Power is the most important ingredient and the basic infrastructure needed for economic development of a country. 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 national economy. Power is the most preferred form of energy due to its versatility and convenience both in its use as well as its generation, that is why its demand and supply both have been increasing much faster, compared to other forms of energy.

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.

The study has been divided into eight chapters. A summary of each chapter is chronologically given in the paragraphs that follows.
Power Industry in India has developed into one of the most important basic industries of our economy. Before independence there were very few and small power stations in India which were owned and operated by private as well as public establishments. In 1938 the National Planning Committee of the Congress made a number of recommendations for the growth of electric power generation and consumption. These recommendations remained the guiding force behind the power policy after independence in India. The constituent (legislative) Assembly passed the Electricity (Supply) Act on 10th Sept. 1948 to provide for rationalisation of production and supply of electricity.

Since the short term solutions to mitigate the immediate power shortage have been getting priority over long-term solutions, consequently thermal projects having substantially shorter gestation periods have been getting pushed up for early gains, leading to the deferring of benefits from hydro schemes and power development have moved along sub-optimal course. The delays in environment and forest clearance are also responsible for slow growth of hydro power in India. Hydro power has also been delayed due to differences and disputes between States on sharing of water resources. Besides this, uncertainties
in constructing civil works in difficult geological terrains and several administrative and managerial problems associated with specific hydro projects have also been contributing to the slow pace of hydro power development in the country.

Though thermal power has a maximum share in the total power generation in India as it constitutes over 67 per cent of total installed capacity and contributes over 69.8 per cent of total power generation, but its performance has not been up to the mark due to various reasons such as low plant load factor in thermal station, high percentage of unforeseen outages, inferior quality of coal, unavailability of spare parts, short supply of coal, poor maintenance, outdated design of equipments etc. Plant load factor, which provides an indication of performance of thermal plants is not satisfactory in Indian thermal power stations. Plant load factor has been low due to ageing of some of the thermal plants, higher incidence of outages, poor quality and inadequate supply of coal, nonavailability of spares in stock, inadequate maintenance, inadequate training of staff, defective supply of equipments etc. Some of the State Electricity Boards are operating at plant load factor as low as 30 per cent. It has also been observed that number of outages have been
increasing in thermal plants. Due to excessive outages full generating capacity is not utilized in thermal power plants.

India is producing only 2 per cent of electric power from nuclear sources, but radiation hazards and safety aspects associated with nuclear power plants create problems in installing a new nuclear power plant. Safety of reactors is one of the main factors restricting the expansion of nuclear power.

The structure of power industry in India has emerged over a period of nearly hundred years. At the beginning of the twentieth century a few private companies were operating small power stations mainly catering to urban loads. In 1910 the Indian Electricity Act was passed to govern the grant of licenses for electricity generation and distribution. This Act of 1910 was more concerned with the regulatory and safety aspects of electricity than with organisational structure of the industry itself. The organisational structure of power industry has emerged only after the Electricity (supply) Act, 1948 was passed. After Independence the Constitution of India put electricity in the concurrent list and it became possible for both the Union Government and
State Governments to legislate on the subject. The Electricity Act of 1948 laid down that a sound, adequate and uniform national policy should be developed coordinating the activities of planning agencies in relation to control and utilization of national power resources. It was in accordance with this Act that autonomous Electricity Boards were set up in all the eighteen states except in some north-east areas and the Union territories. These boards were entrusted with the responsibilities of promoting the coordinated development of generation, transmission and distribution of electricity within the state in the most efficient and economical manner. State Electricity Boards play a major role in our country's power policy. The power supply industry is presently owned and operated by and large by the State Electricity Boards. The Electricity (supply) Act, 1948 also envisaged creation of Central Electricity Authority under the Central Government with the responsibility to develop a sound, adequate and uniform national power policy and coordinate the activities of the various planning agencies.

In 1976 the Electricity (Supply) Act, 1948 was amended to provide for establishment of generation companies under the authority of central Government. The
national company namely National Thermal Power Corporation (NTPC) and National Hydro Power Corporation (NHPC). The NTPC was given the authority to establish regional thermal power stations and made responsible for bulk transmission from these units to the state power system. The NHPC was established to set up major hydro electric projects on regional and national considerations. The Department of power was created in 1974 by the Ministry of Energy. The Department of power is responsible to parliament for laying down national policy planning for the development and regulation of the power resources in India.

In spite of heavy investment made by the Government and sizeable expansion taken in electrification of villages, most of the villages experience power cut or irregular supply of power specially during the peak period. Regular supply of power is essential for overall economic development of rural areas. It has also been observed that rural electrification has mainly benefitted large and medium farmers while small farmers are not getting full benefit of it due to inadequate credit facilities.

Many structural changes have taken place in the power sector in India since the beginning of this century. After independence the Government of India and State
governments have established a number of corporations and boards to develop power industry efficiently. But we have observed that these corporations and boards have failed to achieve the desired objectives. It may be due to large bureaucratization and red tapeism. Another significant point that we have observed is the lack of co-ordination between these bodies.

It has been observed in the study that the gap between demand and supply of power has been increasing at a faster rate. In the context of the present power shortage and resource crunch for implementation of new power projects, various measures to manage the supply and demand may help in bridging the existing gap.

The first measure to improve the supply is to get better output from the existing facilities. To increase the supply in a situation of resource constraints optimal output from existing installed capacity is needed. To achieve these, the power generating units which were installed more than a decade back and were based on the outdated technology prevalent at that time, may be made to give better output by utilising the advanced technology available in the field through modification and renovation of the equipments.
The demand management consists of shifting system load from peak hours to the off peak and thereby improving to power system load factor.

It has been observed in the study that transmission and distribution loss is high in the sector in India. The growth of transmission and distribution system could not keep pace with the growth in generation capacity may be due to low level of investment in transmission and distribution during the five year plans. This has resulted in several imbalances in the system performance. Therefore, it is proposed that due priority may be given in making adequate investments in transmission and distribution works with a view to reduce the imbalances.

Analysis of hydro power development depicts that hydro power development was given high priority during the first three five year plans. It registered substantial increase during these plans. The decline in the contribution of hydro power to the overall capacity addition commenced in the Fourth Five Year Plan, reached a value of 28 per cent at the end of the Seventh Plan. An optimal hydro thermal mix for improved economies of system operation indicates a ratio of 40:60 for the Indian
system. Therefore, it is suggested that necessary measures should be taken to improve the hydro-thermal mix during the course of planning.

It has observed in the study that 66226 MW of potential available for hydro power development still remains unharnessed despite inherent advantages of hydro electric power plants over thermal and nuclear plants. Bulk of the undeveloped potential lies in the northern region. Therefore, it is suggested that unharnessed hydro projects should be developed in those areas which are away from coal resources like Northern Region. The share of hydro power is also declining as environmental and forest clearances are given after a lapse of considerable time which has resulted in substantial time and cost over-runs. To reduce time and cost over-run due to delayed environment and forest clearance procedures, procedural bottlenecks must be identified and clearance process must be streamlined.

Accelerated hydro power development would be the corner stone of improvement in productivity of power sector in the long-run. It has been observed from the study that performance of thermal plants in the country is not satisfactory as plant load factor is not upto the mark. The plant load factor of thermal power plants can
be improved by reducing the periods for planned shut-down of the unit for thorough maintenance work through proper organisation and coordination. Further improvement in the performance of the thermal power stations may also take place by maintaining high efficiency of operation and high degree of availability of the units. For increasing efficiency of operation of units it may be necessary that the units operate at or near the designed maximum output. Adequate maintenance and operational standards may also be of great importance for obtaining best efficiency.

To improve the performance of thermal plants, the availability of the plants should be increased. Improvement in the design of boilers, modifications in basic design and material of the equipments may improve the availability of the plant. The availability factor would also increase if forced outages may be brought down to the minimum by following proper maintenance practices. It has also been noticed that some of the thermal units would complete their expected life by 1994-95, while many units of 60 MW have completed their lives; and majority of the 100 to 150 MW units have been in service for more than 15 years. So they require major overhauling. As the units go on ageing, their performance declines. Therefore, thermal power plants need major renovation and modernisation schemes. It is also suggested that whenever
the plants under go renovation, efforts should be made to introduce modern sub-systems which were not available earlier at the time of installation of the units, to improve their performance.

It has also been observed that inferior grades of coal are being supplied to the thermal power plants creating serious problems to boilers, which were basically designed to use different and superior grade of coal. The supply of coal to power stations should be in requisite quantity and also of good calorific value according to the boiler design so that the cost of power generation may not increase further.

Air pollution is one of the grey areas with coal based power generation. The main air pollutants generated are particulate matters, sulphur dioxide, oxides of carbon and nitrogen. The improved design of electrostatic precipitators may result in controlling fly ash emission to very low level. Besides various new technologies available may also help in controlling environmental pollution of thermal plants. In view of the abundant availability of nuclear fuels in the country, it would be worthwhile to lay stress on the installation of nuclear power stations in future, specially in the areas which are far away from coal belts so as to cut down on
transportation cost of coal and ease congestion on railways. However, appropriate safety measures in regard to setting up of nuclear power stations may have to be strictly followed.

It has been observed in the study that supply of power is not regular in rural areas due to lack of close integration in many states between the planning of rural electrification and the rest of the distribution network. Therefore, transmission and distribution planning should comprise the rural electrification system also, and power cut should be brought to minimum to enhance the agricultural productivity. It has also been observed that rural electrification has been uneven among the states and Union territories. For the balanced development of the rural areas backward and undeveloped states and Union territories should also be electrified.

It has also been observed that State Electricity Boards are mainly responsible for generation, transmission and distribution of power in the country, yet their performance is very dismal. They are criticized for their inability to operate power generating and distribution systems efficiently. The causes of inefficiencies in SEBs may be because the Boards have not yet adopted the
modern management system. The same old bureaucratic style of functioning still prevails in the State Electricity Boards. Therefore, it is suggested that modern management system should be introduced in SEBs. Maintenance should be improved through skilled personnel and importance should be given to proper training facilities. It is also suggested that for the healthy growth of the power sector and to formulate agreed policies and programmes, there should be close and constant interaction and better coordination among different organisations of power industry.