, Technology mix-1, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	59.598	23.058	16.242	28.828
B(S8-S12)	18.018	10.206	21.168	16.632
C(W3-W7,S1)	29.106	49.140	14.943	18.295
D(W0-W2)	6.930	0	0	31.600
Total	113.652	83.160	52.354	95.911
Environment	0.876	0.564	0.227	

Table A.28

2012	6% growth, Scenario-1 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	50.404	18.519	2.781	17.680
B(S8-S12)	15.230	8.197	3.624	10.200
C(W3-W7,S1)	24.616	39.468	2.558	11.220
D(W0-W2)	5.860	0	0	19.380
Total	96.120	66.184	8.965	58.820
Environment	0.539	0.462	0.038	

Table A.29

2012	6% growth, Scenario-2 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	61.605	8.857	5.562	11.440
B(S8-S12)	18.624	3.920	7.249	6.600
C(W3-W7,S1)	30.086	18.876	5.117	7.260
D(W0-W2)	7.163	0	0	12.540
Total	117.480	31.653	17.93o	38.060
Environment	0.659	0.221	0.077	

Table A.30

2012	6% growth, Scenario-3 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	45.177	13.285	8.900	25.168
B(S8-S12)	13.658	5.880	11.599	14.52
C(W3-W7,S1)	22.063	28.314	8.188	15.972
D(W0-W2)	5.253	0	0	27.588
Total	86.152	47.480	28.688	83.732
Environment	0.483	0.332	0.124	

Table A.31

2012	8% growth, Scenario-1 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	54.138	20.130	2.781	18.720
B(S8-S12)	16.367	8.910	3.624	10.800
C(W3-W7,S1)	26.439	42.900	2.558	11.880
D(W0-W2)	6.295	0	0	20.520
Total	103.24	71.940	8.965	62.280
Environment	0.579	0.503	0.038	

Table A.32

2012	8% growth, Scenario-2 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	66.365	9.541	5.992	12.324
B(S8-S12)	20.064	4.223	7.809	7.110
C(W3-W7,S1)	32.411	20.334	5.513	7.821
D(W0-W2)	7.7169	0	0	13.509
Total	126.558	34.099	19.315	41.001
Environment	0.710	0.238	0.083	

Table A.33

2012	8% growth, Scenario-3 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	48.668	14.312	9.588	27.112
B(S8-S12)	14.713	6.335	12.495	15.642
C(W3-W7,S1)	23.768	30.501	8.820	17.206
D(W0-W2)	5.659	0	0	29.7198
Total	92.809	51.149	30.904	90.2022
Environment	0.520	0.357	0.134	

Table A.34

2012	Auto-Regression growth, Scenario-1 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	45.550	16.506	2.275	16.120
B(S8-S12)	13.771	7.306	2.965	9.300
C(W3-W7,S1)	22.245	35.178	2.093	10.230
D(W0-W2)	5.296	0	0	17.670
Total	86.864	58.990	7.335	53.630
Environment	0.487	0.412	0.031	

Table A.35

2012	Auto-Regression growth, Scenario-2 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	66.645	9.581	6.017	12.376
B(S8-S12)	20.148	4.241	7.842	7.140
C(W3-W7,S1)	32.547	20.420	5.536	7.854
D(W0-W2)	7.7495	0	0	13.566
Total	127.092	34.243	19.397	41.174
Environment	0.713	0.239	0.084	

Table A.36

2012	Auto-Regression growth, Scenario-3 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	48.873	14.372	9.628	27.227
B(S8-S12)	14.775	6.361	12.548	15.708
C(W3-W7,S1)	23.868	30.630	8.858	17.278
D(W0-W2)	5.682	0	0	29.845
Total	93.200	51.365	31.0352	90.582
Environment	0.522	0.359	0.134	

Table A.37

2017	6% growth, Scenario-1 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	67.205	24.961	3.135	23.400
B(S8-S12)	20.318	11.048	4.086	13.500
C(W3-W7,S1)	32.821	53.196	2.884	14.850
D(W0-W2)	7.814	0	0	25.650
Total	128.160	89.205	10.106	77.850
Environment	0.987	0.611	0.043	

Table A.38

2017	6% growth, Scenario-2 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	82.607	11.876	7.459	15.340
B(S8-S12)	24.974	5.256	9.720	8.850
C(W3-W7,S1)	40.343	25.311	6.862	9.735
D(W0-W2)	9.605	0	0	16.815
Total	157.530	42.444	24.042	51.035
Environment	1.214	0.290	0.104	

Table A.39

2017	6% growth, Scenario-3 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	60.578	17.815	11.934	33.748
B(S8-S12)	21.0925	7.885	15.553	19.47
C(W3-W7,S1)	34.0725	37.966	10.979	21.417
D(W0-W2)	8.1125	0	0	36.993
Total	115.522	63.666	38.468	112.277
Environment	0.890	0.436	0.167	

Table A .40

2017	8% growth, Scenario-1 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	69.767	26.992	19.014	33.748
B(S8-S12)	21.092	11.947	24.780	19.470
C(W3-W7,S1)	34.072	57.525	17.492	21.417
D(W0-W2)	8.112	0	61.287	36.993
Total	133.045	97.350	0	112.277
Environment	1.0255	0.661	0.266	

Table A.41

2017	8% growth, Scenario-2 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	54.138	26.992	11.934	33.748
B(S8-S12)	16.367	11.947	15.553	19.470
C(W3-W7,S1)	26.439	57.525	10.9797	21.417
D(W0-W2)	6.295	0	0	36.993
Total	103.240	97.350	38.468	112.277
Environment	0.795	0.661	0.1670	

Table A.42

2017	8% growth, Scenario-3 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	82.775	32.025	22.559	40.040
B(S8-S12)	25.025	14.175	29.400	23.100
C(W3-W7,S1)	40.425	68.250	20.754	25.410
D(W0-W2)	9.625	0	72.711	43.890
Total	157.850	115.500	0	133.210
Environment	1.216	0.784	0.315	

Table A.43

2017	Auto- Regression growth, Scenario-1 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	59.770	28.365	3.947	19.240
B(S8-S12)	18.070	12.555	5.145	11.100
C(W3-W7,S1)	29.190	60.450	3.632	12.210
D(W0-W2)	6.950	0	12.724	21.090
Total	113.980	102.300	0	64.010
Environment	0.878	0.694	0.0552	

Table A.44

2017	Auto- Regression growth, Scenario-2 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	75.142	14.213	9.386	12.116
B(S8-S12)	22.717	6.291	12.232	6.990
C(W3-W7,S1)	36.697	30.290	8.635	7.689
D(W0-W2)	8.737	0	30.254	13.281
Total	143.295	51.260	0	40.309
Environment	1.1045	0.348	0.131	

Table A.45

2017	Auto- Regression growth, Scenario-3 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	55.104	21.319	15.018	26.655
B(S8-S12)	16.659	9.436	19.572	15.378
C(W3-W7,S1)	26.911	45.435	13.816	16.915
D(W0-W2)	6.407	0	48.406	29.218
Total	105.083	76.89	0	88.679
Environment	0.810	0.522	0.210	

Table A.46

6% growth, Scenario-1 of fuel mix, Technology mix-2, E-1				
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	92.450	45.140	6.365	28.080
B(S8-S12)	27.950	19.980	8.295	16.200
C(W3-W7,S1)	45.150	96.200	5.855	17.820
D(W0-W2)	10.750	0	20.515	30.780
Total	176.300	162.800	0	93.420
Environment	1.359	1.105	0.089	

Table A.47

2020	6% growth, Scenario-2 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	113.520	21.472	14.180	18.304
B(S8-S12)	34.320	9.504	18.48	10.56
C(W3-W7,S1)	55.440	45.760	13.045	11.616
D(W0-W2)	13.200	0	0	20.064
Total	216.48	77.440	45.705	60.896
Environment	1.668	0.526	0.198	

Table A.48

2020	6% growth, Scenario-3 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	83.248	32.208	22.688	40.268
B(S8-S12)	25.168	14.256	29.568	23.232
C(W3-W7,S1)	40.656	68.64	20.872	25.555
D(W0-W2)	9.68	0	0	44.140
Total	158.752	116.16	73.129	133.971
Environment	1.223	0.789	0.317	

Table A.49

2020	8% growth, Scenario-1 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	100.808	37.039	5.208	35.36
B(S8-S12)	30.477	16.394	6.788	20.4
C(W3-W7,S1)	49.232	78.936	4.791	22.44
D(W0-W2)	11.721	0	0	38.76
Total	192.24	132.369	16.789	117.64
Environment	1.481	0.907	0.072	

Table A.50

2020	8% growth, Scenario-2 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	123.210	17.714	11.125	22.880
B(S8-S12)	37.249	7.840	14.499	13.200
C(W3-W7,S1)	60.172	37.752	10.235	14.520
D(W0-W2)	14.326	0	0	25.080
Total	234.96	63.30	35.86	76.120
Environment	1.811	0.434	0.155	

Table A.51

2020	8% growth, Scenario-3 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	90.354	26.571	17.801	50.336
B(S8-S12)	27.316	11.761	23.198	29.040
C(W3-W7,S1)	44.126	56.628	16.376	31.944
D(W0-W2)	10.506	0	0	55.176
Total	172.304	94.960	57.376	167.464
Environment	1.328	0.651	0.249	

Table A.52

2020	Auto- Regression growth, Scenario-1 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	54.138	20.130	2.579	19.760
B(S8-S12)	16.367	8.910	3.361	11.400
C(W3-W7,S1)	26.439	42.900	2.372	12.540
D(W0-W2)	6.295	0	0	21.660
Total	103.240	71.940	8.313	65.740
Environment	0.795	0.493185	0.036	

Table A.53

2020	Auto- Regression growth, Scenario-2 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	70.566	10.145	6.371	13.104
B(S8-S12)	21.333	4.490	8.303	7.56
C(W3-W7,S1)	34.462	21.621	5.862	8.316
D(W0-W2)	8.205	0	0	14.364
Total	134.568	36.257	20.538	43.596
Environment	1.037	0.248	0.089	

Table A.54

2020	Auto -Regression growth, Scenario-3 of fuel mix, Technology mix-2, E-1			
All figures in 000's	Thermal	Hydro	Nuclear	Renewable
A(E1-E9)	51.748	15.218	10.195	28.828
B(S8-S12)	15.644	6.735	13.286	16.632
C(W3-W7,S1)	25.272	32.432	9.379	18.295
D(W0-W2)	6.0172	0	0	31.600
Total	98.688	54.386	32.860	95.911
Environment	0.760	0.372	0.142	

Appendix IV - Training Load for Technical Personnel

Training Load for Technical in Thousands Man Months

S No.	Area	Manpower to be Trained in thousands	Average Duration in Months	Total for 12th Plan(Thousand man months)	Per Year (thousand man months) A	On job component (50 % of A)	Infrastructure required per year	Infrastructure Available	Surplus(+) Deficit(-)
1	Thermal(Induction)								
	Engineers-30%	9.60	12	115.21	23.04	11.52	11.52	13.43	1.91
	Oper-15%	4.80	12	57.60	11.52	5.76	5.76	11.24	5.48
	Tech-55%	17.60	12	211.21	42.24	21.12	21.12	16.11	-5.02
	Sub-Total	32.00		384.02	76.80	38.40	38.40	40.77	2.37
2	Hydro(Induction)								
	Engineers-20%	4.88	9	43.92	8.78	4.39	4.39	0.86	-3.53
	Oper-35%	8.54	6	51.23	10.25	5.12	5.12	1.69	-3.44
	Tech-45%	10.98	6	65.87	13.17	6.59	6.59	2.51	-4.08
	Sub-Total	24.40		161.02	32.20	16.10	16.10	5.06	-11.05
3	Power System								
	(a) Transmission(Induction)								
	Engineers-10%	1.79	12	21.50	4.30	2.15	2.15	2.51	0.36
	Oper-20%	3.58	6	21.50	4.30	2.15	2.15	1.87	-0.28
	Tech-70%	12.54	6	75.26	15.05	7.53	7.53	10.20	2.67
	Sub-Total	17.92		118.27	23.65	11.83	11.83	14.57	2.74
	(b) Distribution(Induction)								
	Engineers-10%	20.43	6	122.57	24.51	12.26	12.26	3.01	-9.24
	Oper-20%	40.86	3	122.57	24.51	12.26	12.26	2.37	-9.88
	Tech-70%	143.00	1	143.00	28.60	14.30	14.30	10.54	-3.77
	Sub-Total	204.29		388.15	77.63	38.81	38.81	15.92	-22.89
4	Refresher Course	647.34	1	647.34	129.47	0.00	129.47	11.00	-118.46
5	Management Training	647.34		161.83	32.37	0.00	32.37	3.12	-29.25
	Grand Total	925.94		1860.64	372.13	105.15	266.98	90.44	-176.54

Appendix V - Training Load for Non-Technical Personnel and Transmission and Distribution

Training Load for Non-Technical in Thousands Man Months

S No.	Area	Manpower to be Trained in thousands	Average Duration in Months	Total for 12th Plan(Thousand man months)	Per Year (thousand man months) A	On job component (50 % of A)	Infrastructure required per year	Infrastructure Available	Surplus(+) Deficit(-)
1	Thermal(Induction)								
	Exec-20%	2.38	3	7.14	1.43	0.00	1.43	0.00	-1.43
	Non Exec-80%	9.51	1	9.51	1.90	0.00	1.90	0.00	-1.90
	Sub-Total	11.89		16.65	3.33	0.00	3.33	0.00	-3.33
2	Hydro(Induction)								
	Exec-20%	1.11	3	3.33	0.67	0.00	0.67	0.00	-0.67
	Non Exec-80%	4.43	1	4.43	0.89	0.00	0.89	0.00	-0.89
	Sub-Total	5.54		7.76	1.55	0.00	1.55	0.00	-1.55
3	Power System								
	(a) Transmission(Induction)								
	Exec-20%	1.11	3	3.32	0.66	0.00	0.66	0.00	-0.66
	Non Exec-80%	4.43	1	4.43	0.89	0.00	0.89	0.00	-0.89
	Sub-Total	5.54		7.75	1.55	0.00	1.55	0.00	-1.55
	(b) Distribution(Induction)								
	Exec-20%	12.62	3	37.87	7.57	0.00	7.57	0.00	-7.57
	Non Exec-80%	50.49	1	50.49	10.10	0.00	10.10	0.00	-10.10
	Sub-Total	63.12		88.36	17.67	0.00	17.67	0.00	-17.67
4	Refresher Course	210.61	1	210.61	42.12	0.00	42.12	0.00	-42.12
5	Management Training	210.61		52.65	10.53	0.00	10.53	0.00	-10.53
	Grand Total	296.70		383.78	76.76	0.00	76.76		-76.76

Appendix VI: The list of Training Institutes Officially Recognized by the Central Electricity Authority.

Group A: Specialized Institutes offering programmes independently			
NPTI Badarpur	**Ministry of Power**		
Course	**Duration**	**Seats/Eligibility**	**Type**
B.E(Power Engineering)	4yrs	60	Technical(Mi
PGD (Thermal Power) Engineering)	1 yr	N.A.	O&M
PGD(Hydro power)	1yr	40	O&M
PDC(Thermal Power) Engineering)	Onsite/distance	50	Supervisory
NPTI Faridabad	**Ministry of Power**		
MBA (Power Management)	2yrs	120	Managerial
PGD(Thermal Power) Plant Engineering)	1 yr	65	O&M
PDC(Thermal Power) Engineering)	Onsite/distance	50	Supervisory
PGD(GIS and Remote) Sensing)	1 yr	50	Design
PGD(Hydro Power Plant) Engineering)	39 week	50	Construction/ O&M
NPTI Nagpur		**Ministry of Power, Maharashtra Generation Corporation**	
B.E(Power) Engineering)	4yrs	60	Technical(Misc.)
PGD((Thermal Power) Engineering)	1 yr	N.A.	O&M
PDC(Thermal Power) Engineering)	Onsite/distance	50	Supervisory
Jindal Institute of Power Technology, Raigarh	**Jindal Power**		
PGP(Thermal Power Technology)	1 yr	50	O&M
PD(Thermal Power Technology)	1 yr	50	Supervisory
JSW Energy Center for Excellence, Bellary	**Jindal Power**		
PG Diploma in Power Plant Engineering	1 yr	60	O&M
Post Diploma in Power Plant Engineering	N.A.	N.A.	Supervisory

Industrial Training Certification	4 week	20-25	Introductory

Power Systems Training Institute, Bangalore	**NPTI**		
Employment Oriented Course on O&M of T&D systems	26 week	40	T&D
NPTI, Neyveli	**Ministry of Power**		
PGD (Thermal Power) Engineering)	1 yr	N.A.	O&M
PDC(Thermal Power) Engineering)	Onsite/distance	50	Supervisory
Graduate Engineers Course, Thermal	1 yr	50	O&M
NPTI, Durgapur	**Ministry of Power**		
B.E(Power Engineering)	4yrs	60	Technical(Misc.)
PGD (Thermal Power Engineering)	1 yr	N.A.	O&M
PDC(Thermal Power Engineering)	Onsite/distance	50	Supervisory
NPTI, Guwahati	**Ministry of Power**		
PGD (Thermal Power Engineering)	1 yr	N.A.	O&M
Graduate Engineers Course on O&M of T&D systems	26 week	40	T&D
OMS Power Training Institute, Bhubaneshwar	**O&M Solutions**		
Thermal Power Plant Training	26 Weeks	N.A.	Construction,O&M ,
Thermal Power Plant Refresher Course	2 weeks	Power Plant Professionals	O&M
Refresher Course on Power Plant Chemistry	1 week	Power Plant Professionals	O&M
Vocational Training	4 week	Undergraduate Engineering Students	Introductory

Group B: Specialized Institutes Offering Courses to both parent organization and non-sponsored candidates			
Course	Duration	Seats/Eligibility	Type
Management Refresher Seminars	2-7 days	Executives of NTPC	Managerial
Advanced Management Programmes	3 weeks	NTPC Executives(AGM/DGM Rank)	Managerial
General Management Capsule	2 weeks	NTPC Executives(Managerial Rank)	Managerial
Foundation Course	13 days	Freshly promoted Deputy Managers	Managerial
Programme for Executive Development	30 Days	Fresh Recruits	Managerial
Technical Expertise Refreshers	3-10 days	Engineers	Construction/R &D/O&M/
IT refresher Courses	2-7 days	Engineers	IT Support
Simulator Training	30 days	Engineers	O&M
Fundamentals of Boiler construction	7 days	Online	Construction
M.Tech (Power Engineering)	2 years	5-10(NTPC Employees only)	Technical(Misc.)
Employee Development Centre, Korba	**NTPC**		
Simulator Training	30 days	Open to engineers from all power facilities (30-40)	O&M
Employee Development Centre, Kawas	**NTPC**		

Simulator Training	30 days	Open to engineers from all power facilities (30- 40)	O&M
Koradi Training Center, Koradi	**Maharashtra Generation Corporation**		
Induction Programme	4 months	Engineering Trainees	Technical(Misc.)

Induction Programme, Technicians	6 week	Technicians, Linesmen	Supervisory,T& D
Induction Programme, Security	2 week	Security and safety staff	Safety
Induction Programme, HR	2 weeks	HR staff	Managerial
Induction Programme, MIS	2 week	IT Staff	IT Services
Induction Level Programme, Civil	6 week	Construction engineers	Construction
Vocational Training	4 weeks	Undergraduate Engineering students	Introductory
Induction Programme, Chemists	8 week	Chemists	Maintenance
Core Skill Training Center, Bhubaneshwar	**OPTCL**		
Practical Orientation programme for transmission and distribution systems	30 days	Undergraduate Electrical Engineers	T&D
Induction-cum- Orientation Programme	21 days	Management Trainee	Technical(Misc.)

O&M of Transmission Line and Sub-stations	8 days	Engineers	T&D
T&D Systems	30 days	Post ITI,MCTI Staff	Supervisory
T&D Systems	15-30	Post Diploma Students	Supervisory
Group C: Dedicated In-House Training Centers			
Course	Duration	Seats/Eligibility	Type
Electricity Training Institute, Lucknow	**UPPCL**		
Refresher Courses	7-15 days	UPPCL Employees	T&D
Gujarat Energy Training and Research Institute,Vadodara	**Gujarat Electricity Board**		

General Management, finance ,HR and Accounts	Short Term(1-3 months)	GUVNL Executives	Managerial
Generation	Short Term(1-3 months)	GUVNL Engineers	Construction, O&M
Transmission and Distribution	15-30 days	GUVNL Engineers, Linemen	T&D
Department of Training Research and Development, Nashik		**Maharashtra State Electricity Distribution Company Limited**	
Induction Programme	4 months	Engineering Trainees	Technical(Misc.)
Management Refresher Programmes	2 weeks	Senior Management, Senior Engineers, Non-technical Staff	Managerial

Junior Level Training	3 weeks(thrice a year)	Linesmen, Operators Artisans	Supervisory, O&M
Generation Training Center, Nashik	**Maharashtra Generation Corporation**		
Induction Programme	360 days	Engineering Trainees(32)	Technical(Misc.)
Center for Power Sector Development, Pune	**Maharashtra Generation Corporation**		
Induction Level Training	45 days	Junior Engineers(30-40)	Technical(Misc.)
Reliance Energy Management Center, Mumbai	**Reliance Energy**		
Induction Programme in Power Management		Executive Staff	Managerial
Versova Technical Training Center, Mumbai	**Reliance Energy**		
Induction Programme , Technicians		Linesmen	Technical(Misc.)
Main Training Center, Mumbai	**Tata Power**		
Induction Programme for new recruits	3 months	Campus Recruits	Technical(Misc.)
Induction Programme	2 week	Lateral Recruits	O&M, Managerial
Induction Programme in Ethical Practices	2 week	All staff	Managerial

Diversity Training		Executives and Engineers	Managerial
Training Center, Krishna District	**APGENCO**		
Induction Programme	3 months	Assistant Engineer Trainees	Technical(Misc.)
Refresher Courses on O&M of Thermal Power Stations	2 week	Assistant Engineer Trainees	O&M
Accounts and Services Training	10 days	Accountants	Accounts
Refresher Courses on O&M of Thermal Power Stations	2 week	Workmen	Supervisory
Computer Training programmes in Basic Microsoft Packages	10-20 days	All staff	Miscellaneous
Training programme in advanced packages	8-10 days	Executive engineers	Construction Design
26 week Training Programme on Thermal Power Plants	6 months	N.A.	Construction/O &M
Thermal Training Institute, Vallur	**TNEB**		
Induction Programme	4 months	Engineering Trainees	Technical(Misc.)
Simulator Training Programme	15-30 days	Engineering Trainees	O&M

OHPC Training Center, Bhubaneshwar	**OHPC**		
Disciplinary Proceedings	1 month	Executive staff (19)	Managerial

Refresher Course in Hydropower	12 days	Junior and Assistant Level Engineers	Technical (General)
Power Plant Training Simulator Center, Bakreswar	**WBPDCL**		
Basic Operation Training Programme	2 weeks	Graduate Engineer Trainees, Operation Engineers	Technical (Misc.)
Refresher Programme	2 weeks	Operation Engineers	O&M
Operation Familiarisation Programme	1week	Maintenance Engineers	O&M
Group D: Institutes Having Affiliate Programmes, part-time programmes with specialized institutions in Group A&B			
Course	**Duration**	**Seats/Eligibility**	**Type**
Linemen Training Center, Solan	HPSEB		
Chamera Power Station-I, Chamba	NTPC		
Training Center, Uri	NTPC		
Training Center,Salal	NTPC		
Hydro Training Center, Tanakpur	NHPC		
Employee Development Center (EDC), Singrauli	NTPC		
Employee Development Center, Rihand	NTPC		
EDC, Dadri	NTPC		
EDC, Unchahar	NTPC		
EDC,Tanda	NTPC		
EDC, Ballabhgarh	NTPC		
Thermal Training Institute, Ropar	PSEB		
Officers' Training Center, Jaipur	RVPN		
Thermal Training Institute, Obra	UPRVUNL		
Center for Research and Industrial Staff Performance, Bhopal	Independent		

Wanakbori Training	GUVNL		
Institute, Kheda			
EDC,Vindhyachal	NTPC		
EDC, Itarsi	PGCIL		
Technical Training Center, Dahanu	Reliance Energy		
Plant Training Center, Raigad	Tata Power		
Plant Training Center, Mumbai	Tata Power		
Training Center Sabarmati	Torrent Power		
GMR Training Center, Mangalore	GMR Energy		
Power Engineers' Training and Research Center, Idukki	KSEB		
Power Station Training Center, Neyveli	NLC		
EDC, Ramagundam	NTPC		
EDC, Rangareddy	PGCIL		
Hydro Training Institute, Erode	TNEB		
Transmission and Sub-station Training and development Institute, Madurai	TNEB		
O&M Training Center, Kolkata	CESC		
Plant Training Center, Pujali	CESC		
Plant Training Center, Titagarh	CESC		
Plant Training Center South, Kolkata	CESC		
DVC Training Institute, Bokaro	DVC		
EDC, Farakka	NTPC		
Central Power Training Institute, Rourkela	SAIL		
Central Training Institute, Bandel	WBPDCL		

Appendix VII List of Institutions Visited

Generation-

- National Thermal Power Corporation (NTPC)
- National Hydro electric Power Corporation (NHPC)
- Nuclear Power Corporation India Limited (NPCIL)
- Himachal Pradesh Power Corporation (HPPPC)
- SJVN Ltd. (formerly Sutlej Jal Vidyut Nigam Limited-SJVNL)
- Tata Power Limited (TPL)
- Jindal Power & Steel Limited (JPSL)
- Lanco Power Limited (LPL)
- Larsen & Tourbo Power (L&T)
- Moser Baer Projects Power Limited (MBPPL)
- Jaypee Group (JG)
- GMR Power Corporation Limited (GPCL)

Transmission & Distribution Utilities

- Power Grid Corporation of India Limited (PGCIL)
- New Delhi Power Limited (NDPL)
- Bombay Suburban Electric Supply Regards, Yamuna (BSES)

Training Institutes

- Power Management Institute (PMI)
- National Power Training Institute (NPTI)
- Center for Power Training for Distribution & Transmission (CENPIED)

Appendix VII - List of Experts Consulted

- Mr. S.Singh (Director –HR, NTPC)
- Mr. A.C. Chaturvedi (Executive Director HRD, NTPC)
- Mr.S Roy(Executive Director-HR & IE, NTPC)
- Mr. Dayal Mathur(Executive Director, NHPC)
- Mr. J.S.S. Rao (Principal Director, NPTI)
- Col Ashok Chauhan (Head- HR, NDPL)
- Mr. Deepak Bharara(Director Corporate- HR, LPL)
- Mr. V.K. Tiwari, (Director –Personnel, HPPC Ltd.),
- Mr. Adleeb Jain(Vice President –HR, LPL)
- Mr. Ashish Wadekar(Corporate Head-HR, L&T)
- Mr. Sanjiv Kumar(Vice President- MBPPL)
- Mr. Rahul Bhargava (Head- HR, JSPL)
- Mr. T.Singh(GM-HR, TPL)
- Ms. Yogita Shetty (GM-HR, JP)
- Mr. H.P.Paul(GM-HR & IE, PGCIL)
- Mr. R.P Singh(GM- HR &IE, NHPC)
- Mr. Upendra Rai(GM- HRD, NHPC)
- Mr. Rakesh Pathak (GM,NHPC)
- Mr. P.K Senapati(GM-HR&IE, NTPC)
- Mr. D.M.R. Panda(Coordinator, HR – Power Forum)
- Mr. Ashish Pradhan(GM-HRD, JPL)
- Mr. V.S.B Babu(GM-HR, NPCIL)
- Ms Anjana Verma(GM-HR, GMR)
- Ms Sanjana Kapoor(GM-HR, BSES)
- Mr. A.K.Mukherjee (GM- P&A, SJVN Ltd.)
- Ms Vatshala Sharma (Coordinator, NTPI)
- Mr. Narang Kishore(Founder Narnix)

References

Arthur.W & Bennett.W (1995) The international assignee: the relative importance of factors perceived to contribute to success, Personal Psychology, Vol.48 Nos-1,pp 99-115

Brooks. K & Nafukho.F M(2001), Human resource development, social capital, emotional intelligence: any link to productivity, *Journal of European Industrial Training*, (30), 117-28.

Brislan.R & Yoshida (1994) Improving intercultural interactions: Modules of Cross Cultural Training Programs, Longon Sage Publication, Vol 51 Nos-4, pp 109-146

Bodger P. and Mohamed Z(2006), Electricity Intensity Patterns for New Zealand, Selected Countries and World Regions , Power Forum Report,(2006), 21-29.

Blancaro.D, Boroski.J& Dyer.L (1996), Key competencies for transformed human organizations: Results of a field study, Human Resource Management, Vol 34, Nos-3, Fall 1996, pp.383

Capon N & Glazer,(1987) Marketing & Technology. A strategic codegnment, Journal of Marketing, 1987, 51(3) 1-14

Chang ,V.H. (2007) , Theory and Evidence for their Functional Relationship .Department of Economics at the Massachusetts ,Institute of Technology , *Journal of Energy & Economics*,2007, 12(2), pp 76-82

Chontanawat, J. and Hunt, L. C. and Pierse R. (2006), *Surrey Energy Economics Centre (SEEC)* Department of Economics, SEEDS, (2006) 113,11SN 1749-8384

Cedant (2001) Finance & Information Technology skills in demand in Asia Pacific: Human Resource Survey, Business & Economics, PR Newswire, http://search.proquest.com/docview/449166109?accountid=81487

Central Electricity Report (2011) All India Electricity statistics: General Review http://www.cea.nic.in/report.html

Chien (2004) A study to improve organizational performance, Journal of American code of business, Cambridge University, Vol-4.1/2, pp-289-291

Chima, C.M(2011).Intensity of Energy Use in the USA 1949-2003.*Journal of*

Business and Economics Research, 2011, (5) 29-51.

Currie, C.(1996) Energy Efficiency and Energy Intensity Fiji 1981-1990. *Journal of Pacific studies*, 1996(19) 110-117

Economic Survey (2010-11) http://indiabudget.nic.in/survey.asp

Eto, Joseph, Jonathan K., Bryan L., Nathan M., Evan M., Carrie W., Ernst W., (2001), Scoping Study on Trends in the Economic Value of Electricity Reliability to the U.S. Economy (2001),35-42

Fine C.H, & Hax, A.C(2001) Manufacturing strategy a methodology and an illustration, Interfaces, 1985(18) 28-46

Goodwin(2004) Human Resource managers voice concerns over skills 'black hole' Computer Weekly, April 27th 2004, pp..38

Gupta M.D., Gupta E. and Jaswal.P(2006), Asia Energy Security Issues Focus on China and India *.Asian Energy Institute* -Article in April in AEI newsletter.2006

Grugulis.I & Macmillan.P(2007), Skills , Training & Human Resource development: A critical Text, Labor & Industry, Vol 19, Nos 1-2, August-December 2008, pp..128.

Henderson, D.(2007) Causal Relationship between Economic Activity and Electricity Consumption. The Case of Korea, Time series analysis. State University of New York at Binghamton., 2007, ECON-618B

Hesketh,B & Ivancic,K(2002), Enhancing performance through training in Sonnentag, S(E.d), Psychological Management of Individual Performance, John Wiley, Chichester, 2002, 249-65

Holton, EF (2000) Development of generalized Learning transfer system Inventory, Human resource Development quarterly, Vol 11, nos 4 pp-333-60

Ho, C.Y. and Siu, K.W(2006.) A Dynamic Equilibrium of Electricity Consumption and GDP in Hong-Kong. An Empirical Investigation, 2006 *.Energy Policy* 35(2007), 2507-2513.

Lucon.M & D Moreno (1993) Training & implementation of quality programs by sample of small & medium sized firms, The International Journal of Quality & Reliability Management. Vol-10, Nos-3 pp-6

Jackson, David J Mardsen & Alan.W(1994) Responding to competence requirements with relavent & effective training & development programs, Industrial & Commercial Training, Vol-26.7 pp-24

Kirwan.C, Birchall.D (2006) Transfer of learning from management development programmes: testing the Holton model, International Journal of Training and Development, Vol-10 Nos-4 pp-252-68.

Kumar R, Chadee(2002), International Competitiveness of Asian Firms, an analytical framework, Asian Development Bank Report, 2002, EDP (4) 1-39.

Krugman, P.R(1994), Competitiveness: A dangerous obsession, Foreign Affairs, 1994, 7461, 29-44.

Lim D.H & Johnson S.D (2002) Trainnee perception of the factors that influence learning transfer, International Journal of Training and Development, Vol-6 Nos-4 pp-37-49.

Kastava.M & Condrey.S (2005), Motivating personnel at Russian nuclear power plants: A case study of motivational theory applications, Public Personnel Management, Vol 34, Nos- 4, Winter2005, pp.343

Kay.C & Moncarz.E (2004) Knowledge, skills and abilities for lodging management success, Cornell Hospitality Quaterly, Vol 45, Nos 3, August 2004, pp..285

Martin, J. R. and Cerda , M. O (2003,). Non-linear Relationship between Energy Intensity and Economic Growth .ESEE Conference frontiers 2,held in Tenerife, Spain on, 2003, Feb 12-15.

Mishra, V., Sharma. S. and Smyth R, (2007). Are fluctuations in Energy Consumption per Capita Transitory? Evidence from a Panel of Pacific Island countries *.Asian Business and Economic Research Unit, 2007, Discussion* paper - 70.

Nondo, C. and Kahsai (2009) Energy Consumption and Economic Growth Evidence from COMESA Countries .Presentation at the Southern Agricultural Economics Association-Annual Meeting ,Atlanta, Georgia on 2009,Jan31-Feb3.

Neumann, C.A(1989), Edward, J.E & Rojao, N.S,Organizational development interventions- a meta-analysis of these effects on satisfaction and other attitude, *Personal Psychology*,1989,(42), 461-89.

Ordonez de Pabes, P(2004), Human resource management systems and their role in the development of strategic resource, empirical evidence, *Journal of European Industrial Training*, 2004, (28), 474-89.

Ray, K. B. and Reddy, B .S(2007) .Decomposition of Energy Consumption and Energy Intensity in Indian Manufacturing Industries .Indira Gandhi Institute of Development Research (IGIDR) ,2007,WP-020.

Reddy, M(1996). Energy Consumption and Economic Activity in Fiji. *Journal of Pacific Studies,* 1996, (22), 81-96.

Rowe & Chirstoper (1992) The problem of evaluation of In-house training Programs, Industrial & Commercial Training. Vol – 24 Nos 7 pp-24

Salas, E and Cannon-Bower, JA(2001), The Sceince of training, a decade of progress, Annual review of Psychology, 2001,(52), 471-99

Sheehan, P. and Sun, F(2007). Energy Use in China .Interpreting Changing Trends and Future Directions. CSES c l i m a t e change, 2007, WP-13.

Schein (1999) How to set stge for change in organizational culture, New York: Double day pp-334-342

Squalli, J. and Wilson, K. , (2006), A Bound Analysis of Electricity Consumption and Economic Growth in the GCC. EPRU, Zayed University, 2006, WP-06-09.

Sub- Group 9 , for Manpower Estimation in Power Sector Report (2011) Ministry of Power Reports Committee formed for 12th Plan.

Tongia R(2003)., The Political Economy of Indian Power Sector Reforms, Vaclav Smil, Light behind the fall: Japan's Electricity Consumption, the Environment, and Economic Growth, (2003), Vol- 11, 45-52.

Vanden , F. K. (2002) .What is driving China`s Decline in Energy Intensity/Brandies University, Journal of Pacific Studies, 2002(21) 142-177.

Vaill PB (1996) Learning as a way of being, San Francisco Jossey-Bass

Peters(2005) Entrepreneurial skills in leadership and Human Resource management evaluated by apprentices in small & tourism businesses, Education & Training, Vol 47, Nos -8/9, 2005, pp..575

Ulrich, Brockbank, Yeung & Lake (1995) Human Resource Competencies: An Empirical Assessment, Human Resource Management, Vol 34, Nos-4, Winter 1995, pp.473

Yuksel(2011) Core Competencies of managers in an Emerging Market, The Journal of America Academy of Business, Cambridge, Vol 17, Nos-1, pp..104-111