HYDRO POWER IN INDIA

Hydro power is a very significant, primary and conventional energy source for generating electricity. Hydro power plants utilize a natural resource which is renewable and have a relatively long life.

Hydro power "accounts for 23 per cent of total power production in the world. (Landsberg) It can be obtained easily as it comes in mechanical form which does not need conversion. It is one of the earliest means of providing electricity. The use of waterwheels in ancient times to produce energy for various purposes is well known.

In this chapter an attempt has been made to study hydro power potential in India, electricity generation by hydro power plants, their performance, present status of these plants, their problems, and strategies.

3.1 PRODUCTION PROCESS

In hydro power plants electricity is generated through water. Water is collected in reservoir and a steady stream is regulated through a specially built dam.
This water is brought by pipes to a lower level, where it flows through turbines. This rotation in the turbine provides mechanical energy which is converted into electrical energy in the generators.

3.2 WORLD'S HYDRO POWER POTENTIAL

There is immense potential of energy produced from hydro power. "The estimated maximum world wide production of water power is equivalent of about 3 million megawatts of installed electrical capacity equivalent to 3000 large nuclear power plants of which a little over 10 per cent has already been developed." (Landsberg).

The estimated probable potential which is technically and economically useable has been assessed as 10,000 Twh (Tera watt hours = $10^{12}$ units). About 48 per cent of this total belongs to the developing countries. In the year 1979 the total electricity generation was 7,400 Twh of which 1570 Twh was produced by hydro-power stations, 610 Twh by nuclear power stations, 5,210 Twh by conventional thermal stations and 10 Twh by geo-thermal stations.

'Developing countries have a large potential of hydro power, but only 10 per cent of hydro power potential has been developed. These countries have made rapid
progress since 1973 after the rise in oil prices. Despite the renewed interest shown, development of hydro power is uneven. While Latin America produces a large amount, Africa's production is around two per cent, most of it is coming from big hydro projects like Kariba in East Africa, Aswan in Egypt and Aknsombo in Ghana. China has large size hydro power stations on the one hand and at the other extreme it has a number of micro hydro power stations. The developing nations are exploiting only a minimum of their total potential.' (Energy options and policy Issues in developing countries, 1979).

3.3 HYDRO POWER IN INDIA

The river systems in India provide plenty of scope for large scale water management as they descend from their sources in mountains and hills and flow along the plains towards the sea.

3.3.1 PHYSIOGRAPHY AND RIVER SYSTEMS

India is endowed with towering mountain ranges, rolling hills, lofty plateaus and extensive plains criss-crossed by rivers affording scope for hydro generation. India can be classified into seven well defined regions physiographically:

(i) The Northern Mountains comprising the mighty Himalayan Ranges.
(ii) The Great Plains, traversed by the Indus and Ganga Brahmaputra river systems. As much as one third of this lies in the arid zone of western Rajasthan. The remaining areas is mostly fertile plains.

(iii) The Central Highlands, consisting of a wide belt of hills running west east starting from Aravalli Ranges in the west and terminating in a steep escarpment in the east.

(iv) The Peninsular Plateaus comprising of the Western Ghats, Eastern Ghats, north Deccan plateau, South Decean plateau and Eastern plateau.

(v) The East Coast, a belt of land about 100-120 Km wide, bordering the Bay of Bengal and lying to the east of the Eastern Ghat.

(vi) The West Coast, a narrow belt of land of about 10-25 Km wide, bordering the Arabian Sea and lying to the west of the Western Ghats.

(vii) The island comprising the coral islands of Lakshadeep in Arabian sea and the Andaman and Nicobar Islands of the Bay of Bengal.
3.3.2 RIVER BASINS

Rivers in India fall into four categories viz (a) Himalayan rivers (b) Deccan rivers (c) Coastal rivers and (d) Rivers of the inland drainage.

Himalayan rivers are generally snow fed and perennial besides getting copious supply during south west monsoons. The rivers in Deccan are mostly rain-fed especially during south-west monsoon carrying huge volume of water during rainy season and dwindling thereafter till the next monsoon. Many of these rivers are not perennial. The coastal streams, especially on the west coast receive copious rainfall, command huge inflows from limited catchment areas, loses great heights within short length affording scope for development of hydro power.

Depending on the size of the catchment area, river basins are categorised as major, medium and minor basins. Major river basins of India are.

1. Indus
2. (a) Ganga (b) Brahmaputra (c) Barak
3. Sabarmati
4. Mahi
5. Narmada
6. Tapi
Besides, there are 22 west flowing and 24 east flowing medium river basins which along with major rivers make bulk contribution to hydro power development.

3.4 PROGRESS OF HYDRO POWER PLANTS

The first hydro electric power plant of a tiny 200 KW was set up in tea estates of Darjeeling in 1897. This small hydro electric plant established at the turn of the 19th century, marked the beginning of hydro-electric Power development in India. An installation of 4 KW to provide electricity to Rolar gold fields was commissioned in 1902 at Sivasamudram utilising the falls of Cauvery River. The capacity of this plant was gradually increased to 42 MW by the early thirties. Tata Power Company took up the development on three sites viz, Khopoli (72 MW), Bhivpuri (72 MW) Bhira (132 MW) on Western Ghats during the early part of twentieth century.
Inspite of an early start the progress of hydro power was very slow and the total installed capacity was only 570 MW by the end of 1951. The period immediately following the second worldwar was characterised by several food shortage and a number of river valley projects oriented to food production were taken up. These projects were planned for multipurpose benefits and included hydro electric power generation as an important component. During the first three five year plans, five major multipurpose projects were set up. The most spectacular multi-purpose river valley project undertaken during this period was the Bhakra Nangal project in the North which was planned to irrigate land in Punjab, Haryana and Rajasthan and afford electricity generation with a total installed generating capacity of 1204 MW. Chambal Valley project was also set up in north, Hirakund and Damodar Valley in the East and Tungabhadra in the South. Besides these multipurpose projects, Several single purpose hydro electric projects like Rihand (in U.P. in the north), Kohna (in Maharashtra in the west), Balimela (in Orissa in the east), Uminan (in Meghalaya in the North-East) and Kundah (Tamil Nadu), Sharavati (Karnataka), Machkund and upper-Sileru (Andhra Pradesh) and Panniar Nerimangalam, Sabarigri (Kerala) all in south were also taken up for the development in the first three five year plan period. At
the end of the Third Plan, the total installed capacity reached up to 5900 MW. During the Fourth Plan three hydroelectric projects were commissioned namely, Salal of 345 MW in Jammu and Kashmir, Baira Siul in Himachal Pradesh of 180 MW and Lokta in Manipur of 105 MW. The need for central participation in hydroelectric development was felt during the Fourth Plan period. The National Hydro Electric Power Corporation and North Eastern Electric Power Corporation were set up during the Fifth Plan to enable greater central participation, particularly in regard to major projects in remote areas, but the emphasis shifted to thermal power projects. This shift in favour of thermal power has been continuous. Towards the end of the Sixth Five Year Plan the capacities in hydel stood at 11,384 MW and in thermal 16,424 MW. The hydro-thermal mix which was 40:60 during the Fifth Five Year Plan came down 33.7:66.3 at the end of the Sixth Plan. The share of hydro power decreased mainly due to long gestation period and environmental considerations.

A study in the planning commission of the hydel projects commissioned in the Sixth Plan has revealed that the average gestation period of hydel project has increased. With a view to ensuring timely implementation of such projects in future the Seventh Five Year plan emphasised on-
(a) better assessment of geological and environmental factors,
(b) strengthening of construction agencies in terms of equipment, organisation, technical know how and skilled manpower,
(c) development of optimal equipment, both qualitatively and quantitatively for various activities.
(d) arranging on lease basis large and costly machinery for construction agencies and regular flow of funds.

During the Seventh FYP 3827 MW of hydro installed capacity was added, but the share of hydro power declined to 20 per cent at the end of the Seventh Plan.

The Eight Five Year plan lays emphasis on new hydel projects, so that the share of hydel generation in the total installed generating capacity increases to a level of 40 per cent by the end of the Ninth Plan.

3.5 TOTAL HYDRO POTENTIAL IN INDIA

The Central Electricity Authority has made an extensive and systematic assessment of hydro potential of the country during 1978 to 80. The estimated annual energy potential is placed at 472.15 billion Kwh units which is equivalent to 84044 MW at 60 per cent load
factor, which is said to be 2.9 per cent of world's potential. Of this potential 49.67 billion Kwh units have already been developed and 26.96 billion Kwh units are under development. More than 80 per cent of hydro potential still remains unharnessed. The details of Central Electricity Authority's estimates of the hydro potential in the country's river systems are given in Table 3.1.

**TABLE - 3.1**

**HYDRO ELECTRIC POTENTIAL OF RIVER SYSTEMS**  
(Basin Wise Distribution)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of River No. system</th>
<th>No. of Basins studied</th>
<th>Firm Potential (MW)</th>
<th>Potential at 60% Load factor (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Great Indus</td>
<td>6</td>
<td>11992.8</td>
<td>19988.0</td>
</tr>
<tr>
<td>2.</td>
<td>Great Brahmaputra</td>
<td>9</td>
<td>20951.9</td>
<td>34919.8</td>
</tr>
<tr>
<td>3.</td>
<td>Ganga</td>
<td>10</td>
<td>6428.8</td>
<td>10714.8</td>
</tr>
<tr>
<td>4.</td>
<td>West flowing River of s. India</td>
<td>7</td>
<td>3689.0</td>
<td>6149.0</td>
</tr>
<tr>
<td>5.</td>
<td>East flowing of S. India</td>
<td>9</td>
<td>5719.0</td>
<td>9531.7</td>
</tr>
<tr>
<td>6.</td>
<td>Central India</td>
<td>8</td>
<td>1644.2</td>
<td>2740.3</td>
</tr>
</tbody>
</table>

**Total**  
49  
50426.1  
84043.6

**Source:** Central Electricity Authority's Estimates of Hydro Potential in India.
## Hydro Electric Potential of River Systems

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of Basin Studied</th>
<th>Firm Energy Potential (GWH)</th>
<th>Potential at 60 x LF (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central India</td>
<td>8</td>
<td>53</td>
<td>2740</td>
</tr>
<tr>
<td>East Flowing Rivers of S. India</td>
<td>9</td>
<td>35</td>
<td>9532</td>
</tr>
<tr>
<td>West Flowing Rivers of S. India</td>
<td>7</td>
<td>81</td>
<td>6149</td>
</tr>
<tr>
<td>Ganga</td>
<td>10</td>
<td>248</td>
<td>10714</td>
</tr>
<tr>
<td>Great Brahmaputra</td>
<td>9</td>
<td>148</td>
<td>39419</td>
</tr>
<tr>
<td>Great Indus</td>
<td>6</td>
<td>19988</td>
<td>49988</td>
</tr>
</tbody>
</table>

Fig. 3.1
The number of river basins, firm energy potential in Gwh and potential at 60 per cent load factor in (MW) of our country's river systems are pictorially depicted in figure 3.1.

The present status of development of hydro power in the country on the regional basis is given in Table 3.2. Table 3.2 shows progress achieved during different periods since 1947, capacity wise, and potential available for further development. It is clear from the table that bulk of hydro potential is yet to be harnessed in different areas of the country.

The table also shows that 78 per cent of hydro potential still remains undeveloped despite inherent advantages of hydro electric power plants over thermal and nuclear plants. Bulk of the undeveloped potential lies in the northern region in the Himalayan range and in the associated foot hills of the Indus, the Ganga and Brahmaputra basins. The sizeable untapped potential is also available in the peninsular river basins-Narmada, Mahanadi and Godavari basins.

The potential in MW available for future development in the country are shown in Fig. 3.2.
### TABLE - 3.2

REGION-WISE STATUS OF HYDRO ELECTRIC POTENTIAL DEVELOPMENT

<table>
<thead>
<tr>
<th></th>
<th>North</th>
<th>West</th>
<th>South</th>
<th>East</th>
<th>North</th>
<th>All India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Potential at 60% L.F. (MW)</td>
<td>30155</td>
<td>5679</td>
<td>1073</td>
<td>5590</td>
<td>31857</td>
<td>84044</td>
</tr>
<tr>
<td>% of total potential of the country</td>
<td>36</td>
<td>7</td>
<td>13</td>
<td>6</td>
<td>38</td>
<td>100</td>
</tr>
<tr>
<td>Potential developed in (MW)</td>
<td>6160</td>
<td>3099</td>
<td>6365</td>
<td>1596</td>
<td>599</td>
<td>18818</td>
</tr>
<tr>
<td>% Potential developed</td>
<td>20.4</td>
<td>54.5</td>
<td>59.2</td>
<td>28.5</td>
<td>1.9</td>
<td>21.2</td>
</tr>
<tr>
<td>Potential available for future development (MW) 60% L.F.</td>
<td>23955</td>
<td>2580</td>
<td>4398</td>
<td>3994</td>
<td>31258</td>
<td>66226</td>
</tr>
<tr>
<td>% Potential available for further development</td>
<td>79.6</td>
<td>45.5</td>
<td>40.8</td>
<td>71.5</td>
<td>98.1</td>
<td>78.8</td>
</tr>
</tbody>
</table>

Source: Central Electricity Authority.
REGION-WISE STATUS OF HYDRO ELECTRIC POWER DEVELOPMENT

(ALL FIGURES IN MW)

- [] POTENTIAL AVAILABLE FOR DEVELOPMENT
- [] POTENTIAL DEVELOPED

<table>
<thead>
<tr>
<th>Regions</th>
<th>Potential Available</th>
<th>Potential Developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTHERN</td>
<td>30115</td>
<td>23455</td>
</tr>
<tr>
<td>WESTERN</td>
<td>5679</td>
<td>2580</td>
</tr>
<tr>
<td>SOUTHERN</td>
<td>10763</td>
<td>4398</td>
</tr>
<tr>
<td>EASTERN</td>
<td>5500</td>
<td>3994</td>
</tr>
<tr>
<td>N.EASTERN</td>
<td>31857</td>
<td>21258</td>
</tr>
<tr>
<td>ALL INDIA</td>
<td>84044</td>
<td>66226</td>
</tr>
</tbody>
</table>

Fig. 3.2
### 3.6 INSTALLED CAPACITY AND POWER GENERATION OF HYDRO PLANTS

The progress of installed capacity and power generation of hydro plants and their share in overall capacity and power generation are presented in Table 3.3.

**Table 3.3**

<table>
<thead>
<tr>
<th>Year</th>
<th>Installed capacity (MW)</th>
<th>Share of hydro IC to the total installed capacity (in %)</th>
<th>Generation in Hydro power (in MU)</th>
<th>Share of hydro power in overall power generation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>575</td>
<td>31.3</td>
<td>2860</td>
<td>48.8</td>
</tr>
<tr>
<td>1956</td>
<td>1061</td>
<td>36.7</td>
<td>4295</td>
<td>44.5</td>
</tr>
<tr>
<td>1961-62</td>
<td>2419</td>
<td>46.3</td>
<td>9814</td>
<td>49.9</td>
</tr>
<tr>
<td>1966-67</td>
<td>4757</td>
<td>47.1</td>
<td>16734</td>
<td>46.0</td>
</tr>
<tr>
<td>1971-74</td>
<td>6612</td>
<td>43.3</td>
<td>28024</td>
<td>40.0</td>
</tr>
<tr>
<td>1976-77</td>
<td>9025</td>
<td>42.0</td>
<td>34836</td>
<td>39.4</td>
</tr>
<tr>
<td>1981-82</td>
<td>12173</td>
<td>37.6</td>
<td>49565</td>
<td>40.6</td>
</tr>
<tr>
<td>1986-87</td>
<td>16195</td>
<td>32.8</td>
<td>53840</td>
<td>28.6</td>
</tr>
<tr>
<td>1987-88</td>
<td>17265</td>
<td>31.8</td>
<td>47444</td>
<td>23.4</td>
</tr>
<tr>
<td>1988-89</td>
<td>17798</td>
<td>30.1</td>
<td>57867</td>
<td>26.1</td>
</tr>
<tr>
<td>1989-90</td>
<td>18307</td>
<td>28.7</td>
<td>62054</td>
<td>25.2</td>
</tr>
</tbody>
</table>

Table 3.3 indicates that total installed capacity of hydro stations has increased to 18307 MW in 1989-90 recording an increase of 36 times. The total energy generation which stood at 2860 million units in 1951 rose to 62054 million units in 1989-90, an increase of about 27 times. But the share of hydro installed capacity to total installed capacity has been declining.

The pace of hydro electric development has slowed down after 1970 as more emphasis was laid on thermal power projects. Its share has dropped to 32.8 per cent 1986-87.

3.7 DECLINE IN HYDRO POWER DEVELOPMENT

The growth of hydro capacity in the country has been very satisfactory during the period upto the end of Third Five Year Plan (1969). The share of hydro power in the overall installed capacity of power plant in the country during this period increased from 33 per cent in 1951 to 46 per cent in 1969. The average annual growth rate of installed capacity of hydro power plant during this period has been at about 14 per cent.

It was during the Fourth Plan and beyond that more emphasis was placed on thermal development due to various reasons. Consequently growth of hydel power was hampered and its share in the overall installed capacity declined rapidly from 46 per cent in 1969-70 to 29.8 per cent in
1989-90. The annual rate of growth in installed capacity of hydro power plant during the period 1973-74 to 1989-90 came down to as low as 6 percent only as compared to the earlier growth rate of 14 percent.

The pace of hydro electric development has slowed down inspite of its intrinsic merits.

Sambamurti (1983) has pointed out that in Indian conditions hydro power is the most economical source of power generation. He has further pointed out that there is a need for accelerating hydro development. Hydro projects of the storage type should be given the highest priority in view of the support they provide for stable system operation. Special policy measures are necessary to overcome the constraints slowing down hydro development at present. This includes finding adequate funds for investment in the long term projects and evolving techniques of accelerating construction at sites remotely located and presenting geo-technical complexities.

3.8 PERCENTAGE SHARE OF HYDRO CAPACITY

The percentage shares of hydro capacity in the Hydro-Thermal mix as it existed during various plans are depicted pictorially in the figure 3.3.
PERCENTAGE SHARE OF HYDRO IN HYDRO- THERMAL MIX SINCE INDEPENDENCE

Fig. 3.3
HYDRO DEVELOPMENT. SINCE INDEPENDENCE

PLAN WISE GROWTH RATES

16.56
15.3
12.72
10.95
10.24
9.08
8.4
7.5
6.0
5.8
4.9
4.83
3.35
2.24
1.09
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

PLAN PERIODS

Fig. 3.4
The figure shows that Hydro Thermal mix was quite satisfactory (40:60) till the end of the Fifth Plan. It declined considerably during the Sixth and Seventh Plans creating an imbalance in the hydro thermal mix. The share of hydro electric power has slowed down considerably during the Sixth and the Seventh Plans due to constraints of financial resources, environmental consideration as well as problems in acquisition of forest land.

3.9 PLAN-WISE GROWTH RATES OF HYDRO POWER

The plan-wise annual percentage growth rates of hydro capacity is indicated in figure 3.4. The figure shows that growth rate was maximum during the third Five Year Plan and lowest 2.43 per cent during 1990-91. It remained constant between 4 per cent from 1979-80 to 1990-91 due to financial constraints and environmental problems.

3.10 CONSTRAINTS AND STRATEGIES

Even though the hydro power in general is the least cost power supply option and inspite of the recommendations of various committees, the pace of hydro power development has not gained momentum and has instead slowed down considerably after mid Sixties. There are several factors constraining the development of hydro power in the country.
3.10.1 FINANCIAL CONSTRAINTS

Lack of adequate financial resources has been one major constraint in the matter of power development, but it had the severest effect on the hydro power development in the country.

Since the short term solutions to mitigate the immediate power shortage have been getting priority over long-term solution, therefore, 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 has moved along sub-optimal course. A decision is required to strike a balance between short term and long term solutions so that the power development could move towards optimal course.

In order to finance the hydro power schemes it is necessary that the allocations be kept reserved for the particular schemes. In the past it has been experienced that since the allocation for the multipurpose schemes are given by the irrigation and energy sectors the hydro, including multipurpose schemes remain at the mercy of these two sectors. For each of the sector the priority shifts towards their own singular schemes and thus the multipurpose scheme suffers, there are slippages and cost over runs.
Since heavy investments are required for the hydro schemes it may not be possible to fund these schemes from the State's own resources, then it would be necessary to get financial aid from outside. Power Finance Corporation may also provide necessary funding for the development of important hydro projects, which are languishing in addition to its transmission and distribution systems.

3.10.2 ENVIRONMENTAL PROBLEMS

In India very few hydro power projects have been abandoned on account of considerations of adverse impact on the environment. Almost all the power projects have been given environmental clearances, but after a lapse of considerable time which has resulted in substantial time and cost over-runs. These delays in environment and forest clearance have been mainly on account of various procedural constraints and delays in necessary studies required to be conducted for making an overall assessment of impact of the concerned power project on 'the environment'. To reduce time and cost over-run due to delayed environment and forest clearance, procedural bottlenecks must be identified and clearance processes must be streamlined. The Department of Environment may consider giving principle clearance to hydro power projects based on minimum required information, prime
facie satisfying that there are not going to be major adverse impacts on the environment necessitating final rejection of the complete schemes.

3.10.3 ORGANISATIONAL PROBLEMS

There is no uniformity in the functional distribution and the organisational set up for hydro electric development among the various States. While in some States, the responsibility is vested with the State Electricity Boards (or Power Corporation), in most of the States, the responsibility is either divided between the State Electricity Boards and the Irrigation Department (or organisation responsible for water resources development) or it is almost entirely with Government or divided between the Irrigation Department and the departmental organisation responsible for hydro-electric power development.

An analysis of hydro-electric power development in the past shows that in the States where the responsibility for hydro electric development is vested with the State Electricity Boards, the progress has been faster. There are several States/Union Territories where organisation for hydro-electric development exists only in a rudimentary form.
Large number of hydro sites, yet to be developed lie in Jammu & Kashmir, Himachal Pradesh and Uttar Pradesh in Northern Region, Madhya Pradesh in Western Region, Andhra Pradesh, Karnataka and Kerala in the Southern Region, Orissa, Bihar and West Bengal in the Eastern Region and Arunachal Pradesh and Meghalaya in the North Eastern Region. Uttar Pradesh, Andhra Pradesh, Karnataka, Kerala, and Orissa have considerable experience in hydro electric development and from the point of view of expertise, the organisations in these States do not pose any serious problem. Jammu & Kashmir, Himachal Pradesh, Bihar, Meghalaya, and Arunachal Pradesh have limited experience in hydro-electric development, limited to smaller projects. It would be necessary for the Government to review the organisational structures in these States and reorganise them to make functionally effective.

3.10.4 INTER-STATE DISPUTES

Sharing of water resources of inter state river systems is a complex as well as political issue. Differences and disputes between riparian States have inhibited and delayed hydro-development in some of our major river systems.

The Inter-State disputes in the Narmada, the Godavari and the Krishana river basins might be partly
responsible for Madhya Pradesh, Maharashtra and Andhra Pradesh turning away from hydro projects after pioneering developments in the Chambal, the Koyna, the Sileru and the Tunga-Bhadra valleys. The Tribunal awards on sharing of water resources in the Narmada, the Godavari and the Krishna river basins in the last few years have set at rest the competing claims of the riparian States for shares and released a large quantum of hydro-electric potential for development. Most of the undeveloped sites in these river systems require Inter-State cooperation. Such co-operation would involve participation, in completing investigation and project report preparation, project organisation and management and financing. There is also need for effective coordination between organisations responsible for irrigation and power development within each State. Inter-State differences and disputes are delaying important hydro-electric projects in the Cauvery and the Yamuna River Basins. Settlement of these differences would have to be followed by active cooperation between States in which the potential sites are located for rapid development of the potential in these river basins.
3.10.5 TECHNOLOGICAL UPGRADEATION AND GESTATION PERIOD

The gestation period of hydel projects depends on several factors, viz, geological conditions at site, features of the project and the method of construction, etc. Since most of the sites are now located in remote and difficult areas where infrastructural facilities for transportation and communications are lacking, the same is resulting in prolonged period of initial site preparation.

To speed up the construction activities of hydro project, Government of India should advise State Governments. Central/State organisations responsible for developing hydro-electric projects to take up site development including site clearance, levelling, roads formation, colony construction and providing of telecommunication links as soon as the schemes are techno-economically cleared by Central Electricity Authority. The project implementing authorities may take up these works as advance action without awaiting final sanction by the government. Government of India may take appropriate action in making available the required funds, as soon as Central Electricity Authority accords their techno-economic clearance. It may also be desirable that the project implementation agencies like State Electricity Boards/organisations are advised by the Government of India to ensure that the prospective contractors must be
competent, equipped both with modern construction equipment, latest technology and follow the modern project management techniques to help in bringing up the projects at a faster pace.

It would also be helpful if the Power Finance Corporation could either provide funds as loan assistance to the project authorities to buy the required modern and special construction equipment and tools as found necessary for speeding up the construction activities. Alternatively, the Power Finance Corporation may purchase such modern construction equipments and lease them to project authorities on commercial lines.

3.10.6 PROBLEMS RELATING TO LAND ACQUISITION

The land required for the projects is being acquired under land Acquisition Act 1894 through previous consent of the appropriate Government and by an award of the respective District Collector after observing the procedure Laid down in the Act. The minimum time required for taking possession of the land is about an year, though in practice it takes about 2 to 3 years depending up on the efficiency and co-operation of the Civil Authorities.
The alternative method of acquiring land is through private negotiations by committee constituted for this purpose, which may generally include a representative of the Revenue Authorities to help in identification of the legal owners of the land. In this case, the time of acquisition of land is drastically cut down and it is possible to get possession of the land within 3 to 6 months time. The associated problems with this method are that the land thus acquired is not incumbrance free, possible litigations may arise when some of the land owners do not agree to execute the sales deed even after their signing the agreements. Also the rate to be paid is much higher than the rate that is applicable under the land Acquisition Act for land so acquired. Under these conditions, the Government should bring out adequate amendments in the land Acquisition Act and procedures to speed up the process of land acquisition for hydro projects treating the hydro resources as national assets with a view to bring up hydro electric projects at a much faster pace.

3.10.7 GEO-POLITICAL FACTORS

The hydro resources are unevenly distributed among the political divisions in the country. Most of the untapped hydro potential lies mainly in the States which
do not have either the demand for or resources for their development and this has been a major inhibiting factor in the area of hydro power development. 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.

3.11 INDIGENEOUS MANUFACTURING OF HYDRO POWER EQUIPMENTS

A programme of indigenous manufacturing of heavy electrical power equipments was initiated during the fifties, when recognising the need for manufacture of turbines and generating units indigenously the Government of India had set up Bharat Heavy Electricals Ltd. in Bhopal to facilitate speedy development of power. This was followed by three heavy electrical factories with facilities for manufacture of steam and hydro generating units, transformers and switchgear at Hardwar, Hyderabad and Tiruchi. Bharat Heavy Electricals Ltd. has been been supplying most of the equipments required for hydroelectric stations. The first hydro generation equipment indigenously manufactured went into operation in the year 1970-71. This was immediately followed by another unit at Bassi (15 MW) in Himachal Pradesh during
the same year. The country is now in a position to manufacture the whole range of hydro power equipments at international standards.

**TABLE - 3.4**

**INDIGENOUS HYDRO-POWER GENERATION EQUIPMENT**

(The capacities commissioned from seventies onwards)

<table>
<thead>
<tr>
<th>Year</th>
<th>Indigenous Equipments (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-71</td>
<td>96</td>
</tr>
<tr>
<td>1971-72</td>
<td>63</td>
</tr>
<tr>
<td>1972-73</td>
<td>15</td>
</tr>
<tr>
<td>1973-74</td>
<td>26.3</td>
</tr>
<tr>
<td>1974-75</td>
<td>286.3</td>
</tr>
<tr>
<td>1975-76</td>
<td>720</td>
</tr>
<tr>
<td>1976-77</td>
<td>412</td>
</tr>
<tr>
<td>1977-78</td>
<td>755</td>
</tr>
<tr>
<td>1978-79</td>
<td>725</td>
</tr>
<tr>
<td>1979-80</td>
<td>394</td>
</tr>
<tr>
<td>1980-81</td>
<td>304</td>
</tr>
<tr>
<td>1981-82</td>
<td>380</td>
</tr>
<tr>
<td>1982-83</td>
<td>840</td>
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<tr>
<td>1983-84</td>
<td>760</td>
</tr>
<tr>
<td>1984-85</td>
<td>400</td>
</tr>
<tr>
<td>1985-86</td>
<td>742.5</td>
</tr>
<tr>
<td>1986-87</td>
<td>548.5</td>
</tr>
<tr>
<td>1987-88</td>
<td>958.45</td>
</tr>
</tbody>
</table>

*Source:* Central Electricity Authority.
Table 3.4 gives the trends in the indigenous manufacture and supply of power equipments during the period 1970-71 to 1987-88. The largest unit in operation at present is 165 MW at Dehar Power Station Beas Project.

Some of the projects under construction like Sardar Sarovar, Tehri Hydro Electric Project and Nathpa Jhakri Hydro electric project will have units of capacity varying from 200 MW to 250 each, which Bharat Heavy Electric Limited, (BHEL) will be supplying.

3.12 NEED FOR ACCELERATION HYDRO PROJECT

Hydro power is the cheapest among various available source of power supply because in case of hydel power, the fuel cost component is nil as compared to other conventional options of power supply namely, coal and gas, thermal and nuclear.

Hydro electric power plants utilize natural resource which are renewable and the production of power does not consume water. The raw material, i.e. water can be put to other uses like irrigation etc. after it has been put to generation of power. Unlike coal it does not involve transportation of raw materials by rail. Thus the effect of inflation on the raw material and transport is not reflected in the cost of generation.
Hydro-power projects have a relatively longer life and low depreciation, unforseen breakdowns in hydro projects are less frequent and overhaul and maintenance require plant shut downs of very short durations. They are non pollutable. Their operation and maintenance costs are low compared to other sources of generation. Their ability for quick start and stop operation and varying their outputs make them eminently suitable for meeting peak loads. The hydro power projects which are based on reservoirs have peaking capacities. They have the unique advantage of increasing the capacity of peaking manifold by having pumped storage schemes.

Due to difference in peaking capabilities of hydro and thermal plants, less capacity of hydro projects is needed as compared to thermal plants when both are called to meet the system peak load. The study in Central Electricity Authority indicates that reduction of 1 MW hydro capacity in the optimal power plan, on an average, would require addition of 1.6 MW of thermal power projects which would increase the investment accordingly.

Besides, hydropower fills in the lacuna found in uneven availability and production of energy. The main coal producing states of Bihar and West Bengal are not well favoured with respect to hydro resources. On the
other hand, a number of States in the South and North West, which have no coal resources and are remote from the coal producing areas are well endowed with hydro-electric potential such as Himachal Pradesh, Uttar Pradesh and North Eastern Region.

Hydro power needs to be harnessed to the maximum feasible limit as it would result in reduced environmental pollution and conservation of non-renewable fossil fuel reserves.
SUMMARY

Thus it is clear from the discussion in the present chapter that hydro power is an important, primary and conventional source of electricity. Hydro power plants utilize a natural resource which is renewable and have a relatively long life. The river systems in India provide plenty of scope for large scale hydro development.

The growth of hydro power capacity in the country has been very satisfactory during the period upto the end of the Third Five Year Plan. It was during the Fourth Plan and beyond that more emphasis was placed on thermal development, consequently growth of hydel power was hampered and its share in the overall installed capacity declined. The share of hydro capacity declined considerably during the Sixth Five Year plan and the Seventh Five Year Plan creating an imbalance in the hydro-thermal mix. The hydro-thermal mix which was 40:60 during the Fifth Five Year Plan came down to 33.7:66.3 at the end of the Sixth Five Year Plan. The share of hydro electric power has slowed down considerably during the Sixth Five Year Plan and Seventh Five Year Plan due to constraints of financial resources, environmental considerations as well as problems in acquisition of forest land.
Hydro power needs to be harnessed to the maximum possible limit, as it is the cheapest source of power generation among various available sources of power supply. It utilizes natural resource i.e. water as a result fuel cost component is nil as compared to other conventional options of power supply namely thermal and nuclear.

To meet the growing demand of power, the generation of electricity through thermal power is very essential. Thermal power is playing an important role in power sector. The study of thermal power development has been taken up in the next chapter.