HYDRO POWER DEVELOPMENT- SOME PROBLEMS & REMEDIAL MEASURES

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Abstract

India has a hydro–power potential of 90,000 MW at 60% load factor corresponding to a potential installed capacity of 1,50,000 MW. Currently hydro-power share is about 17 % against an ideal share 40% in a hydro-thermal mix of power supply. Out of 1,45,320 MW of major hydro-potential of India, 94, 900 MW i.e. 65.3% is yet to be developed in the country. State of Arunachal Pradesh with a major potential of about 50,000 MW has developed only 5-6% of hydro-power so far and a large numbers of projects are in the pipeline in Arunachal, Himachal and Uttarakhand. Execution of hydro-electric projects in India is being increasingly difficult mainly due to objections raised by several groups of environmental lobby. The paper addresses some of the problems in execution and remedial measures adopted by the developers.

Key Words: Hydro-power, run-off the river plants, problems of execution, remedial measures

1. INTRODUCTION

Hydro-power is a clean and renewable source of energy. Unlike thermal power, it does not pollute air. Properly planned and executed, hydro-power has long life with very little maintenance cost. Unit cost of hydro-electric power is the lowest. The greatest advantage of hydro-power is its flexibility of operation. It is for this reason, hydro-power is generally assigned peak part of load whereas base load is assigned to thermal power in hydro-thermal mix of power supply. Ideal mix of thermal and hydro-power in a power system is about 60:40. The current mix of about 83:17 indicates that India badly needs more of hydro power for economy and stability of power grid supplying power all over the country. There are countries like Norway where 100% power is supplied by hydro.

The Himalayan region is attractive for hydro-power generation because all the rivers in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh descend from around 3,500 m to 500 m in a short distance of 200-km stretch. This water wealth and terrain head are nature’s gift and a bounty for the relatively underdeveloped states and for the country as a whole. Our country has planned a large numbers of hydro-power projects, especially in the north east where hydro-power potential is in abundance but development is extremely poor. This is not to say that abstraction of fresh water by blocking of rivers for power generation is being indiscriminately allowed disregarding either the geotechnical/seismic safety of the terrain or the riparian need of the river to support the needs of humans as well as terrestrial and aquatic ecosystem down the river. Apart from hydro-power, the project proponents offer drinking water, recreation, tourism, infrastructures, education, employment opportunities of poor people living in hilly areas in India. Execution of the hydro projects is becoming increasingly difficult because of several problems. One of the objectives of this paper is to highlight some of these problems and discuss remedial measures for early execution of hydro- power projects in our country.

2. HYDRO-POWER DEVELOPMENT IN INDIA

Canada, USA, Brazil and China have developed 210 GW, 84 GW, 79 GW and 74 GW hydropower respectively, compared to only 38 GW by India as on 30.4.2013.Table-1 gives the hydro-power potential with 60% load factor and hydro-energy potential in some of the countries in the world including India. The hydro-power potential of India has been estimated as 90,000 MW at 60% load factor equivalent to about 1,50,000 MW installed capacity. Total hydro-power potential of India including pump storage, tidal, river linking, mini and micro hydel schemes is about 3,00,000 MW (Mishra, 2013). 60% of India's hydro-power potential lies in Arunachal, Himachal and Uttarakhand states. Table-2 shows the installed capacity of different river basins in India (Madan,2013).

Table-1 Hydro power Potential in some of the Countries in the World (Source: Google)

	Canada	USA	Russia	Brazil	Japan	France	Norway	China	India
Hydro Power Potential at 60% Load Factor (10^3 MW)	341	319	160	286	85	78	122	204	90
Hydro Energy (10^6 KW-h)	67	80	44	58	28	78	78	65	23

Table-2 Hydro-Power potential in different River Basins in India(Source:Google)

River Basins	Installed Capacity(MW)
Indus Basin	33,832
Ganga Basin	20,711
Central Indian River system	4,152
Western Flowing Rivers of southern India	9,430
Eastern Flowing Rivers of southern India	14,511
Brahmaputra Basin	66,065
Total	1,48,701

State-wise distribution of hydro-power potential of India and the status of development as on 29.2.16 is given in table-3. Out of a total of 2,23,626 MW Installed capacity of India (including thermal, hydro, nuclear and wind), the share of major hydro-power in operation is 37,917 MW i.e. 17 % only against an ideal share of about 40%. Out of 1,45,320 MW of major hydro-potential of India, 94, 900 MW i.e. 65.3% is yet to be developed in the country. Against 197 feasible projects with the potential of 21,212 MW (including major,small and mini/micro) in

Ganga and Yamuna basins (table-4), only 38 projects are completed so far with a capacity of about 4,500 MW only.

Table-3 State Wise Major Installed Capacity (above 25 MW) in India as on 29.2.16 (Source: www.cea.nic.in)

Region/State	Identified Capacity as per reassessment study		Capacity Under Operation		Capacity Under Construction		Capacity Under Operation + Under Construction		Capacity yet to be developed	
	Total (MW)	Above 25 MW	(MW)	%	(MW)	(%)	(MW)	(%)	(MW)	%
NORTHERN										
Jammu & Kashmir	14,146	13,543	31,19.0	23.03	1,180.0	8.71	4,299.0	31.74	9,244.0	68.26
Himachal Pradesh	18,820	18,540	9,308.	50.20	2,216.	11.95	11,524.	62.16	7,016.0	37.84
Punjab	971	971	1,206.	100	206.0	21.22	1,412.	100.00	0.0	0.00
Haryana#	64	64	0.0	0	0.0	0.00	0.0	0.00	0.0	0.00
Rajasthan##	496	483	411.0	85.09	0.0	0.00	411.0	100.00	0.0	0.00
Uttarakhand	18,175	17,998	3,756.	20.87	1,430.	7.95	5,186.	28.82	12,811.	71.18
Uttar Pradesh*	723	664	501.6	75.54	0.0	0.00	501.6	75.54	39.0	5.87
Sub Total (NR)	53,395	52,263	18,302.	35.02	5,032.	9.63	23,334.	44.65	28,928.	55.35
WESTERN										
Madhya Pradesh.	2,243	1,970	2,395.	100	400.0	20.30	2,795.	100.00	0.0	0.00
Chhattisgarh	2,242	2,202	120.0	5.45	0.0	0.00	120.0	5.45	2,082.0	94.55
Gujarat	619	590	550.0	100	0.0	0.00	550.0	100.00	0.0	0.00
Maharashtra	3,769	3,314	2,487.	75.05	0.0	0.00	2,487.	75.05	827.0	24.95
Goa	55	55	0.0	0.00	0.0	0.00	0.0	0.00	55.0	100.00
Sub total (WR)	8,928	8,131	5,552.	68.28	400.0	4.92	5,952.	73.20	2,179.0	26.80
SOUTHERN										
Andhra Pradesh	2,366	2,341	1,746.	74.62	1,010.	43.14	2,756.	117.76	0.0	0.00
Telangana	2,058	2,019	551.0	27.29	240.0	11.89	791.0	39.18	1,228.0	60.82
Karnataka	6,602	6,459	3,585.	55.51	0.0	0.00	3,585.	55.51	2,873.6	44.49
Kerala	3,514	3,378	1,881.	55.70	100.0	2.96	1,981.	58.66	1,396.5	41.34
Tamilnadu	1,918	1,693	1,782.	100	0.0	0.00	1,782.	100.00	0.0	0.00
Sub Total (SR)	16,458	15,890	9,546.	60.08	1,350.	8.50	1,0896.	68.58	4,993.2	31.42
EASTERN										
Jharkhand	753	582	170.0	29.21	0.0	0.00	170.0	29.21	412.0	70.79
Bihar	70	40	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Odisha	2,999	2,981	2,027.	68.01	0.0	0.00	2,027.	68.01	953.5	31.99
West Bengal	2,841	2,829	312.2	11.04	240.0	8.48	552.2	19.52	2,276.8	80.48
Sikkim	4,286	4,248	765.0	18.01	2,526.	59.46	3,291.	77.47	957.0	22.53
Sub Total (ER)	10,949	10,680	3,274.	30.66	2,766.	25.90	6,040.	56.56	4,639.3	43.44
NORTH										
Meghalaya	2,394	2,298	282.0	12.27	40.0	1.74	322.0	14.01	1,976.0	85.99
Tripura	15	0	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Manipur	1,784	1,761	105.0	5.96	0.0	0.00	105.0	5.96	1,656.0	94.04
Assam	680	650	375.0	57.69	0.0	0.00	375.0	57.69	275.0	42.31
Nagaland	1,574	1,452	75.0	5.17	0.0	0.00	75.0	5.17	1,377.0	94.83
Arunachal	50,328	50,064	405.0	0.81	2,854.	5.70	3,259.	6.51	46,805.	93.49
Mizoram	2,196	2,131	0.0	0.00	60.0	2.82	60.0	2.82	2,071.0	97.18
Sub Total (NER)	58,971	58,356	1,242.	2.13	2,954.	5.06	4,196.	7.19	54,160.	92.81
ALL INDIA	**1,48,701**	**1,45,320**	**37,917.**	**26.09**	**12,502.**	**8.60**	**50,419.**	**34.70**	**94,900.**	**65.30**

The present status of hydro development in Alakananda and Bhagirathi basins is that only four major projects - Tehri, Maneri-Bhali-I & II and Vishnuprayag of 3,164 MW capacity have been commissioned. Another five projects are in different stages of implementation. State of Arunachal Pradesh with a major potential of about 50,000 MW has so far developed only 5-6% of hydro-power so far and a large numbers of projects are in the pipeline.

TABLE-4: Distribution of Total Hydro-Power Potential (MW) In Ganga &Yamuna Basin

Basin	Large Hydro projects (above 25 MW)		Small Hydro projects (1-25 MW)		Mini-micro Hydro projects (below 1 MW)		Total Hydro projects	
	No of projects	Capacity	No of Projects	Capacity	No of Projects	Capacity	No of Projects	Capacity
Alaknanda	29	4823	43	375.6	2	0.65	74	5199.25
Bhagirathi	5	675	13	125.5	4	1.4	22	801.9
Ramganga	6	314	12	93.5	2	1	20	408.5
Sharda	26	11920	16	101.95	6	0.33	48	12022.28
Yamuna	17	2670	13	110.3	3	0.55	33	2780.85
TOTAL	83	20402	97	806.85	17	3.93	197	21212.78

3. PROBLEMS & REMEDIAL MEASURES

Execution of hydro-electric projects in India is being increasingly difficult mainly due to objections raised by several groups of environmental lobby. There is stiff opposition from this group citing several consequences e.g. submergence of land, rehabilitation of affected people, loss of fish and other aquatic life, loss of natural eco-systems, drying of river, silting of reservoirs etc. Some of the problems and remedial measures adopted by developers are discussed in the following paragraphs.

3.1 Submergance of Land and Forest

In major multipurpose projects e.g. Bhakra, Tehri etc. where a reservoir is built with the objective of storing water for irrigation, hydro-power generation, flood control etc. , a vast area of agricultural and forest land gets submerged. Such hydro-power development is almost impossible now a days because of resistance from people dependent on land and forests.

Run-off the river type developments (Fig.1) with limited storage is now a days popular since it creates little storage as the flow is diverted through tunnels to utilize the terrain head for hydro-power generation. Natha - Zhakri and similar other run-off the river type projects with remote installations are being planned to generate hydro-power by diverting dependable flow through long distance tunnels. (Fig.2) Usually, 90% dependable year flow is considered for determining installed capacity by incremental energy method.

3.2 Siltation of Reservoirs

A major problem being faced is the fast depletion of storage capacity due to siltation of reservoirs. Many of the reservoirs built in fifties and sixties are going to be obsolete (Koomullil et.al2015, Mazumder,2016) as their dead storage capacities are full of sediments and their useful life is limited due to fast depletion of their live storage space. In the earlier designs, it was presumed that all the incoming sediments would be deposited only in the designated dead storage space and the useful life of projects will be the design life. However, sediment deposition and distribution of sediments within the reservoir space is dependent on terrain condition, shape of reservoir and other factors (CBIP,1980). In the initial stage of planning, all these factors were not considered.

In the current planning and design of diversion type development, where a barrage is constructed across the river, the height of solid obstruction is kept very small. They are provided with sluice gates and breast walls (Fig3) to create required head for flow diversion in to the head race tunnels. These gates are fully raised during the flood season to wash out the sediments deposited within the reservoir. Since run-off the river schemes are designed for 90% dependable flow only, large volume of water is available for flushing in the monsoon season. It is customary to eliminate sediments of size more than 2mm or so (depending on the head at which turbines operate) by providing desilting chambers within the tunnel. These desilting chambers are periodically flushed out by diverting flow in to the river downstream of barrage.

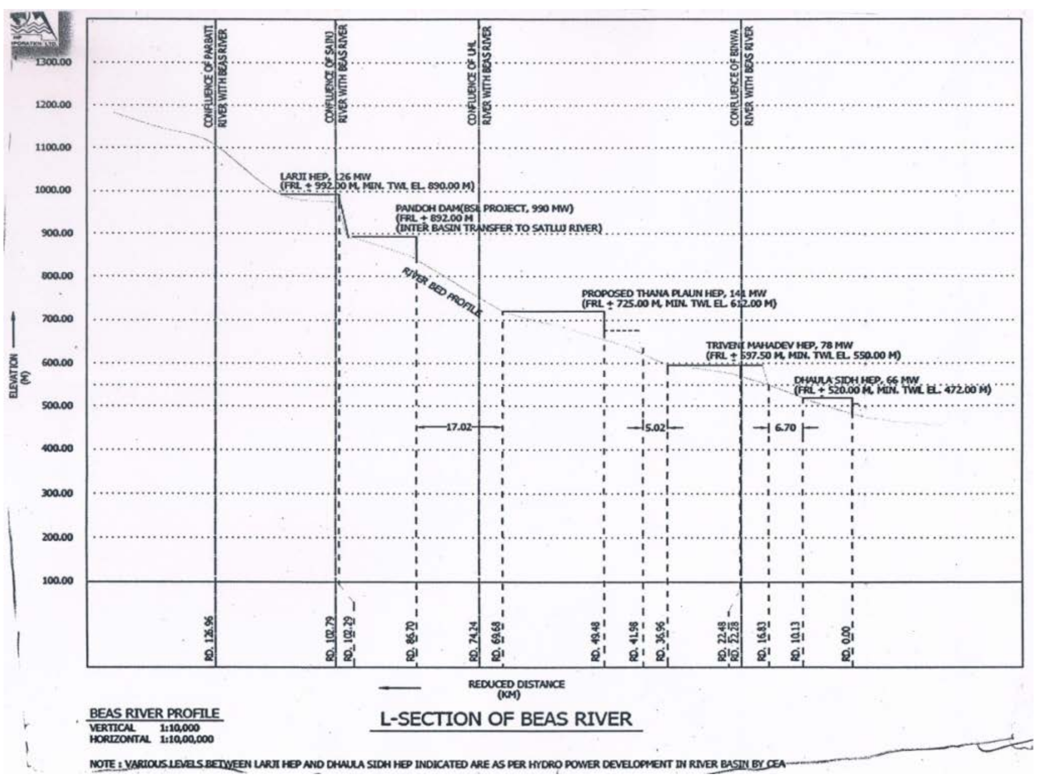

Fig.1 Run-off the River Type Development in River Beas (Source:HPCCL,2011)

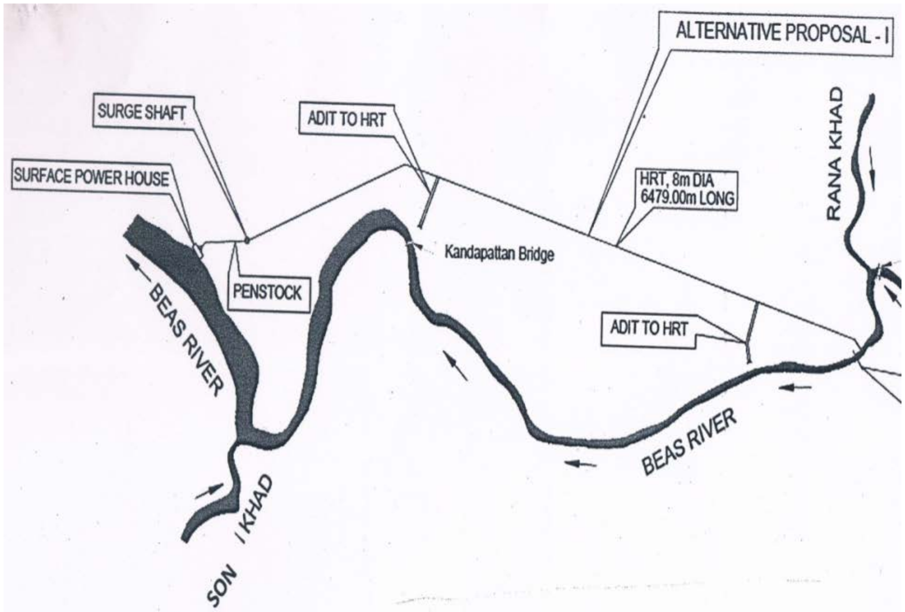

Fig.2 Remote Type Hydro-Electric Installation with Diversion Tunnels in River Beas (Source: HPCCL, 2011)

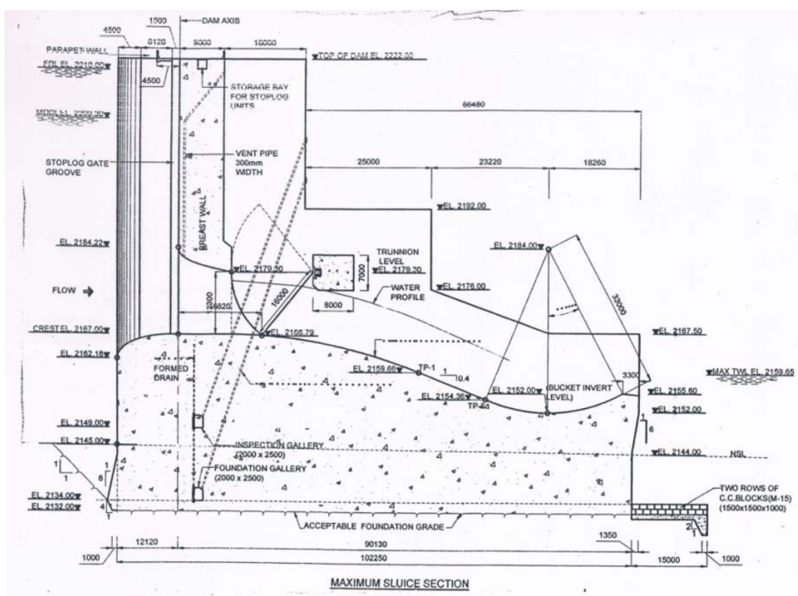

Fig.3 Showing Low height Dam, Breast Wall and Radial Sluice Gates for Flushing (Source: L&T Himachal Hydro-Power Ltd.)

All developers have a tendency to use as much water as possible for generation of power for commercial uses even during the monsoon season. It should be regulated such that water needed for flushing out sediments at intervals are not diverted for power generation. Plant capacities are to be fixed accordingly. Dam toe power house of limited capacity may be permitted.

3.3 Tunneling

In all remote type installations, long tunnels (Fig.2) are to be excavated through the side hills connecting the power house with the power intake. Length of such tunnels is governed by the terrain head to be utilized for hydro-power generation. The terrain head in the tailrace is also used in reaction type turbines e.g. Francis and Kaplan types. Construction of the head race and tail race tunnels by blasting techniques cause not only disturbances to the people living nearby, it may actuate landslides too. The problem is overcome by introducing tunnel boring machines. Tunneling speed is substantially increased by introducing such machines.

Tunnels interfere with ground water flow often resulting in drying up of springs and lowering of ground water table. Local people, depending on ground water, often complain about non-availability of water for drinking and other domestic purposes. Water supply by gravity from ponds at higher elevation through pipe systems is provided at extra cost incurred by the developers. However, maintenance and overhead costs can be borne by people if they are assured of firm piped water supply. Prior to hydro-power development, people used to walk daily down and up the slope which is an arduous task causing lungs and other respiratory deseases.

3.4 Land Slides

Most of the hydro-power projects are located in mountainous and hilly regions where the terrain is steeply sloping. Often there are landslides due to earthquakes, avalanches and other natural phenomena like high rainfall and run-off. Thorough geological study of such slide prone areas are now-a-days compulsorily carried out for deciding location of barrage, power house, tunnels, residential areas and to avoid geological surprises. Use of software like Geo-slope is a very tool for finding stability of hill slopes. Slides can be prevented by rock bolting, geo-textile netting and construction of gabion walls etc.

Mucks generated from tunneling and other construction works are carefully placed at selected sites with terracing and properly designed retaining walls. A minimum of 50m distance should be kept in between the flood line and first retaining wall so that the mucks do not join the river during rainy season.

3.5 Loss of Aquatic Life

All hydro-power projects are responsible for loss in aquatic life like fishes and other aquatic life mainly due to drying of the river in the stretch between barrage and power house. It is for this reason; Govt. of India has enacted to compulsorily ensure a minimum environmental flow usually 20 to 30percent of the lean season flow. Developers have a tendency to use as much dry weather flow as possible for generation purpose. It is very important to monitor that the minimum dry weather flow is admitted to the river from the reservoir either by regulating sluices or by installing dam toe type power house making use of the environmental flow for p[ower generation .

3.6 Loss of Eco-Systems

Environmentalists have serious objection to building hydro-power projects citing loss of eco - system, destruction of animal and plant life, especially those of endangers species. Their views should be respected and all necessary measures are adopted to protect eco-systems. Fish passes of improved design are inbuilt. Minimum dry weather flow ensures aquatic life and natural scenario a river offer to tourist\s and pilgrims. Elaborate environmental impact study is carried out to delineate endangered species and their protection measures. For every tree cut, new plants are sown, birds and animal sanctuaries are protected, and environmental flow released. The habitations and muck disposal areas are properly planned maintaining the natural landscape congenial to the region. All these provisions are inbuilt in the project planning and cost estimtes.

3.7 High Capital Costs

Hydro-Power development needs high capital costs because of long gestation period, acquiring land, rehabilitating affected persons and so on. Developers are required to build roads for communication, buildings for rehabilitation, social improvement by building schools, healthcare facilities, training of local people engaged in the project etc. Although not directly related to projects, such social activities need a lot of money and time. Without these activities, developers face a lot of resistance from local people often misguided by persons opposed to such development and more often by opposition political parties for their vested interest. Project authorities have to convince such people about the utility of the project by convening meetings and publicizing the developmental activities.

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