

# Hydropower Development in India

## Resource Potential

India is endowed with rich hydropower potential; it ranks fifth in the world in terms of usable potential. This is distributed across six major river systems (49 basins), namely, the Indus, Brahmaputra, Ganga, the central Indian river systems, and the east and west flowing river systems of south India. The Indus, Brahmaputra and Ganga together account for nearly 80% of the total potential. In the case of Indus the utilization is, however, governed by the Indus Water Treaty with Pakistan. The economically exploitable potential from these river systems through medium and major schemes has been assessed at 84,044 MW at 60% load factor<sup>10</sup> corresponding to an installed capacity of around 150,000 MW. As mentioned earlier, so far only 32,325 MW has been established. Tables 3 and 4 show the status of development of hydropower on a region-wise and basin-wise basis. In addition, pumped storage sites with an aggregate capacity to the tune of 94,000 MW have also been identified, but only about 5,000 MW have so far been developed. The assessment of small hydro (up to 25 MW) potential has indicated nearly 10,000 MW distributed over 4,000 sites. It is estimated there is still an unidentified small hydro potential of almost 5,000 MW.

**Table 3: Region-Wise Potential and its Status of Development at 60% Load Factor as on 1 January 2005**

Region	Potential Assessed (MW)	Potential Developed (MW)	Potential under Development (MW)	Balance Potential (MW)	Balance Potential (%)
Northern	30,155	5,150	2,905	22,100	73.28
Western	5,679	2,270	1,164	22,450	39.53
Southern	10,763	5,924	153	4,686	43.54
Eastern	5,590	1,364	201	4,025	72.00
North-Eastern	31,857	517	914	30,424	95.5
<b>Total</b>	<b>84,044</b>	<b>15,225</b>	<b>5,339</b>	<b>69,480</b>	<b>75.53</b>

Source: Indian National HydroPower Association. 2005.

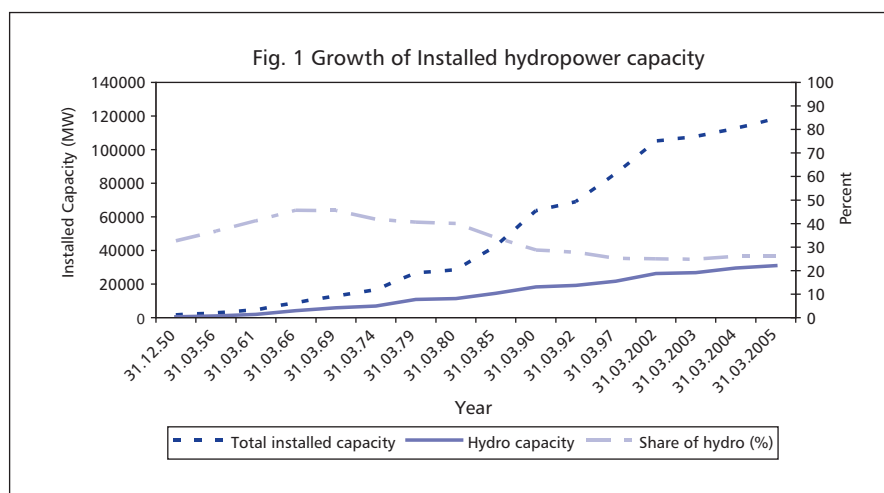
<sup>10</sup> This is based on the reassessment (the first assessment was carried out during 1953–1959) of hydropower resources carried out by CEA in 1980s taking into account new information available on topographical features and hydrology of the river systems, technological advances and experience gained in civil works of hydropower projects, and the latest trends in relative economics of power generation from different sources. The assessment of energy is based on availability of water corresponding to a 90% dependable year and the siting of power stations based on topographical studies.

**Table 4: Basin-Wise Potential and its Status of Development at 60% Load Factor as of 1 January 2005**

Basin	Potential (MW)	Potential Developed (MW)	Potential under Development (MW)	Balance Potential (MW)	Balance Potential (%)
Indus Basin	19,988	3,731	1,156	14,701	73.55
Ganga Basin	10,715	1,901	1,367	7,447	69.5
Central Indian Rivers	2,740	1,060	1,147	533	19.45
West Flowing Rivers	6,149	3,704	41	2,404	39.09
East Flowing Rivers	9,532	4,168	144	5,220	54.76
Brahmaputra Basin	34,920	661	1,085	33,175	95
<b>Total</b>	<b>84,044</b>	<b>15,225</b>	<b>5,339</b>	<b>63,480</b>	<b>75.53</b>

Source: Indian National HydroPower Association.

Hydropower development commenced over a century ago in India with the installation of a 130 kW power station in the Darjeeling district of West Bengal, almost in pace with the world's first hydro-electric station in the United States. However, to date only about 20% of the country's vast hydro potential has been harnessed. The share of hydropower in the total installed capacity has also decreased over the years; from over 50% in 1960-61 to nearly 26% now (Fig 1).



## Barriers in Development

The main barriers/concerns that have come in the way of development of hydropower projects are briefly discussed below.

**Longer gestation period and capital intensive nature of the projects:** Preparation of detailed projects reports (DPRs) for hydropower projects takes relatively longer period than for thermal projects because reliable hydrological, geological, seismological and environmental studies have to be carried out for a longer period. Thus hydropower projects generally entail a long gestation period. In addition to this, these projects are comparatively capital intensive. In the context of resource shortages and continuing power shortages, thermal projects (coal, liquid fuel and gas), which need a relatively short gestation period, have been getting priority in fund allotments.

**Dearth of good contractors:** A matter of concern in the execution of large projects is the dearth of competent and resourceful contractors, as it often results in time and cost overruns of hydro projects.

**Inter-state aspects:** A large number of hydropower projects having common river systems between adjoining states are held up on account of inter-state aspects. Some of these projects have received the techno-economic clearance (TEC) of CEA but the investment sanction could not be accorded due to inter-state aspects. A number of projects have also not been accorded CEA clearance on account of inter-state issues.

**Environmental impact and rehabilitation issues:** Important environmental concerns in hydro-electric projects are: (a) rehabilitation of project-affected people; (b) deforestation; (c) likely submergence of archaeological, religious and historical monuments; (d) protection of flora, fauna, forests, and wildlife; (e) degradation of catchment area; and (f) disaster potential in the event of earthquakes, reservoir induced seismicity, surplusage of reservoirs, etc. Rehabilitation of project-affected people is also a major issue in implementation, especially in case of storage-based hydro development. It is essentially a human problem and has to be dealt with understanding and sensitivity. In fact, many times it is one of the main reasons for the delay in the execution<sup>11</sup> of projects. Sardar Sarovar, Indira Sagar, Bansagar Tons and Tehri are some of the hydro projects where the progress had been severely hampered in the past from sustained opposition to project construction by environment activists and project-affected people.

**Valuation of forestland based on net present value:** The manner of valuation of forest land diverted for non-forestry purposes based on the net present value (NPV) of diverted land has been a matter of concern for developers of hydropower projects. As per the recommendations of a Centrally Empowered Committee (CEC), the NPV of forestland diverted for non-forest use has been charged at Rs5.80–9.20 lakhs per hectare, depending upon the density of forest involved. Under NPV, the state government has to pay to the CEC the NPV of forestland lost to mining and other projects, including resettlement. State governments, in turn, have asked for exemption in case of projects such as government hospitals, schools, and rainwater harvesting meant for public welfare. In some cases, it is argued that loading of NPV on the project may result in increase in tariff of hydro-electricity.<sup>11</sup> There is thus an urgent need to rationalize NPV calculations of forestland in case of hydroelectric projects. The matter had also come up before the Supreme Court of India, which has directed the formation of a committee to look into various issues pertaining to assessment of NPV. The Energy and Resources Institute is also undertaking a study to analyze various aspects of NPV calculation for hydroelectric projects in India.

**Law and order problems:** Disturbed law and order is one of the factors causing delay in project execution and even suspension of work. Some of the hydropower projects affected due to these problems are Dulhasti, Upper Sindh, Doyang and Dhansiri.

**Land acquisition problems:** The problems arising in acquisition of land for hydropower project are causing suspension and delay in the construction activities. Thein Dam, Doyang, Ghatgar pumped storage plants are some of the projects affected in the past due to this problem.

**Geological surprises:** The features of the hydropower projects being site specific, depend on the geology, topography and hydrology at the site. The construction time of a hydro project is greatly influenced by the geology of the area and its accessibility. Even when extensive investigation using new techniques of investigations are undertaken, an element of uncertainty remains in the sub-surface geology and the geological surprises during actual construction cannot be ruled out. This in turn adds to the construction risks.

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<sup>11</sup> Appendix 3 elaborates issues related to clearances in this regard.

<sup>12</sup> As per some reports, payment of NPV as per prevailing norms is likely to result in 20% increase in project cost (by nearly Rs1,000 crores) as in the case of the proposed Tapaimukh project in NER.

**Power evacuation:** A number of the hydropower projects are located in remote sites and the home states do not have adequate demand. Timely provision of power evacuation system presents many complexities in such cases, since (a) the beneficiaries are to be identified well in advance, and (b) where there are serious right-of-way constraints, excess capacity would have to be built in one go considering likely future development of projects in the evacuation corridor. This could result in high transmission tariffs initially and also adversely affect sustainability of the project in case of slippages in projects. These issues are especially relevant in case of projects in NER.

**Lack of private sector interest:** The private sector has also not been evincing much interest in taking up hydro projects in view of non-availability of adequately investigated projects, construction risks, etc.

**Tariff and regulatory issues:** The existing tariff formulation norms for hydro projects (based on a cost plus approach) with no premium for peaking services and the provision for 12% free power<sup>13</sup> to distressed states from the initial years are also proving to be deterrents.

**Small hydro segment:** Development of small hydro often suffered due to inaccessibility of the sites, lack of power evacuation infrastructure, investigation and construction difficulties, land acquisition and financing difficulties, inadequacies in institutional support and in some cases law and order problems.

## The Way Forward

The power planners in India are concerned about this slow development of hydropower, especially in view of its several advantages over other forms of energy sources including its role in promoting the country's energy security, as discussed in Section III.

## Hydropower Technologies

India has achieved a fairly high degree of self-reliance in hydropower technology. Nevertheless, there is a continuing thrust toward adoption of new technologies. The focus on the civil engineering side is on using techniques and tools that could improve quality of planning and investigation and reduce construction delays, and to adopt measures that will help contain silting problems. On the electrical and mechanical side, the focus has been to improve the life and performance of turbines (through metallurgical improvements, design and coatings of blades, etc.) and to minimize problems in transportation of equipment to project site and in installation due to space constraints within the powerhouse (through use of split transformers, gas insulated substations, etc.). The country is also trying to use new technologies like powerformers, adjustable speed turbines, etc. Another technological advance in recent years has been the widespread use of information technology in new projects for construction monitoring activities as well as for operation and control after project commissioning.

<sup>13</sup> As per the decision taken by the Central Government in 1990, 12% of power from the energy generated by the power station would be supplied free of cost to those states of the region (including the state where the project is located) where distress is caused by setting up the project at the specific site, like submergence, dislocation of populations, etc. The Government of HP is seeking 12% of the deliverable energy of the project for the period starting from the date of synchronization of the first generating unit and extending up to 12 years from the date of commercial operation of the project, at 18% of deliverable energy of the project for a period of the next 18 years and thereafter at 30% of the deliverable energy for the balance of the agreement period beyond 30 years.