

## **OVERVIEW OF SMALL HYDRO POWER DEVELOPMENT IN HIMALYAN REGION**

**Manoj Kumar Kesharwani**

*Assistant Engineer Uttarakhand Jal Vidyut Nigam Limited  
Dehradun*

### **GEOGRAPHICAL ASPECTS**

The Himalayan region covers mainly eight countries i.e. India, China, Nepal, Bhutan, Bangladesh, Myanmar, Pakistan and Afghanistan. In Indian perspective Himalayas consist of four ranges extending about 2 500 kilometres from Arunachal Pradesh on the Tibetan border in the east to Jammu and Kashmir in the West. The mountains in the range are between 5 000 metres and 9 000 metres in height and fall steeply through sheer-sided gorges and river valleys to the northern Indian plain over only a few hundred kilometres.

The total land area of the Himalayas is about 600 000 square kilometres. Nineteen major river systems, including the Brahmaputra and the Indus, rise among the mountains. Our image of the Himalayas is dominated by jagged, snow-capped peaks, but in fact the bulk of this land area is below the snow line.

The physical geography provides excellent hydropower potential which was recognised very early in the history of modern hydropower. Nevertheless, there are a number of practical obstacles to the realisation of this potential. The region is quite harsh in climate and in some areas construction work is not feasible for a large part of the year. Many prospective sites are in quite remote locations and the infrastructure costs associated with their development are high. This inevitably pushes up the unit cost of installed capacity.

### **FROM THE WATER WHEEL TO HYDROPOWER**

Hydropower, or hydroelectricity, is a source of energy produced by the fall of water turning the blades of a turbine. The turbine is connected to a generator that converts the energy into electricity.

People have been benefiting from the power of water for more than two thousand years. Water wheels were used to grind wheat into flour as early as 100 B.C. During the 19th century, the water wheel was used to produce electricity. At the end of that century, the water turbine gradually replaced the water wheel, and soil and rock dams were built to control the flow of water. Since then, the hydroelectric potential of rivers continued to be developed.

Hydropower is recognized as a renewable source of energy, which is economic, non-polluting and environmentally benign. The history of hydropower generation in India is more than 100 years old. The first hydropower station in India was a small hydro power station of 130 KW commissioned in 1897 at Sidrapong near Darjeeling in West Bengal. Subsequently, many small hydro power stations were set up. With the advancement in technologies and increasing requirement of electricity, emphasis was shifted to large sized hydro power stations. In 1963, the hydropower had attained a share of 50.62% in the total installed capacity of power

generation in India. While there has been a continuous increase in the installed capacity of hydropower stations, which now stands on 32,976 MW, the share of hydropower has been reduced to 26% currently. Ministry of Power in the Government of India is responsible for the development of large hydropower projects in India. In order to maintain the balance between hydropower and thermal power, Ministry of Power has announced a Policy for accelerated development of Hydro Power in the country. Development of small hydro at an accelerated pace is one of the tasks in the Policy.

## **HOW HYDRO WORKS**

Hydropower converts the natural flow of water into electricity to light our homes and power our industries. The energy is produced by the fall of water turning the blades of a turbine. The turbine is connected to generator that converts the energy into electricity. The amount of electricity a hydropower installation can produce depends on the quantity of water passing through a turbine (the volume of water flow) or on the height from which the water falls (the amount of head). The greater the flow and the head, the more electricity produced. Some hydropower facilities include dams to increase the head of a waterfall or to control the flow of water, and reservoirs to store the water for future energy use (storage dam), while others produce electricity by immediately using a river's water flow (run-of-river). Some hydropower plants also use pumped storage systems, which store the water for reuse in the production of electricity during periods of high demand.

Presently, the following forms of hydro power projects are existing in India:

- Storage Schemes
- Run-of-River (ROR) Schemes without Poundage
- Run-of-River Schemes with Poundage
- Pumped Storage Schemes.

## **TOP TEN REASONS TO INCLUDE HYDROPOWER IN ALL RENEWABLE ENERGY INITIATIVES**

### **1 Hydropower is a renewable source of energy.**

Hydropower uses the power of flowing water, without wasting or depleting it in the production of energy; therefore, all hydropower projects – small or large, run-of-river or storage – meet the definition of renewable.

### **2 Hydropower supports the development of other renewables.**

Hydropower facilities with reservoirs provide a unique operational flexibility that allows them to respond almost immediately to fluctuating demands for electricity. Hydropower's flexibility and storage capacity makes it the best source to support the deployment of wind or solar energy.

- 3 Hydropower contributes to fresh water storage.**  
Hydropower reservoirs harvest rainfall, thereby supplying fresh water for drinking and irrigation. This fresh water storage protects aquifers from depletion, and reduces our vulnerability to floods and droughts.
- 4 Hydropower helps improve the air we breathe.**  
Hydropower is a clean source of electricity because it produces very few greenhouse gases, no other air pollutants, and it does not generate any toxic waste by-products.
- 5 Hydropower helps fight climate change.**  
By offsetting emissions from gas, coal and oil fired power plants, hydropower can contribute to reducing air pollution and to slowing down global warming. Currently, hydropower displaces the consumption of 4.4 million barrels of oil-equivalent each day.
- 6 Hydropower stimulates local and regional development.**  
Hydropower facilities bring electricity, roads, industry and commerce to communities, developing the economy, improving access to health and education, and enhancing the quality of life.
- 7 Hydropower optimizes the performance of other energy technologies.**  
Through flexible, reliable and efficient operation, hydropower ensures an effective electricity network, where the performance of thermal plants is optimized and air emissions reduced.
- 8 Hydropower fosters national energy security.**  
Water from rivers is a domestic resource that is not subject to fluctuations in fuel prices; therefore, hydropower fosters energy independence and security.
- 9 Hydropower means clean, affordable power for today and tomorrow.**  
With an average life span of 50 to 100 years, hydropower projects are long-term investments that can easily be upgraded to take advantage of the latest technologies. Hydropower is an electricity source with long viability and very low operation and maintenance costs that one generation bestows onto several subsequent ones.
- 10 Hydropower is sustainable development.**  
Hydropower projects that are developed and operated in an economically viable, environmentally sound and socially responsible manner represent sustainable development at its best; that is to say, “Development that meets the needs of the people today without compromising the ability of future generations to meet their own needs.”

## **CONSTRAINTS AFFECTING HYDRO DEVELOPMENT**

There are several constraints that affect the hydro power projects, such as,

- **Land acquisition problems:** Land acquisition is done by the State Government and often gets delayed due to litigation, poor maintenance of land records, etc.

- **Resettlement & Rehabilitation problems:** Reservoir schemes require large extents of lands to be acquired resulting in displacement of families. For example - Sardar Sarovar, Tehri, Indirasagar Projects. The national R&R policy addresses some of these issues.
- **Law & Order problems:** Most hydro projects are located along the Himalayas. Projects in J&K and States of the North East face problems on account of insurgency, terrorists, etc. Projects like Dulhasti (J&K) and Tuirial have faced several problems.
- **Difficult / Inaccessible sites:** Much of the untapped hydro potential is in the remote areas of the Himalayas for which excess roads running into over 100 kms. at a time have to be first constructed before work can commence. Further, power would have to be transmitted over long distances to load centers from these remote areas requiring construction of long transmission lines.
- **Geological Surprises:** In the Himalayan mountains in particular, geological surprises while tunneling causes large time and cost overruns.
- **Delays in environment and forest clearances:** The process for getting clearance is cumbersome and involves inputs from both State and Central Agencies. Delays occur particularly at the State level.
- **Inter-State Aspects:** Inter-State water disputes have come in the way of taking up of many projects.
- **Funding of hydro power projects:** Till recently, hydro projects were funded only by Government Agencies and hence only limited number could be taken up. Position has changed considerably in recent years.

## **HYDROELECTRIC POTENTIAL IN THE INDIA**

### **First Survey (1953-59)**

The first systematic and comprehensive study to assess the hydro-electric resources in the country was undertaken during the period 1953-1959 by the Power Wing of the erstwhile Central Water and Power Commission on the basis of prevailing technology of hydro construction and the constraints imposed by topographical and hydrological considerations etc. These studies placed the economical utilizable hydro power potential of the country at 42100 MW at 60% load factor (corresponding to an annual energy generation of 221 billion units).

### **Re-assessment Studies (1978-87)**

The re-assessment studies of hydro-electric potential of the country, completed by Central Electricity Authority in 1987, have placed the hydro power potential at 84044 MW at 60% load factor. A total of 845 hydroelectric schemes have been identified in the various basins which will yield 442 billion units of electricity. With seasonal energy, the total energy

potential is assessed to be 600 billion units per year. The hydro potential of 84044 MW at 60% load factor when fully developed would result in an installed capacity of about 150000 MW on the basis of probable average load factor.

### **Pumped Storage Schemes**

The development of pumped storage schemes attracted much attention in recent past because of important role in evening out energy generation from base load thermal stations and in meeting peak load and system contingencies. The reassessment studies of CEA acknowledged the need for identifying PSS sites and identified 56 sites for Pumped Storage Schemes (PSS) with total installation of about 94,000 MW. As on 1.1.2006, 8 schemes (3260 MW) are under operation and 3 schemes (1550MW) are under construction.

### **Hydro Share**

At present the hydro share in the total installed capacity in the country accounts for 26% . The total installed capacity of the country is 1,26,839 MW as under:

<b>SN</b>	<b>Fuel</b>	<b>Capacity (MW)</b>	<b>%age</b>
1	Total Thermal	83,772	66.0
	(a) Coal	68,988	54.4
	(b) Gas	13,582	10.7
	(c) Oil	1,202	0.09
2	Hydro	32,976	26.0
3	Nuclear	3,900	3.1
4	Renewable	6,191	4.9
	Total	1,26,839	

The position of hydro share in the total installed capacity over successive plan periods is as below:

<b>Year</b>	<b>1956</b>	<b>1965-66</b>	<b>1978-79</b>	<b>1989-90</b>	<b>As on July 31, 2006</b>
<b>Hydro Share as a %age of total installed capacity</b>	36.78%	45.68%	40.60%	28.77%	26.00%

### **Hydro Capacity Addition**

7th Five Year Plan: 3848 MW

8th Five Year Plan: 2427 MW

9th Five Year Plan: 5538 MW

10th Five Year Plan: 6500 MW (till date)

**Total Hydro Power Capacity : 32,976 MW (till date)**

**REGION WISE DETAILS OF HYDRO POWER CAPACITY IN INDIA**  
(As on 31.07.2006)

SN	REGION	CAPACITY (MW)
1	NORTHERN	11520.30
2	WESTERN	6798.80
3	SOUTHERN	11004.35
4	EASTERN	2429.35
5	NORTH EASTERN	1094.70
<b>TOTAL</b>		<b>32847.50</b>

**SECTOR WISE DETAILS OF HYDRO POWER CAPACITY IN INDIA**  
(As on 31.07.2006)

SN	SECTOR	CAPACITY (MW)
1	CENTRAL	9265.70
2	STATE	22445.35
3	PRIVATE	1136.45
<b>TOTAL</b>		<b>32847.50</b>

**SMALL HYDRO POWER – STATE OF THE ART**

**Background**

Small or mini–micro hydro power is one of the earliest known renewable energy sources, in existence in the country since the beginning of the 20th century. In fact much before that, the technology was used in Himalayan villages in the form of waterwheels to provide motive power to run devices like grinders. References to mechanical energy extraction have been found from as early as twelfth century.

SHP (small hydro power) technology was introduced in India shortly after the commissioning of the world's first hydroelectric installation at Appleton, USA in 1882. The 130 kW plant at Darjeeling in the year 1897 was the first shp installation in the country. A few other power houses belonging to that period such as Shivasundaram in Mysore (2 MW, 1902), Galgoi in Mussoorie (3 MW, 1907), and Chaba (1.75 MW, 1914) and Jubbal (50 kW, 1930) near Shimla are reported to be still functioning properly.

Most of these power houses utilized the high head available at the sites, and impulse turbines were generally preferred in such conditions. Initially, the development of SHP was restricted to small hilly streams in the Himalayan region lacking alternative sources of power. Later, between 1930 and 1950, some low head SHPs installations came up on a number of canals on the Ganga. The major impediment to SHP stations in the early stages was that high voltage transmission lines had not been developed, resulting in heavy line losses wherever the load centres were spaced far apart.

## International Network

Hydropower throughout the world provides 17% of our electricity from an installed capacity of some 730GW, making hydropower by far the most important renewable energy for electrical power production. The contribution of Small Hydropower (SHP) to the worldwide electrical capacity is of a similar scale to the other renewable energy sources (1-2% of total capacity). 23% of total technically feasible hydropower potential is exploited in China, 82% in USA, 65% in Canada, 73% in Germany, but only 5% in Africa and 13% in Asia as a whole. The world's installed capacity of small hydro plants is 47,000 MW, against an estimated potential of 180,000 MW. The development of small hydro projects appears strong in many parts of the world, especially in Asia.

## Definitions

One of the many definitions of Small Hydropower plants are available in today's literature are given in following table, and it varies in different countries

SN	Country	Micro (kW)	Mini (kW)	Small (MW)
1	India	<100	101-1000	1-25
2	China	-	<500	0.5-25
3	United States	<100	100-1000	1-30
4	France	5-5000	-	-

## Advantages of Small Hydro Plants

The Small hydro projects have following distinct advantages:

1. Hydro power involves a clean process of power generation.
2. It is a renewable source of energy and contributes to the upliftment of the rural masses, especially projects located in remote and inaccessible areas.
3. It is the most cost effective option for power supply because it does not suffer from the limitation on account of fuel consumption.
4. Most small hydro projects in Himalayan region are being developed in remote and backward areas where substantial support for economic development is actually needed.
5. Small hydro power contributes in solving the low voltage problem in the remote hilly areas and helping reducing the losses in transmission and distribution.
6. In certain cases projects are helpful in providing drinking water and irrigation facilities.
7. It helps in promoting the local industries in remote areas.
8. The development of small hydro projects requires minimum rehabilitation and resettlement as well as environmental problems .
9. Small hydro projects help in generating self employment in remote areas of the state.
10. Small hydro power projects help in providing stable electricity supply at remote areas where such facility by other source shall be much costlier and unreliable.

## **Potential in China**

China has built a total of 43,000 small hydro-electric projects with an installed capacity of over 35,000 MW for 300 million people living in the mountainous areas. The 43,000 small hydro-electric power stations nationwide produce 23 million kwh a year. According to International Symposium on Renewable Energy held recently in Guilin that China has 100 million kilowatts of explorable small hydro-electric power resources in mountainous areas, but only 29 percent of the resources has been used. According to Liu Yong, an expert with the Rural Electrification Institute, in China's rural area, 75 million people still have no access to power supply, and they still depend heavily on burning timber and straw, which is equivalent to burning 600 million tons of standard coal a year.

## **Small Hydro Power: Indian Scenario**

Hydro power is recognized as a renewable source of energy, which is economical, non-polluting and environmentally benign. Small and mini hydel projects have the potential to provide energy in remote and hilly areas where extension of grid system is un-economical. These projects are economically viable, environmentally benign and need a relatively short time for implementation and are not generally affected by the constraints associated with large hydro projects. Realizing this fact, Government of India is encouraging development of small and mini hydropower projects in the country.

Till early 1989, all activities pertaining to the development of SHP (Small Hydro Power) were under the administrative control of the Ministry of Power and the CEA (Central Electricity Authority), while the responsibility of execution and maintenance was with the SEBs (State Electricity Boards). Since 1989, Ministry of Non-conventional Energy Sources (MNES) has been responsible for small and mini hydro projects up to 3MW station capacity. The subject of small hydro between 3-25 MW has been assigned to MNES w.e.f. 29th November, 1999. In order to promote activities in this sector and to exploit SHP potential in the country in a systematic manner, the Ministry is adopting a multi-pronged strategy. Various physical and financial incentives are being extended to develop this sector. The focus of the SHP programme is now towards commercialization through private sector participation.

The small hydropower projects are developed in the potential regions by the State Electricity Boards/ State Agencies. Most of the SHP projects are grid connected. However, there are some projects, which are decentralized and are managed by local community/ NGOs. Recently, a programme on development and up-gradation of water mills has been started to directly use mechanical power for different applications. The Ministry is also implementing an UNDP-GEF Hilly Hydro Project in 13 States of Himalayan and Sub-Himalayan Region.

## **Development in India**

Small hydropower development is one of the thrust areas of power generation from renewables in the Ministry of Non-conventional Energy Sources (MNES). Ministry of Non-conventional Energy Sources is encouraging development of small hydro projects in the State sector as well as through private sector participation in various States. In 1989, when the

subject of small hydro up to 3 MW station capacity was given to the Ministry of Non-conventional Energy Sources, the total installed capacity of such projects was only 63 MW. In just 10-12 years, this capacity has increased 4 fold. Among the major initiatives taken in this regard includes identification of potential sites and their feasibility studies, R&D-cum-demonstration projects with new and innovative approach and technical and financial support to set up grid-connected as well as decentralized small hydro projects.

From 1989 to 1993, the thrust of the programme was on setting up of demonstration projects in various States to regenerate interest of State Governments/ SEBs to set up SHP projects. For this purpose capital subsidy of up to 50% of the cost of project subject to a maximum of Rs. 2.50 crores per MW was provided.

During 1993-94, keeping in view the over all policy of Government of India to encourage private sector participation in the field of power generation, the thrust of SHP programme was also shifted to encourage private sector for setting up of commercial SHP projects. All the States were requested to announce suitable policies for private sector participation in the field of SHP. For this purpose guidelines were issued by MNES to the States in September, 1993. So far 15 potential States have announced their policies for private sector participation in SHP sector.

Till December 31, 2004, 514 SHP projects with an aggregate installed capacity of 1693 MW have been installed. At the end of the 9th Plan the total installed capacity of SHP projects upto 25 MW station capacity was 1438.89 MW. A capacity of 80.39 MW was added during 2002-03. SHP projects with a total capacity of 84.04 MW were commissioned during the year 2003- 04, taking the total installed capacity to 1603 MW from 496 projects. In 2004- 05, 90 MW capacity from 18 projects was commissioned till December 2004. Besides these, 159 SHP projects with an installed capacity of 489 MW are under implementation. Small hydro power of station capacity up to 25 MW is being promoted.

### **Estimated Potential**

The estimated potential of Small Hydro Power is about 15,000 MW in the Country. In the last 10-12 years, the capacity of Small hydro projects up to 3MW has increased drastically. A database has been created for most potential sites by collecting information from various sources and the State Governments. The database for SHP projects created by MNES now includes 4233 potential sites with an aggregate capacity of 10,324 MW. It is proposed to further strengthen the identification of new sites during the 10th Plan period.

As there is still an unidentified potential of about 5000 MW in India, a new scheme for providing financial support to States for the identification of new potential sites and the preparation of a perspective plan for SHP development has been introduced. Models have been developed that take into account the regional flow duration curves, geological and seismological data, vegetation cover etc and that use Geographic Information Systems (GIS) for identification of potential sites. In this regard, a software package has been developed at Alternate Hydro Energy Centre (AHEC), IIT, Roorkee which incorporates regional

hydrological models that enable users to rapidly estimate the hydro power potential and other salient features of potential sites.

### **Commercial SHP Projects**

15 States in India namely, Himachal Pradesh, Uttar Pradesh, Uttarakhand, Punjab, Haryana, Madhya Pradesh, Chhattisgarh, Karnataka, Kerala, Andhra Pradesh, Tamil Nadu, Orissa, West Bengal, Maharashtra and Rajasthan have announced policies for setting up commercial SHP projects through private sector participation. The facilities available in the States include wheeling of power produced, banking, attractive buy-back rate, facility for third party sale, etc.

In States where policies were announced, an encouraging response has been received from the private sector. Over 800 sites of about 2000 MW capacity have already been offered / allotted in these States. The State of Himachal Pradesh has offered about 400 sites aggregating 570 MW followed by Uttarakhand offering 35 sites aggregating 175 MW

### **Renovation and Modernisation of SHP Projects**

MNES has a scheme for providing financial assistance for renovation and modernisation (R&M) and capacity up rating of Small Hydro Power Stations. Under this Scheme, financial assistance is provided up to 75% of the R&M cost or Rs.2 crores per MW, whichever is lower, to the utilities in Government sector/ Public sector. The R&M scheme has been extended to cover SHP projects up to 15 MW with a maximum support of Rs. 10 crores per project. The main aim of the scheme is to extend the life of these stations with improved performance and reliability.

### **Uttarakhand: Small Hydro Power Scenario**

#### **Introduction:**

Uttarakhand Jal Vidyut Nigam Limited (UJVNL) was incorporated as a Company by the Government of Uttarakhand on 14th February 2001, under the Companies Act 1956. UJVNL manages hydropower generation at existing power stations, organizes development and promotion of new hydropower projects with the purpose of harnessing already identified and yet to be identified hydro power resources of the State of Uttarakhand. UJVNL is one of the large hydropower companies of the country operating more than 31 power stations of different sizes ranges from 0.2 MW to 240 MW with a combined capacity of 1000 MW and of different vintages up to 100 years. Currently, UJVNL is in the process of developing 14 new large hydropower projects and 16 new small hydro projects. One of the projects, Maneri Bhalu –II (304 MW), is expected to be commissioned soon.

In Uttarakhand, the estimated capacity of small hydro power projects is 1478 MW out of approximate estimated capacity of 20000 MW. The estimated capacity of small hydro power projects of Uttarakhand is 8.7% of total estimated capacity of Hydro power in Uttarakhand and 10.25% of targeted contribution of Hydro power in 10th Five Year Plan. Uttarakhand Jal

Vidyut Nigam is primarily responsible for the Small Hydro development in Uttaranchal & is a nodal agency to speed up this development.

**Achievements/developments of UJVNL in the operation, maintenance & construction of SHP's after formation of state (9.11.2001)**

- a) After formation of Uttaranchal, Uttar Pradesh Jal Vidyut Nigam Limited has transferred 40 small hydro projects to UJVNL, out of which only 10 projects were in running conditions. UJVNL made efforts on those projects which are in closed condition and 6 Projects were made operative after carrying out necessary repairs. 10 projects are in unviable condition and are still in closed position.
- b) RMU works of six projects of total capacity 11.35 are in advanced stage and shall be commissioned soon .
- c) The following projects are in construction stage and shall be commissioned soon

d) The

Sl.No.	Project	District	Capacity (KW)
1.	Asiganga-I	Uttarkashi	4500
2.	Asiganga-II	Uttarkashi	3000
3.	Dunao	Pauri	1500
4.	Jumagad	Chamoli	1200

construction of following projects have been taken up with project funding from ADB in Ist phase :

Sl.No.	Project	District	Capacity (KW)
1.	Kaliganga-I	Rudraprayag	4000
2.	Kaliganga-II	Rudraprayag	6000
3.	Madhyameshwar	Rudraprayag	10000
4.	Kaldigad	Uttarkashi	9000
<b>Phase-II</b>			
1.	Tankul	Pithoragarh	12000
2.	Bhilangna*	Tehri	11000

- e) Eight projects of total capacity 41 MW are in various stages of development.
- f) Venturing into the areas of CDM: The Projects which are being constructed with ADB funding, are being put up to CDM Board for CDM benefits so that viability of the projects can be increased. Similarly all projects which are being planned shall have the options of using this facility.

### Performance of SHPs.

Integrated efforts by UJVNL have steadily increased the generation of SHPs after 9.11.2001 which is tabulated hereunder:

Year	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Generation (in MU)	28.5677	30.1243	40.9359	36.3511	40.1693	49.07

### Strategy planned for capacity addition:

(a) Earlier the projects used to be constructed with insufficient data and detailed investigation and Engineering, with the result that most of the existing running projects are plagued with the following problems:

- Under utilization of full capacity due to non availability of water.
- Non availability of grid connections.
- No detailed engineering.
- No protection against natural calamities.

Now case has been taken to base the capacity on detailed data and engineering has also been carried out utilizing external experts agencies. Safe designs have been adopted where ever found necessary power channels have been replaced by tunnels.

(b) Small hydro power is a class in itself and is instrumental in the development of remote areas of the state, therefore strategies have to be developed to facilitate the growth of the small hydro power stations.

- Geological Surveys are being conducted in thorough manner so as to locate the power station at a safe place making it less prone to natural calamities.
- Power Channels are more prone to land slides/cloud bursting etc., therefore the water conductor system is being changed to tunnel as per site specific conditions.
- Machines of simple design are planned to be used for the power stations located in far off areas for their easy operation & maintenance.
- Staff posted at these power stations is being given proper training in the operation & maintenance so as to minimize the down time.

### Impediments/Problems in operating SHP's :

The development & Operation of Small Hydro Power Projects poses unique challenges:

- i. The power stations are located in remote hilly areas where even road linkages are not available.
- ii. The small hydro power stations are prone to natural calamities such as flash floods due to cloud bursting, land sliding, avalanche's causing heavy damages & long shut

- downs. Road blockages & severe climatic conditions causing difficulty in construction, operation & maintenance.
- iii. Small Hydro Power Stations are normally connected through service lines or weak grid connections, therefore incidence of disruptions are mainly, causing low generation.
  - iv. The specific cost (Cost/kW) of a small hydro projects generally tends to be higher because of the intrinsic reasons associated with them comparatively small power output. The specialized nature of the generating plant and equipment especially in case of very small heads, leads to comparatively higher cost of generation.
  - v. Due to their locations in far off & inaccessible locations of the state, it is difficult to provide necessary technical skill & spares in case of breakdown, necessitating long shut down requiring heavy expenditure & loss of revenue.
  - vi. The new tariff which are not consume rate with the amount of efforts and risks involved in the small hydro power is making difficult to operate the plants on sustainable basis and making this sector unviable.
  - vii. The load factor of SHP's tend to lower and there is considerable variability in quantum of generation across different SHP's in different years. An important reason for there variations in output is the lack of entical size in case of SHP & also varying hydrological and climatic conditions for year to year.
  - viii. The plants have to be shut down for app. 30- days during monsoons due to high silt contents & debris in the flowing water which can not be handled by D-silting tanks. This happens normally every year.
  - ix. Some of the commissioned plants have highly sophisticated machines and without the availability of skilled labour in remote areas, there is lot of difficulty in operating & maintaining them . As a result the machines are degenerating and their efficiencies are declining.

### **Total SHP's Potential in Uttaranchal & UJVNL's Plan**

In Uttaranchal the estimated potential of small hydro projects is app. 1478.00 MW. Out of which UJVNL is operating nearly 51.75MW. The plan of UJVNL is detailed hereunder:

<b>Sl.No.</b>	<b>Status</b>	<b>No. of projects</b>	<b>Capacity (MW)</b>
1.	Under Operation	22	51.75
2.	Under Construction	8	39.2
3.	Under Development	8	41.00
4.	Under RMU	6	11.35
<b>Total Capacity</b>			<b>143.3</b>

Apart from UJVNL IPPs also plays major role in the capacity addition of small hydro power in Uttaranchal. Before separation of Uttar Pradesh, 32 small hydro projects of a total capacity abbot 182 MW have been allocated to private developer by the UP Government. These projects are in various stages of development and some of them will be commissioning soon. Uttaranchal Govt. has allocated 8 small hydro projects of a total capacity abbot 85MW to

private developers by two stage bidding process. Apart from these, 35 nos. of small hydro projects capacity ranging from 0.4 MW to 25 MW of a total capacity 175 MW are still available for allocation to private developers.

Recently Govt. of Uttaranchal in association with Infrastructure Leasing & Financial Service Ltd. (IF&FS) has taken a remarkable step for identification, survey and development of new small hydro power sites. In this continuation IL&FS has identified 23 no. of projects of a total capacity about 168 MW in Nayar, Khoh, Saraju, Western Ramganga, Kosi and Eastern Ramganga Valleys.

### **Conclusion**

The future of development of small hydro projects in Uttaranchal state is bright and in view many power stations shall come up in future which will facilitate the development of far off areas of the state and will provide quality power to the people of area. It is the need of time that the small hydro power development should take place keeping all the parameters of safety and quality management in place so that the problems which are hampering the operation and maintenance of existing power stations may not re-occur. UJVNL is spear heading the present URJA revolution in the state and helping in making it a URJA Pradesh in the true sense.

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