HYDROPOWER DEVELOPMENT IN INDIA

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ABSTRACT

India is posed for large deployment of hydropower in present conducive policy and investment environment. Growing energy demand and concern for carbon emission is making hydropower development more favorable. The Government of India is ensuring a good performance of the new SHP stations by linking the incentives to the SHP developers with the performance of the station.

1. INTRODUCTION

India has a geographical area extending to 3.28 million sq. km. and has 1.17 billion population (projected for year 2010). It consists of 28 States and 7 Union Territories. They are further divided into Districts (640), tehsil and Development Blocks and finally in to towns/cities (urban areas) and rural areas (villages). About 30% of India's population lives in 7742 towns and 70% in about 0.608 million villages.

2. STATUS OF ELECTRICITY IN INDIA

Electricity is a concurrent subject meaning thereby that both the Central (Federal) Government and the State Governments have responsibility to promote this sector and authority to make necessary laws, regulations, formulate and implement policies and programmes. The States function under the guidance of the Central government. The whole country is divided into five power regions and planning is done on a regional concept.

At the time of independence in the year 1947 only 1362 MW of electricity was produced in India. India paid considerable attention to the generation of power as a result of which the installed capacity of power generation has presently grown to 164,509 MW of which Hydro is 37086 MW (25%), Thermal is 106,433MW (65%), Nuclear is 4560MW (2.9%) and Renewable energy sources 16429MW (7.7%) (Fig 1). The share of small scale hydropower (SHP) is 2,820 MW.

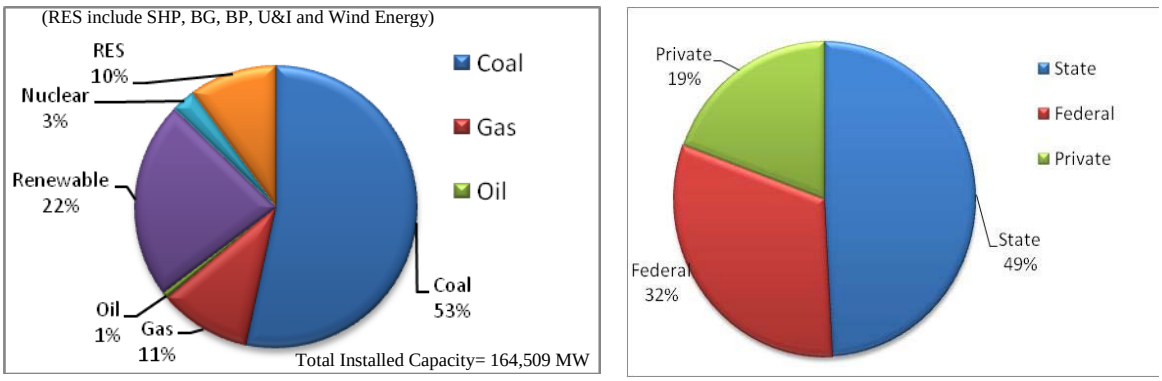

Fig.1: Electricity Generation Capacity (Ministry of Power Aug 2010)

The access to electricity is low in the rural areas. Out of about 608,000 villages only 85% of the villages are electrified and only 85 % of the irrigation pump sets are energised. However, only about half of the rural households have electricity connections. Even those who have the electric connections have low

load. Consumption of electricity per person was only 733 kWh during the year 2008-09and is expected to grow to 1000 kWh by the year 2011-12.

On the whole, India face shortage of electricity of 12% in peak demand and 11% overall shortage. India has to harness every available source of power generation and in this context Hydropower has acquired priority and Small Hydropower has a special place. The total hydroelectric power potential in the country is assessed at about 150,000 MW, equivalent to 84,000 MW at 60% load factor. The potential of small hydro power projects is estimated at about 15,384 MW with 5718 potential identified sites.

Water is the state government subject and hence hydropower development is the responsibility of state governments. Central government advises on the hydropower matter and play role for overall river basin planning and arbitrator.

3. REFORMS IN THE ELECTRICITY SECTOR IN INDIA

With the liberalization of the economy, the Government of India has been encouraging and invited private sector for investment in the power sector. Accordingly, a conducive policy environment has been created by modifying the Electricity Act. The new Electricity Act-2003 deals with the laws relating to generation, transmission, distribution, trading and use of electricity. The Act has specific provisions for the promotion of renewable energy including hydropower and cogeneration. It has been made mandatory that every state regulatory commission would specify a percentage of electricity to be purchased from renewable by a distribution licensee. The National Electricity Policy announced in 2005 aims at access of electricity by all households and per capita availability of electricity to be increased to 1000 units by 2012. The Policy underlines that renewable energy potential needs to be exploited and private sector would be encouraged through suitable promotional measures. Regarding fixing of tariff, the government has announced Tariff Policy in 2006 wherein the State Regulatory Commissions are required to fix tariff in their respective state and also decide about the renewable purchase obligation. The Electricity Act and Tariff Policy are favorably tilted towards increasing power generation from renewable. Now, Central Electricity Regulatory Commission has also announced the tariff calculation guidelines for renewable technologies including for small hydro projects.

The existing power deficit and a rapid growing demand coupled with government commitment to provide access to electricity for all has necessitated a large scale capacity addition programme. A capacity addition of 78,000 MW in the 11th Plan (2007 to 2012) and approximately one 100,000 MW in the 12th Plan (2012-2017) is planned. Concurrent investments in Transmission and Distribution are also going on. Such a gigantic task is strongly supported and complemented by the private sector.

These changes facilitated the removals of barriers to investment, improved the functioning of the system and resulted in additional generation of power much in excess of that achieved in the earlier plans. Ministry of New & Renewable Energy (MNRE) Government of India is the nodal ministry for small hydropower development in India.

4. GOI POLICY ON HYDROPOWER DEVELOPMENT

Despite hydroelectric projects being recognized as the most economic and preferred source of electricity, the share of hydropower in our country continued declining since 1963. The hydro share declined from 50% in 1963 to about 25% in 2010. For grid stability the ideal hydro-thermal mix ratio for Indian condition is 40:60. In order to correct the hydro-thermal mix to meet the grid requirements and peak power shortage, in August, 1998 and thereafter in Nov 2008, the Government of India announced a Policy on ‘Hydro Power Development’. Project Affected People have been made long term beneficiary stakeholders in the hydro projects by way of 1% of free power with a matching 1% support from State government for local area development thus ensuring a regular stream of benefits. An initiative of installing 50,000 MW large hydro projects in the country was announced by the government. By 1998 small hydro power projects established themselves as a techno economically viable option for generating power with some preferential treatments. Encouraged by the growing private sector participation in the sector and the potential of SHP projects to meet power requirements of remote and isolated areas, where grid extension is relatively expensive, small scale hydro was identified as an area to provide thrust in the overall hydropower development of the country. This led to transfer of the subject of hydro up to 25 MW from Ministry of Power (MOP) to MNRE in December 1999.

The process of reforms is an ongoing one and Government of India has been vigorously pursuing this path for the past five to six years. Hydro Power is a renewable source of clean energy and is used to supplement the base load provided by thermal power plants and storage for wind energy through pumping. To enable the project developer in the Hydro Sector a reasonable and quick return on investment, merchant sale of up to a maximum of 40 percent of the saleable energy has been allowed.

Central Electricity Authority (CEA) has issued various hydroelectric related reports and guides are available through web. Some of them are the best practices in Hydroelectric Generation; Preliminary ranking study of hydroelectric scheme; Guidelines for accord of concurrence of HE Scheme; Guidelines for formulation of DPRs for HE scheme; Draft model contract document for hydro projects; Project monitoring status reports; Project clearance status reports and Status of 50,000 MW Hydroelectric Initiative reports

The 12th five year plan also suggests that for projects held up for environment and forest problems, efforts may be made by the concerned State Govt. / developer to get the timely E&F clearances. Problems such as local agitation (law & order), land acquisition etc. need to be resolved by the concerned State Government. Tendency of converting storage projects (as identified by CEA) to Run-of-River projects should be discouraged. Project developer should seek long term open access by indicating at least the region(s) in which they intend to supply their power to enable development of transmission system.

5. HYDROPOWER CLASS

There is no worldwide consensus on definitions regarding SHP, mainly because of different development policies in different countries. Based on installed capacity of hydropower projects, classification of hydropower varies differently in various countries. A general classification may be taken as:

Pico	5 kW & below
Micro	100 kW & below
Mini	2000 kW & below
Small	25000 kW & below
Medium	100,000 kW & below
Large	above 100,000 kW

India has a history of about 110 years of hydropower. The first small hydro project of 130 kW commissioned in the hills of Darjeeling in 1897 to mark the development of hydropower in India. At Present the biggest capacity plant is a run of river Naptha Jhakri Hydro project of 1500 MW in Himachal Pradesh

6. HYDROPOWER DEVELOPMENT

Table 1: 12th Plan Target for Hydro Power Generation

Sl. No.	States	Central Sector		State Sector		Private sector		Total	
		No.	MW	No	MW	No.	MW	No.	MW
1.	Himachal Pradesh	2	816	7	892	6	749	15	2457
2.	Jammu & Kashmir	4	2450	4	1473	0	0	8	3923
3.	Uttarakhand	12	4374	7	1655	5	829	24	6858
4.	Punjab	0	0	1	168	1	75	2	243
5.	Madhya Pradesh	3	166	0	0	0	0	3	166
6.	Andhra Pradesh	0	0	3	1560	0	0	3	1560
7.	Kerala	0	0	6	373	0	0	6	373
8.	Karnataka	0	0	2	400	0	0	2	400
9.	West Bengal	1	120	2	66	0	0	3	186
10.	Sikkim	1	520	0	0	10	1935	11	2455
11.	Arunachal Pradesh	3	1610	0	0	23	7969	26	9579
12.	Assam	0	0	1	150	0	0	1	150
13.	Manipur	2	1566	0	0	0	0	2	1566
14.	Tamil Nadu	0	0	1	500	0	0	1	500
15.	Meghalaya	0	0	1	54	1	450	2	504
	Total	28	11,622	35	7291	46	12,007	109	30,920

Development of hydro power resources is important for energy security of the country. It takes about 10 years for developing a large scale hydro project from planning to commissioning. The hydropower

development is greatly boosted with the hydropower policy announcement in 1998 and again in 2008. Advance action on the identified hydro electric schemes need is being taken during 11th Plan (2007-12) period itself as long period is required for development of detailed project reports (DPRs), obtaining various clearances like Environment & Forest clearances and CEA clearance, investment decision and achieving financial closure. It has been proposed to maximize hydro capacity addition during 12th Plan (2012-17) for reducing CO2 emissions and energy security of the country. A shelf of 109 hydro electric schemes aggregating to 30,920 MW has been identified. State-wise break up of these schemes is given in Table 1.

7. SMALL HYDROPOWER DEVELOPMENT

7.1 Grid Based SHP

Beginning of the 21st century saw near commercialization in the small scale hydro sector. There are 760 small hydro projects in India with total installed capacity of 2820 MW. The MNRE decided that out of the total grid interactive power generation capacity that is being installed, 2% should come from small hydro. This translates to about 1400 MW capacity addition during 2007-2012. A target of 3000 MW for the 12^{th} from small hydro has been fixed and to increase capacity addition of about 500 MW per year. The present focus of the SHP programme is to lower the cost of equipment, increase its reliability and set up projects in areas that give the maximum advantage in terms of capacity utilisation. SHP projects are being set up both in public and private sector.

Today the SHP programme in India is essentially private investment driven. 228 private sector SHP projects of about 1230 MW capacity have been setup. Private sector entrepreneurs are finding attractive business opportunities in small scale hydro.

The MNRE is giving financial subsidy, both in public and private sector to set up SHP projects. In order to improve quality and reliability of projects, it has been made mandatory to get the project tested for its performance by an independent agency and achieving 80% of the envisaged energy generation before the subsidy is released. In order to ensure project quality/performance, the ministry has been insisting to adhere to IEC/International standards for equipment and civil works. The subsidy available from the Ministry is linked to use of equipment manufactured to IEC or other prescribed international standards.

7.2 Decentralized SHP

The rural energy scenario in India is characterized by inadequate, poor and unreliable supply of energy services. Realizing the fact that small scale hydropower projects can provide a solution for the energy problem in rural, remote and hilly areas where extension of grid system is comparatively uneconomical, promoting small scale hydro projects is one of the objectives of the small hydro Power programme in India. A number of mini/micro hydro projects have been set up in remote and isolated areas, mainly in Himalayan region. While these projects are developed by various state agencies responsible for renewable energy, the projects are normally maintained with local community participation. A number of tea garden owners have also set up such micro hydro projects to meet their captive requirement of power. Isolated grid often faces the problem of poor plant load factor and making financial return difficult for the plant. But this provides opportunities for the area to have industry expansion, cottage or small industry, irrigation pumping, drinking water, agro and other application, education and entertainment activity for the overall development of the area.

Water wheels have traditionally been used in the Himalayan regions for rice hulling, milling of grain and other mechanical applications. With the R&D efforts, new and improved designs of water mills have been developed for mechanical as well as electricity generation of 3 to 5 kW. These designs were tested at AHEC, IIT Roorkee and have been replicated by about 12 very small scale manufacturers. Local organizations such as the Water Mill Associations, cooperative societies, registered NGOs, local bodies, and State Nodal Agencies are being encouraged to install watermills in their areas. The state of Uttarakhand has taken a lead in setting up electricity generation watermills and over 500 such watermills were installed in remote and isolated areas of the state.

8. EQUIPMENT MANUFACTURING STATUS

India has a wide base of manufacturers of equipment for hydro power projects. State-of-the-art equipment are available indigenously. 15 manufacturers produce almost the entire range and type of

hydropower equipment. Most of the world's leading equipment manufacturers have their factory and or offices in India. In addition, there are about 5 manufactures that are producing micro hydro and watermill equipment.

9. PERFORMANCE TESTING OF SHP STATIONS

In the hydropower the energy transformation process is highly efficient, usually with well over 90% mechanical efficiency in turbines and about 98% in the generator. The inefficiency is due to hydraulic loss in the water circuit (intake, turbine, tail-race), mechanical loss in the turbo-generator group and electrical loss in the generator. Old turbines can have lower efficiency, and it can also be reduced due to wear and abrasion caused by sediments in the water. The rest of the potential energy (100% - η) is lost as heat in the water and in the generator. Thus energy efficiency measurement is one of the key issues.

The efficiency in electromechanical equipment, especially in turbines, can be improved by better design and also by selecting a turbine type with an efficiency profile that is best adapted to the duration curve of the inflow.

As per MNRE directive the small hydro project when commissioned is required to be tested for its performance by Alternate Hydro Energy Centre (AHEC), Indian Institute of Technology (IIT) Roorkee. The subsidy is released after project attaining the following:

a) Overall performance of the station should be satisfactory.
b) Plant equipment should conform to Indian/International standards.
c) Weighted average efficiency of generating units should, with certain exceptions, be at least 75%.
d) Project should have attained 80% of projected generation for a minimum of 3 months at a stretch.

The biggest challenge for the performance testing was observed the absence of availability of provisions required for such tests in majority of the commissioned SHP plants. With such initiative SHP developers have started taken keen interest by way providing the necessary provisions in the civil structure/equipment for facilitating the testing. Needless to say that such evaluation shall help SHP plant owners regular monitoring of performance of their plants.

However there is no mandatory condition for performance testing for large hydropower projects until the owner wishes to do so as per contractual conditions. Electricity regulators and financial Institutions are being followed up to adopt conditions for remunerative tariff from Hydropower.

10. ESTABLISHMENT OF R&D HYDRAULIC TURBINE LABORATORY

A R&D hydro turbine Laboratory of International level being established at AHEC IIT Roorkee with the financial support from MNRE, at AHEC, IIT Roorkee for the multiple purposes viz; turbine-model testing, research & development (R&D), human resource development (HRD) along with the other purposes of verification of designs, generation of design data, design validation through CFD analysis, Witnessing tests on turbines/pumps in field. The laboratory is expected to be fully functional by the end of year 2012.

11. STANDARDS FOR SMALL HYDRO

There is a series of standards, guidelines and manuals on hydropower issued by international standards organizations like ISO, IEC, IEEE, ASME, USBR and the national statuary bodies of several countries, including India where it has from CEA, REC, BIS and CBIP. But most of them were prepared keeping in view the large water/ hydropower projects. SHP needs to be made profitable and a long-term investment opportunity, while ensuring quality and reliability of the power. To make SHP cost effective and reliable, standards, guidelines and manuals are required covering entire range of SHP activities. Necessity of the standards/ guidelines and manuals has been strongly felt by developers, manufactures, consultants, regulators and others. The efforts of Government of India have taken initiatives to prepare about 30 standards for SHP and are expected available by the year 2011.

12. REAL TIME SIMULATOR

Training and human resource development is given due importance by the ministry of new and renewable energy. Towards this, apart from regular training programmes, a real time digital simulator (rtds) for shp plants has been established at alternate hydro energy centre (ahec), iit roorkee, and india with the aim of providing efficient initial and advanced training to operators and engineering staff of different types of shp plants. Training conditions have been created very close to real operating conditions. This will meet the large requirement of trained personnel for operation and maintenance of shp plants, reduce o&m costs, reduce damage to plant, increase plant life and reduce training time. The hydraulic part, the generator, the transformers as well as auxiliary electricity systems are taken care in the simulation. Present and future operators are taking the benefits of such training and is being utilised by national and international personnel.

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