CHAPTER-I

INTRODUCTION

Power is the most important ingredient and the basic infrastructure needed for economic development of a country. It is one of the powerful vehicle of economic progress and social changes. It is the basic input for industrial development and economic growth of a country. This prime input has a very prominent role in agriculture, industry, transport, commercial and domestic sector of the national economy.

"The availability of easily transportable and cheap energy transformed the face of western world through wide-spread industrialisation, generation of new employment and consequent urbanisation, modernisation of agriculture, increase in social and civic amenities for community etc. Indeed, electricity delinked the working of human mind from primeval and tribal attitudes to one of enlightened vision" (Kumar, R. 1986).

In this chapter an attempt has been made to explain the problem, scope, objectives and limitations of the present study. The data base, methodology, plan of the study and review of the available relevant literature have also been underlined in brief.
1.1 PROBLEMS OF THE STUDY

Electricity is an important intermediate input in the production of various commodities. It is mainly produced in the public sector in India with three types of sources, namely, hydel, thermal, and nuclear. It is mainly consumed by industrial, agricultural, and domestic sector of the economy.

The main problem of power sector in India is the gap between consumption and supply of power, which is continuously increasing. The rapid development of industries, speedy rural electrification, expanded irrigation facilities and change in the socio-economic life of people have increased the consumption of power. As a result, rate of growth in demand of power has outstripped the rate of growth in the installed generation capacity. Besides, there is also a gap between installed capacity and actual generation of power due to very low efficiency levels in power-stations in India. The availability of electric power from already installed capacity has not been up to the mark.

Structural shifts are taking place in generation of power from hydel to thermal and from thermal to nuclear. A shift is also taking place from supply side, as supply of electric power has been shifting from urban areas to rural centres.
To manage the production and transmission of power, administrative responsibilities have shifted and some new bodies have come up. The Government of India has made certain structural changes in the Electricity (Supply) Act, 1948 during the Fifth Five Year Plan to increase the share of Central Government in the generation of power. As a result National Thermal Power Corporation and National Hydro Power Corporation were incorporated in 1975 under the Central Sector. Different types of power generating plants have their own problems. Though hydro power is clean, renewable and has low operational cost, yet its share in total installed capacity has declined in India.

Nuclear power has some economic advantages over other forms of generating electricity. Environmental pollution caused by nuclear plant is minimum but there is always possibility of catastrophic nuclear accidents, which is a matter of great concern from the point of view of safety.

The thermal power plants constitute the backbone of power scenario in India, as they contribute the highest share in the total production of electricity and hence, are very important for the economy. But it is being generally observed that the thermal power plants are generating electricity much less than their installed capacity.
plant load factor in thermal plants has been very low. Forced outages have been increasing due to which full generating capacity has not been utilized. Thermal plants in India also face the problem of low quality and inadequate supply of coal. Supply of coal is irregular and inadequate to thermal plants. Sometime low grade coal and sub-standard quality of coal is supplied to them resulting in serious damages to the equipments.

In brief, the performance of power sector is not satisfactory and there is a need to examine it in detail.

1.2 OBJECTIVES AND SCOPE OF THE STUDY

The objective of the present study is to analyse overall performance of power sector in India. The objectives may be categorised under two broad headings:

(i) To evaluate overall development in power sector in India and also examine the performance of three types of power industries, namely - hydel, thermal, and nuclear;

(ii) To analyse the structural changes which have taken place during the last 30 years.

We have tried to analyse the power sector from 1960 to 1991 to cover the lasted development in this sector, although the title of the thesis refers till 1985 only.

1.3 DATA BASE AND METHODOLOGY

Data source of this study is mainly secondary, obtained from various government reports and publications.
We have tried to make uniform source of the available data as far as possible.

Keeping the aforesaid objectives in mind, the entire work of the study is carried out into three parts. In the first part of the study, a detailed survey of the available existing published literature has been undertaken, with a view to get acquainted with the power sector. In the second phase of the study, the relevant data and information about the growth of power sector is made use of and the performance of the three power generating industries has been analysed. In the third phase of the study structural changes have been examined.

The data have been systematically arranged and synthesised for arriving at certain conclusions regarding the development and structure of power industry in India.

1.4 DEFINITION OF THE TERMS USED

WATTS

Watt is the unit of electrical power or the rate at which electricity is being produced and used. One thousand watts is known as kilowatt (KW). A kilowatt hour (Kwh) is the unit of electrical energy and is equal to 1,000 watts hour.
PLANT LOAD FACTOR

Plant load factor (PLF) provides a measure of average performance of thermal power plant and is defined as:

\[
\text{PLF} = \frac{\text{No. of Kwh generation during a year}}{\text{Installed capacity} \times 8760} \times 100
\]

The numerical figure in the denominator is obtained by multiplying the number of days in a year with number of hours in a day.

INSTALLED CAPACITY

The installed capacity of the power system is the sum of ratings of maximum continuous kilowatt capacity in the system during a year.

PEAK AVAILABILITY

Peak availability of a power system is the maximum power available to the system at the power station bus bars at the time of peak load during a year.

PEAK LOAD

Peak load is the maximum simultaneous ultimate customer demand within the supply area of the power system
which occurs during a year as measured by actual deliveries at generating station bus and bulk sources.

OUTAGES

Outages represent the complete close down of the unit in a year. Outages are of two kinds, i.e., forced outages and planned outages. Both of them are measured separately.

FORCED OUTAGES

Forced outages are those when a unit is closed down due to technical and unforeseen causes.

PLANNED OUTAGES

Planned outages represent shut down of a unit for scheduled maintenance and overhauling.

1.5 LIMITATIONS

The generation of electricity is a highly technical and engineering problem. On the basis of plant load factor a rough estimation may be made about the performance of the power plants.

Due to the difficulties in procuring data related to the cost of production, the extent of pollution and pollution controlling devices, we could not analyse the cost structure of various types of power plants and
environmental problem related with the power industry. We have not discussed the pricing of electricity as it is out of the scope of the study. On account of time constraint, the working of various government bodies have not been analysed in detail.

1.6 PLAN OF THE STUDY

The present study is divided into eight chapters.

In the first chapter, an attempt has been made to outline the problems, objectives, scope, limitations, data base and methodology of the entire research work. The definitions of various terms used in the study and review of the available relevant literature related to power sector are also included.

The second chapter deals with the growth of power sector in India. Sectorwise power consumption in India has been briefly discussed. It also highlights the development of power during various five year plans. Investment on power sector and the development of transmission and distribution networks have also been elaborately analysed.

The third chapter examines the progress of hydro power generation in India. It outlines total hydro power potential available in the country. The chapter also
reviews the present position of hydro power generation and also focusses upon the problems related to slow growth of hydro power generation in the country.

In the fourth chapter growth of thermal power in India has been dealt. It examines the installed capacity, thermal power generation, plant load factor of different unit sizes, state-wise plant load factors and plant load factors in National Thermal Power Corporation units. Performance of the thermal power plants, reasons of outages, and modernisation schemes have also been examined. An attempt has also been made to highlight the problems related to the operation of thermal power plants in India.

The fifth chapter has been devoted to deal with the development of nuclear power. The economics of nuclear power generation has been discussed in brief. An assessment of uranium reserves in India has been made. The nuclear power development in India has also been reviewed.

The sixth chapter highlights the structure of power sector in India since its inception. It also analyses the structural changes that have taken place in the power sector for the last three decades.

In the seventh chapter the growth of rural electrification in India has been given. An analysis of
investment on rural electrification has been made. It also focusses on Rural Electrification Corporation which forms the basis of growth and expansion of electricity in rural areas. The time profile of rural electrification and energisation of pumpsets has also been studied.

The eighth chapter concludes the findings of the preceding chapters. Alongwith the conclusion, a few suggestions have also been made for bridging the gap between demand and supply of power and improving the performance of thermal and hydro plants and increasing the availability of power from the existing installed capacity.

1.7 REVIEW OF THE LITERATURE

In this section we have tried to study the existing literature available on power sector. Individual studies made on different aspects of power sector we have also been included.

Venkatraman (1972) highlights various aspects of power industry such as financial, organisational, electricity tariff, financial working of electricity boards, rural electrification, union and state relations in power development. Industrial growth depends on the supply of power in adequate quantity and available at the requisite periods of time and at a reasonable rates.
The power generation, transmission and distribution constitute an important public sector industry. The lion's share of power generation in India is handled by the electricity boards established by various states. The author has also analysed finances of the State Electricity Boards. The main findings of the study are that there is a situation of imbalances in the financial structure of the electricity undertakings which dates from the days when they were seen departmentally. A comprehensive analysis of the financial aspects of State Electricity Boards to identify the basic causes for financial disequilibrium prevailing in electricity utilities has been made. For this, relevant data has been arranged and presented very carefully. He describes that if the financial scarcity of the State Electricity Boards had recognised earlier, it would not have been difficult for creating a sound financial system of the State Electricity Boards. The state's finances in India have tended to exhibit a fundamental disequilibrium arising out of the distribution of power and financial resources in the constitution. Power development has been a major recipient of the capital assistance given by the Centre. States receive the Central assistance in the form of loans. The problem of repayment of these loans by States is a major one, because States pass on the loans to the
electricity boards and they themselves have to make arrangements for the repayment. Power financing in India has therefore a major dimension in the shape of Centre-State relations but this is an aspect which has not been studied and investigated sufficiently so far.

Chetty (1976) discusses the role of operation and maintenance in power supply industry. Proper practices and timely schedule of maintenance of equipments and line play a crucial role for a reliable power supply.

During the process of operation, certain natural deteriorations take place in machines, plants or equipments which result in a loss of capital or increase in operational costs. Certain processes have to be performed on each kind of plant and equipment to nullify and counteract the deteriorating factors so as to keep the plant and equipments in fully efficient condition for satisfactory and economical operation and these processes are called 'maintenance'. Operation and maintenance of system go hand in hand. Proper understanding of operational procedure will minimise the maintenance process and saves maintenance costs and results in increased revenue. A systematic maintenance schedule helps in greater operational reliability.

Efficient functioning of an electricity distribution requires reliability of power supply,
satisfactory volatage, low line losses, optimum power factor and minimum theft of energy.

Govil (1978) has made an attempt to take a look at the reasons of haphazard management and development of power sector. There has been a shortfall in the planned addition in installed capacity of 200 MW in the First Five Year Plan, shortfall of 1200 MW during Second Five Year Plan and 2520 MW during the Third Plan. Reasons for these shortfalls have been studied in this paper. The main cause of delay in power development were due to lack of adequate project data and investigations before finalising technical project report, delay in issue of authorisation by Central or State authorities, deficiency in organisation for planning and engineering the project, delay in procurement and delivery of the equipments, change in top personnel in the course of implementation of project, shortage of cement and steel etc.

Pachauri (1978) throws light on economic issues in planning for electric power in India. Problems in the power sector of the Indian economy have attracted greater attention at official as well as non official levels. Since the demand for power is a derived demand, and consumption of electricity takes place in a range of domestic, industrial, agricultural and commercial activities, therefore, interruptions in supply bring
about a halt in all these sectors, and thus any lapse in power supply receives immediate attention.

The importance of various concepts and issues related to planning in the power sector, which have not received sufficient attention from decision takers and policy makers bodies in the country, are discussed in this paper. Any exercise in planning in this sector must essentially deal with planning for the economic system as a whole.

Gupta (1976) examined rationalisation of production and supply of electricity and measures conducive to electrical power development. Indian constitution enlists electricity in the concurrent list and places authority on the State Government to amend the Central act. The Central act is generally flexible from the point of view of management of the boards including their business.

The author is of the view that the bright business prospects in the case of electricity ensures earning a surplus, provided the appropriate scientific business management is introduced.

For scientific business management of power supply undertakings the study suggests following items – Devising of systems of coordination with different wings of the Central and State Government agencies for effective
utilization of capital and early return with overall perspective on national economical considerations. Introduction of the use of computers as an aid to management, employment of managerial/supervisory personnel according to the qualifications, experience for the job requirement, Introduction of refresher course and training facility for all categories of personnel at regular intervals and special incentive on area basis for effective utilization of plant and machinery per KW or KVA installed.

Hans (1972) describes that inspite of large number of options available to India in the energy group, power seems to be the best bridge that can help the country tide over the crisis. It can play an important role in the development process of the country. But its role cannot be measured exclusively through economic terms such as GNP alone. Keeping in perspective global changes and a new awareness of man and his relationship with society. States today include social indicators as well. Power industry comprising of so many areas of life, is no longer an economic or technological area of study, but has become a human problem. It has social effects and therefore, constitutes one of the problems facing the identity of a nation. The socio-political-economic impact of power has therefore, to be studied on a vast canvas in which planning plays a significant role. She has also analysed the progress of power during the five years plans.
The study reveals that planning in power sector was not accurate. The gap between demand and supply kept on increasing with time and growth rate projections in the power sector turned out to be completely out of touch with reality of the situation. A policy to increase both agriculture and industry without any relation to the power sector has meant that ultimately both industrial growth and, economic growth as a whole have suffered.

For future power policy, emphasis is being laid on the use of advanced technology in power sector and self reliance in production. A national policy linking together all the regions essential for the balanced growth of power industry.

There is a considerable scope for energy conservation in both the industrial and agricultural sectors in India. Conservation, therefore, should become a crucial principle of governmental policy. Research and Development Insitutes need to be set up by the Government to devise power saving devices for the use in industrial sector.

The study suggets that there should be a uniform national tariff policy. Determination of tariff rates is erratic and based on political rather than on economic factors. A national tariff policy is essential to make the
sector work in cohesive manner. A single tariff policy will help in the integration of this sector physically and avoid regionalism.

Jain (1984) outlines present status of integration of power systems in the country with the ultimate objective of realising a national power grid and tried to identify the factors that are coming in the way of smooth integrated operation. These include sustained under-frequency and over-frequency operations, improper load management and unscheduled drawals of power, large voltage excursions, inadequate monitoring and controlling facilities and lack of incentives in commercial agreements. The study suggests some measures to overcome these problems. These include joint conceptualisation of an operation and control philosophy, agreement to operate the interconnected systems at a single declared frequency within a narrow band and load management scheme, provision of under-frequency relays, metering and instrumentation facilities, adoption of an integrated approach in setting up load dispatch centres, establishment of a well knit communication system owned by the power utilities, proper commercial agreements for inter-state exchanges.

Puttaswamy (1984) describes briefly present day problems connected with the power systems in India, in
general and deficiencies in planning and efficient operation of interconnected power system in particular. The author describes that the first and foremost problem faced by the power systems is inadequate generation capacity due to inadequate funds, slippages in project schedules, low run-off, deficiency in the utilisation of full installed capacity and inter-state disputes.

A fundamental change in the financing policy is necessary to provide adequate resources for power projects, transmission and distribution system. Long term (say 15 to 20 years period) power planning and concurrent power, system studies are essential features for developing a well planned national power grid for India. Introduction of rule/regulations/contracts to enforce decisions taken to achieve fast and efficient operation of interconnected power systems is very necessary. Manpower development and training is of utmost importance to maintain and operate power systems efficiently.

Sambamurti (1984) outlines the historical background of power in India. Power development has been given a very high priority in the plan programmes. The central purpose of power development has been to extend power supply to all parts of the country and provide supply of power of appropriate quality at the lowest possible cost.
Power development in India is mainly based on hydro and coal resources. During the first fifteen years of planned development emphasis was placed on hydro power as a part of the multi-purpose development of river valleys. In the subsequent period attention was focussed on thermal power development to accelerate growth.

Technical factors governing hydro, thermal and nuclear power are also discussed. The author also highlights problems of investments in power sector, which have accentuated due to steep escalation in cost of inputs and other equipments in recent years.

Verma (1985) analyses cost of electricity generation in State Electricity Boards in India. Power industry is based on the principle of "operating costing" which is concerned with ascertaining the cost of electricity generated, transmitted and distributed. The unit of cost in power industry for presenting production cost data is 'kilowatt - hour' (Kwh). The total production is divided by the number of units generated during the period and presented as cost in paise per unit.

The cost structure in State Electricity Boards in India includes generation cost, transmission cost, miscellaneous cost. The study presents the generation cost of six State Electricity Boards including Gujarat, Haryana, Madhya Pradesh, Orissa, Punjab and Rajasthan.
The data on generation cost of all the six State Electricity Borads shows an increasing trend through-out the period of study.

Keshava (1986) highlights some aspects of the theory of electricity pricing relevant to developing countries including Traditional Approach of Electricity Pricing, Marginal cost pricing, Short-run and long-run Marginal costs and peak load pricing. Electricity supply undertakings produce a commodity essential to daily life, they are natural monopolies largely because of technical indivisibilities and they have fiscal and welfare objectives. The fiscal and welfare objectives of public utilities, have several implications for pricing. While the fiscal objective is related to fair returns on capital invested, the welfare objective is related to the maximisation of utility from the output for the benefit of society.

Author has also made an attempt to relate the theoretical discussion to the recent developments in France, United Kingdom, United States of America to illustrate the issues involved and further to draw appropriate lessons for electricity pricing in developing countries.

Bami (1987) throws some light on the power development in India during the five year plans. The remarkable increase in economic infrastructure facilities in
the country is due to heavy investment in power sector during the planning period. But in spite of heavy investment and emphasis on power sector during the planning period, the supply has fallen short of demand due to non-availability of power. This affects the industrial sector, agricultural growth and other sectors of the economy adversely. He therefore, suggests scientific and comprehensive planning for reducing the gap between demand and supply.

Chand (1987) highlights power development during the Seventh Plan and power programme for the Eighth Plan. The capacity addition of about 35,000 to 38,000 MW during the Eighth Plan would enable the country to meet, by and large, the electric power demands. There would, however, be shortages to meet the peaking demands as creation of additional generation and associated transmission facilities of the required extent has to be contained mainly due to constraints of financial resources.

In spite of the achievement made so far for power development, the country faces acute power shortage. This is on account of the fact that the developing countries often face the dilemma of having an electric power growth rate much higher than Gross Domestic Product, on one hand, and constraint in resources on the other. The problem gets further aggravated due to the fact that the investments
required to finance the power development programme keep on increasing considerably both on account of the growing size of the power programme and escalating capital intensity. It is in this context that the challenges that face the power industry need to be reviewed.

Desai (1987) outlines some of the forces that shaped the growth of power system in India and assessed the efficiency of the system. The author has examined the demand for power which has increased rapidly in agricultural and industrial sector after independence. The resources of electricity are also discussed. Electricity is mainly generated from hydro and thermal resources in India. The development of hydro electricity is slow due to long construction period and political problems, with the result 60 per cent power is generated from coal. The author has also discussed investment and finance in power sector.

Chand (1988) describes in his paper that the country has made rapid and significant progress in power sector since independence. The installed power capacity and generation has been increasing with the increase in demand and consumption of power. The demand of power has outstripped the supply of power as its consumption has increased enormously in various sectors of the economy. Electric power is the main input for economic development its consumption is increasing with the advancement of the country. The
author suggests that the power generation should increase to bridge the gap between demand and supply.

Rajgopal (1988) examines power scenario in India. The installed generating capacity which was only 2300 MW in 1950 increased to 58,000 MW in 1989. There has been an increase in the power generation from 5 billion units in 1950 to 221 billion units during 1988-89. The per capita power consumption has increased from 0.5 units to 200 units in the country.

The planning and the operation of the power sector is a very complicated subject which needs long-term planning, co-operation between Centre and State governments, between Central Electricity Authority, Central Sector power generation companies and State Electricity Boards and the management of various inter-related functions like generation, transmission distribution as well as conflicting political and social requirements of a large country like India. This is one sector which fulfills the basic need for various development activities of the country, viz. agriculture, industrial, commercial, rural as well as urban.

Survey (1988) examined the development policies and problems of the Indian power plant sector. The author finds that electricity supply is highly capital intensive. The State Electricity Boards own the major part, around 81 per
cent of electricity supply. Remaining 5-6 per cent is owned and operated by National Thermal Power Corporation. 5-6 per cent is owned jointly by State Electricity Boards and Central Government. Also another 2-3 per cent is controlled by the Department of Atomic Energy. In this study main emphasis is being laid on Bhart Heavy Electrical Limited (BHEL) a public enterprise, manufacturing power equipments. The financial performance of BHEL and industrial material and components supplied to BHEL has also been examined. The author also throws light on production capacity and size of BHEL market which is continuously increasing. The main challenge for the future is to achieve higher productivity of the capital employed in this sector by strengthening indigenous technological capabilities in all aspects of power engineering.

Bhasin (1989) focusses on the development of power sector in India since independence and its contribution in socio-economic development of the country. He has focussed on various issues relating to the power sector, measures which should be adopted to achieve the targetted growth rates and emerging power scenario at the end of nineties. The issues involved and adoption of suitable measures are important for power development of long-term basis.

Narayan (1989) highlights power problems and some of the prospects of power development in the Indian context.
Power was given significant importance in the plan programme and progress of power has been impressive during the plan period. But hydro-thermal mix has been going down in every successive plan.

The study suggests long-term strategy for proper power development in the country including acceleration of hydro development by focussing attention on removing various inadequacies in the areas of organisation, management and funding, adoption of coal benefication through sophisticated techniques which would ensure better quality of coal to the power plants, taking up of larger programme of transmission and distribution to remove the present inadequacies, strengthening of the regional grids and bringing about an improvement in the power system operation to reduce the transmission and distribution losses.

Renovation and modernisation of hydro and thermal plants are stressed for increasing generation, keeping in view the highly capital intensive nature of power supply industry, it is difficult to find adequate financial resources for implementation of additional generation capacity.

Natraj (1989) focusses on hydel and thermal power development in the country. He also throws light on power
shortages which have been increasing. He has suggested
short-term and medium term measures for increase in power
availability. These measures would reduce power shortage in
the country and improve the quality of electricity with
some degree of reliability.

Rajgopal (1989a) outlines the thrust areas in the
Eighth Plan in which the author explains the significance of
power and tremendous potentiality for growth in the country. Power has
always been given priority in the planning process as it is clear
from the plan outlays. The recent discovery of gas and the
construction of gas based projects will facilitate in
bridging the gap in case of short supply from hydro and
coal based projects. The Eighth Five year plan emphasises
on generation planning, load management, institutional
arrangements, captive power generation, reduction in
transmission and distribution losses, energy conservation,
research and development, financial health of State
Electricity Boards etc.

Rajgopal (1989b) throws some light on the
achievements of power sector in the country. The power
generation has increased tremendously since independence, as
enormous resources have been earmarked for power development
in India. But inspite of tremendous increase in power
generation capacity the supply falls short of demand. The
author has also focussed on the projections of power availability during the Eighth and Ninth Five Year Plans. With the projected power supply and demand scenario, the power sector will be unable to cope with the increasing needs of consumers even if capacity targets are fully achieved. For rapid power development on the most optimal path, every possible resource should be utilised fully.

Suri (1989) highlights on the uniform tariff policy for central power generating agencies viz. National Thermal Power Corporation and National Hydro Power Corporation. These central power generating agencies sell power to various State Electricity Boards at different rates. The rates vary from region to region, which creates problems in maintaining common accounts all over the country. The author suggests that National Thermal Power Corporation and National Hydro Power Corporation should have uniform tariff at their power stations. For uniform tariff policy, the proposed National Grid Authority should be entrusted with the responsibility of framing the commercial policies for the sale of power.

Krishna (1990) highlights the power development programme during the Eighth Five Year Plan period. Due to short supply of power on account of inefficient management of power stations, the private sector has been asked to participate in the generation of power and balanced power
development in the country. The author has suggested that there should be quick implementation of awaited and new power projects to increase the power supply in the country. This will facilitate availability of power at every stage for consumption purposes in different parts of the country.

Laxmi (1990) has highlighted power failure in many states of the country and its effect on social welfare. Financial resources have been diverted from other developmental areas in the hope that power will speed up progress, but this substantial investment was considered inadequate for balanced power development of the country due to lack of planning. The author has suggested various measures to manage the demand for power in the country. There should be an improvement in the performance of the thermal power stations to increase the availability of power. There should also be an effective control of peak loads management which is very important from demand side management.

Naidu (1990) focusses on potential areas for improvement in productivity and efficiency of power sector. The main problem of power sector has been the gap between demand and supply. According to the author, optimum utilization of existing available capacity is the most effective course of improving power supply position in the
Improvement in operation and maintenance of hydro plants and of thermal plants would reduce the power shortage. The existing capacity can be fully utilised, by taking positive steps in renovation and modernisation of thermal plants, reduction in transmission and distribution losses, optimum load management and reduction in auxiliary consumption. There should also be proper hydro-thermal mix in power sector. Hydro thermal mix in India has been going down. At present it is as low as 29:71. A minimum of 40 per cent hydro is considered to be a desireable feature. Hydro plants play very distinct role in power system operations. A respectable share of hydro eliminates backing down of thermal plants and improves their efficiency.

Nigam (1983) highlights hydro power scenario in Uttar Pradesh. The total estimated hydro potential in Uttar Pradesh is 13000 MW, out of which 1200 MW has been commissioned so far. Thus a very low percentage of 9 per cent has been utilised so far.

In Uttar Pradesh percentage of hydro installation was about 52 per cent of the total capacity in 1968. There has been a decreasing tendency during 1966 to 1969 which remained constant upto 1978 at 36 per cent. The pace of hydro-electric development has slowed down after 1960. The most important reason is said to be the constraint of
financial resources which necessitated taking up of a large thermal power programme for deriving benefits earlier to meet the rapid demand for power.

For hydro power development in the state, the author suggests that having utilised only 9 per cent of the hydro potential in the state, it is necessary to accelerate hydro-power development by establishing an organisation entirely devoted to hydro-power and multi-purpose projects and having separate allocations for hydro-power. It is necessary to employ cheaper and expeditious methods of constructing dams and tunnels, large multi-purpose and hydro electric projects should be so planned that interim partial benefits are derived in an economical manner, mini hydro schemes on existing irrigation canals should be taken up to fill up gaps in long gestation projects.

Varma (1992) outlines the development of hydro power in India. The rate of growth of hydro power accelerated during post-independence period. At present the country has every conceivable type of hydro generation including run of river schemes, storage schemes, pumped storage plants besides hydro generation due to transbasin diversion of water: either by gravity or pumping with units capacity ranging 6 MW to 165 MW each. Though the need for speedy harnessing of balance of hydro potential is realised, resource crunch have
slowed down the pace of development considerably, leading to an imbalance in hydro-thermal mix thus disrupting the stable operation of the power system.

The present situation warrants speedy harnessing of balance of hydro potential after ensuring that the impact on environment as well as acquisition of forest lands are kept minimum by adopting suitable measures. Since reasource crunch is also one of the factors which has slowed down the pace of hydroelectric power development, it is hoped that the present policy of the Government of India to allow the participation of private sector in executing the power projects will ease the position to some extent.

Sarkar (1984) explains the efficiency of thermal power stations which depends on the adequate quantity and good quality of coal supplied to the power stations. The quantity, quality and transportation of coal pose different problems for maintaining thermal power generation. It has been observed in a number of cases that the quantity of coal supplied to power stations is short of consumption which results in low coal stocks. The shortage in coal supplies to power stations is due to underloading of the wagons at collieries.
It has been found that the quality of coal supplied to power stations is of low grade which creates problems for boilers and leads to rapid erosion of super heater tubes, economiser tubes and I.D. fans. Coal wagons also carry oversized coal stones and extraneous materials like parts of shovels, iron scrap which damage crushers.

Recommendations for regular quantity and improved quality of coal supplied to thermal power stations are given in this paper.

Chakravarti (1987) throws light on the Government's policy to install super thermal power stations at coal pitheads on an integrated basis under the central sector. It was considered convenient and economical to evacuate power from super thermal power stations to the respective power stations far away from the load centres. The National Thermal Power Corporation is given the charge of many super thermal power projects in different parts of the country. The author lays stress on new technologies and style of management for adequate power generation.

Kumar (1987) throws light on social and economic scenario of thermal plants. According to the author demand for power has been increasing in urban as well as rural areas, yet the power availability from already installed capacity is very poor. Some critics think that
this is because most of the power generation is with State Electricity Boards who treats performance as of secondary importance as they function under the bureaucratic system of management, others contribute it to inefficient, unskilled, untrained manpower in power stations. Technology oriented persons suggest the use of washed coal, change in coal combustion system and proper stocking of spares. The author finds that high ash content in coal is responsible for increased pollution and heavy erosion in super heaters and economiser tubes in thermal stations. To increase the load at power plants, demand for the washing of coal before despatch to power stations is favoured.

Singh (1989) investigates whether the Indian thermal power industry is able to realise the economies of scale which are theoretically present across the bigger generating sets. With the help of existing data and some plausible assumptions, the paper gives the impression that the industry can do so. The empirical evidence also reveals that the Indian thermal power industry is capable of taking advantage of the scale-economies prevalent across the bigger sets. Because of this, the industry shall be encouraged to construct bigger sets.
Sharma (1991) throws light on coal resources in India. Coal is the main input in thermal power generating plants. Coal resources have a wide range of potential use in all forms of its availability. It is an important resource of power generation and could be an important substitute for scarce and fast depleting oil and atomic minerals. So, coal has to bear the main burden of power needs of the country particularly in the present day context of shortage of oil, atomic minerals and lack of money to install hydrel projects. India has adequate reserves of coal and Government has taken steps to make it available for power generation. The power sector constitute the largest consumer of coal in India. The study suggests that the low rank Indian coal, both processed and unprocessed can be burnt efficiently with modern equipments in thermal plants to meet the growing demands of power.

Gupta (1992) examined the importance and future of thermal power in India. A major portion of total installed power capacity consists of thermal power mainly because of their low gestation period, flexibility of their site selection, ease of augmentation of existing facilities and lesser investment cost required as compared to hydro stations. Past trends in thermal generation in India shows quadruple increase in thermal capacity alone as
compared to hydel and others. The rapid increase in larger unit sizes from 15 MW in the forties to 500 MW at present has facilitated quicker capacity addition and increased thermal power generation. The cost of thermal power stations has been showing steady upward trend mainly due to the inflationary impact on material and labour, high cost of technology transfer and also due to the market strategy of the suppliers.

Thermal power generation would continue to play an important role in the Indian power sector due to the large coal reserves available in India and low gestation period of installation. But there is need to improve and develop the technologies which could save, reduce specific investment cost and minimise environmental damage.

Sethna (1980) discussed India's atomic power programme. India is among the eight countries of the world, and only developing country, to have the complete fuel cycle, right from uranium exploration, mining, extraction and conversion, through fuel fabrication heavy-water production and reactors, to reprocessing and waste management. India has also reached a stage where its indigenously developed know-how can support all the required activities encompassing feasibility studies, site selection, detailed project design, construction,
commissioning and operation of any plant in the entire fuel cycle chain.

The decade 1966-76 saw the introduction of nuclear power in India. The western, northern, and southern regions of the country were chosen for nuclear power plants because of their distance from coal fields, which are largely concentrated in the eastern and central parts of the country. India's first nuclear power station at Tarapur, near Bombay consisting of 400 MW capacity was commissioned in 1969. Nuclear power in India has not been demonstrated as an economically competitive and safe source of energy only but has also played the invaluable role of a catalyst for the scientific, technical and industrial development of the country as a whole.

Ramanna (1984) examined Indian experiences in nuclear power. The study highlights the progress and status of Tarapur Atomic Power Station, Rajasthan Atomic Power Station, Madras Atomic Power Station and Narora Power Station. Since, the setting up of the Atomic Energy establishment in the mid 1950's, one of the primary objectives has been to achieve self-sufficiency in the technology of harnessing the power of the atom to meet the country's growing power requirements. The demand for electric power has been growing exponentially over the
years and the projections indicate that India will have to nearly treble its present electric power generating capacity by the turn of the century. The magnitude of this demands that all proven and available technologies be fully exploited. Paucity of natural non-renewable resources like oil or high-grade coal and restrictions on the availability of hydro potential lead to the conclusion that these resources cannot meet the projected demand for electric power.

Other exotic technologies like solar, wind, tidal etc. are appropriate only for localised applications requiring small quantities of electric power, but they cannot cater to bulk electricity generation. They are feasible either technically or economically. In India, all the inputs for operation of nuclear power plants like heavy water, fuel, high quality fabrication and testing, fuel, reprocessing and waste management are available. The self-sufficiency attained in the field of nuclear power now enables this source of electric power to contribute significantly in meeting the power requirements during the years to come.

Ramanna (1987) emphasises in his paper that nuclear power is the safest and most economic form of producing electric power. It requires very small built-in
land areas even when the stations are capable of producing large quantities of power. In this way, they upset the environment the least when compared to hydro and thermal power. Nuclear power has an important role as a source of generating electricity in addition to coal and hydro sources. But, nuclear power requires adequate quantities of uranium. It is therefore, necessary to increase the activity to determine uranium in large deposits in places other than have been found hitherto, preferably of richer quality.

After the Chernobyl accident, our newspapers have taken the accident in proper perspective i.e. to consider as a part of the learning process of the world. Future reactors will surely operate more safely under any circumstances as time goes on. Inspite of one or two accidents that have occurred in recent times in developed countries. Nobody in advanced countries have even suggested that their power programme based on nuclear energy should be reduced. This is because they realise that nuclear power is the only source of power available in the future. India must not miss this new industrial revolution.

Srinivasan (1987) throws some light on nuclear power in India. The year 1987 marked coming of age of the country's atomic power programme. Since the passing
of Atomic Energy Act and the setting up of the Atomic Energy Commission during 1948, the objective of nuclear power programme has been to harness the power of the atom for generating electricity. The success achieved in the developmental phase of this programme culminated in the formation of the Nuclear power corporation of India Ltd. (NPCIL) during 1987, which marked the commencement of "industrialisation" of nuclear power in India. Much thought has been given in recent years to the expansion of country's nuclear power programme. As nuclear power projects are capital intensive, the importance of adhering to schedules cannot be over-emphasized, and the formation of NPCIL is expected to go a long way in ensuring this objective. In addition to the use of modern techniques of construction, the functions of planning and monitoring of nuclear power projects are also being strengthened up.

The Indian nuclear power programme is now entering a commercial power phase wherein the experience gathered to date will be utilised on an industrial scale to step up the nuclear power programme in a significant manner. To a country like India that has the constraints of limited fossil resources and a large population, such a programme can definitely yield significant benefits during the coming decades.
Lal (1979) throws some light on the financial objectives of the State Electricity Board, spelt out in the Electricity (Supply) Act, 1948, which guides the process of power development in the country since independence. The author highlights some special features of electric power supply industry—electric power cannot be stored, flow of electricity and therefore, generation of electricity has to remain uninterrupted continuously all through the year, it is a monopoly business and electric power supply industry is highly capital intensive in nature. The nature of the industry being highly capital intensive has an impact on the financial working of the State Electricity Boards. There are various sources of revenue and expenditure of the State Electricity Boards. Revenue receipts include sale of power, other miscellaneous receipts and any subsidy given by the State Government, capital receipts flow from loans taken from State Government, LIC, Rural Electrification Corporation and market borrowings. Fuel costs, operation and maintenance charges, cost of purchasing power from neighbouring systems and establishment charges are four major revenue experiences. Financial uncertainty in the Boards is due to long term debts which require time consuming negotiation and paper work and involve
interaction with several agencies. This results in delays and uncertainties.

Gujral (1980) outlines the capital structure of State Electricity Boards - how it is built, extent of over-capitalization, sources and pattern of financing. The important changes introduced in the financial structure of the Boards by the Electricity (Supply) Amendment Act, 1978, viz. equity participation by States and transfer of the Board's reserves to the State Government in the form of interest payment have been described in detail. Focus has been set on the controversy whether or not the State Government should convert its loans to the Board into equity capital and the relevance of the concept of debt-equity ratio in the Board. Conversion of loans into equity capital by the State Government has been found necessary for facilitating market borrowings by State Electricity Boards. In the end, the effect of these changes on the liquidity position of the Board, the task of its top management, its borrowing powers, Government resources etc. have been highlighted.

Upadhya (1982) examined the working of power supply undertaking i.e. State Electricity Boards in India. Though the State Electricity Boards were entrusted
by Electricity (Supply) Act of 1948, with the responsibilities of promoting the coordinated development of power generation, transmission and distribution of electric power in their own States in the most efficient and economical manner, still their structural, organisational, procedural, financial and technical aspects are in a sorry state. The power industry needs a thorough and deep study of the causes of failure and breakdowns of plants. Research and development activities should be accelerated in collaboration with I.I.T.s, CSIR laboratories and other public and private sector undertakings like BHEL, Tatas etc.

For proper power supply in the country, modern management system should be implemented in the State Electricity Boards, Maintenance should be improved, there should be a provision of adequate training facilities, State Electricity Boards should be made completely autonomous, importance should be given to the quality of the imported equipments and inter and intra-regional links should be optimally used to maximise generation.

Rao (1984) highlights the major deficiencies in materials management of State Electricity Boards. These deficiencies can be traced to extensive growth in organisation, without corresponding changes in purchase policies and techniques to keep pace with this growth in
size and complexity and technological advances. The long administrative lead time and inordinate delays in decision making in purchasing, requiring extensions of validity of tenders, with consequent escalations in costs and increased inventories and multiplicity of purchasing authorities are the most serious deficiencies. Absence of cost-benefit consciousness and of materials planning are also serious. Budgetary control and management information system are conspicuous by their absence or total inadequacy.

State Electricity Boards have been in the limelight for their poor physical and financial performance over the last several years. In view of the constraints on the upward revision of the power tariff to a level that would give the Board adequate resources, the only remedy is to generate savings, which is possible only in the area of materials management in the present context. In view of massive investments expected in the power sector in the next two decades, the State Electricity Boards have to brace themselves up to deal with large purchase in the material-intensive industry. The registration of suppliers and limited tendering would reduce administrative lead time. Standardisation of equipment and development of suppliers would increase competition. Purchase research would contribute to
all round reduction in materials cost, identifying cheaper materials, conducting special studies for cost reduction etc.

Arokiaswamy (1985) throws light on economic viability of electricity boards while fulfilling social obligations. The Electricity (Supply) Act imposes on the Electricity Boards, the social obligations of taking up the uneconomic operations of electrification of rural and tribal areas. At the same time it requires them to ensure not only an adequate, reliable and good quality power supply, but also operate the Board in the most efficient and economic manner. But most Electricity Boards are functioning as huge liabilities for the respective states. The precious plan funds meant to create new assets are being diverted to make up operating losses. Some of the Boards have no money to buy materials and complete the on-going projects or to connect up new services or to maintain a reasonably good quality power supply without power cut and load sheddings for existing consumers. They have accumulated huge outstanding dues to BHEL, NTPC, NLC and CIL etc.

Enabling the power Boards operation economically viable while fulfilling several social obligation is not impossible, provided the State Governments muster a strong
political will, not only to avoid interference but also initiate several measures as hiking up of tariffs, reducing excessive subsidies and plugging revenue leakages by theft and pilferages. The Government of India has also to introduce several legislative measures and Central Electricity Authority must also actively assist the Boards to implement the necessary measures.

Verma (1986) highlighted the capital structure of State Electricity Boards. The capital structure of the State Electricity Boards is debt ridden as it is comprised mainly of fixed interest bearing capital. The State Electricity Boards have no capital of their own other than loans. There is no equity and preference share capital in the capital structure of the State Electricity Boards. All the SEBs have raised their capital only by way of long term debts and internal sources. The capital structure reveals that the State Electricity Boards have financed to the extent of 82 per cent by way of loans and about 18 per cent from internal sources. Out of long term debts, the share of Government loans was about 70 per cent as compared to remaining 30 per cent from non-budgetary sources.

There are permissive provisions as per the amended Electricity Supply Act, 1978 for the issue of share
capital upto rupees ten crores. Conversion of the part of the loan into share capital is also permissible. But these provisions of the Act are not acted upon by the State Governments with the result, all the State Electricity Boards continue to bank upon borrowed capital exclusively. To improve the financial position of the State Electricity Boards, it is suggested that the capital of the State Electricity Boards should be restructured by converting a part of the loan capital into equity capital. Conversion of loan into equity capital will not only reduce the interest burden, but also relieve the Boards in the matter of repayment of loans to creditors, other than the State Government. This will improve the financial performance, thereby enabling them to raise enough internal resources to finance their expansion programme. The availability funds to State Electricity Boards from non-budgetary sources must be increased by making it easier for them to obtain loans from Life Insurance Corporation, other financial institutions and raising the equity capital. The State Electricity Boards should step up internal resources by reducing the cost of power generation, overheads and transmission and distribution losses.
Arokiaswamy (1988) has done a case study of the financial performance of Tamil Nadu State Electricity Board. The study shows that the Tamil Nadu State Electricity Board incurred huge losses during 1984-85. Actually only a few State Electricity Boards are making profits, whereas most are incurring heavy operating losses. Profitable functioning of a State Electricity Board can be attained either by increasing revenues or by reducing expenses. But it requires a strong political will on the part of the State Government to permit the State Electricity Board to accomplish the above, because, the political system has used several State Electricity Boards including Tamil Nadu State Electricity Board to gain popularity by stretching too far subsidies to several consumers including undeserving ones. There is a need to augment revenues of State Electricity Boards from agricultural sector, domestic sector, industrial and commercial sector to reduce the losses incurred by them. By creating more internal resources, the State Electricity Boards would be in a position to generate more to meet the power needs of the country.

Kochar (1978) highlights importance of rural electrification for agricultural sector. Water is the primary need of agriculture. The irrigation facilities can be created through major surface irrigation projects
and minor irrigation. The scope of surface irrigation is limited but there is substantial potential of underground water which still remains to be exploited. The most economical method of pumping out underground water is with the help of electric power pumpsets. During the past few years, energisation of a large number of pumpsets through rural electrification has given a great boost to increased agricultural production in the country. Thus rural electrification in India has made energisation of pumpsets possible resulting in increased agricultural production.

The rural electrification programme was given considerable importance during the Fourth Plan and the subsequent period. In order to accelerate rural electrification programme in the country, the Government of India established Rural Electrification Corporation in 1969. The Rural Electrification Corporation has been functioning as a developmental financing organisation. Low load density, long distribution lines, poor load factor and poor power factor are some problems which make rural electrification a bad financial proposition. To avoid these problems, the construction, operation and maintenance standards should be improved.
Dua (1987) focuses on updating technology in rural electrification and mechanised construction techniques to improve quality of power supply. The programme of rural electrification has been accorded high priority because electric power is seen as the most vital instrument for economic development which increased agriculture and industrial production. More than 70 per cent villages have been electrified, resulting in large number of energisation of electric pumpsets for irrigation. Rapid increase in irrigation facilities has resulted in manifold increase in agricultural production. The country has achieved self sufficiency in foodgrains inspite of rapid growth in population.

Rural electrification requires costly infrastructure. Rapid expansion of the distribution network in the country has not been accompanied by proper strengthening of the system which has led to serious deficiencies. While some of the system deficiencies may be attributed to financial constraint, many of the existing problems can be solved by adopting appropriate technologies. This paper attempts to bring out some of the new technologies which can help to solve the existing problems and will make the system inherently more efficient and reliable.