DEVELOPMENT OF SMALL HYDROELECTRIC PROJECTS BY UJVNL

Er S P Singh — *Managing Director*
Er S K Rastogi — *General Manager-SHP*
Uttaranchal Jal Vidyut Nigam Ltd., Dehradun

INTRODUCTION

Uttaranchal has a large network of rivers and canals which provides an immense scope for hydro-power energy. In India, the development of Micro, Mini, and Small Hydro Power Projects started in the year 1897. One of the first hydro-power stations in India was commissioned at Galogi in 1907 and is being operated by UJVNL. More power stations were subsequently developed over a period of time. In Uttaranchal, the estimated capacity of Small hydro power projects is 1478 MW[1] out of total estimated capacity of 20,363 MW.

Uttaranchal Jal Vidyut Nigam Ltd. (UJVNL) is a wholly owned Corporation of the Government of Uttaranchal setup for managing hydro-power generation at existing power stations and development, promotion of new hydro projects with the purpose of harnessing the known and yet to be known hydro power resources of the state. Overall Hydropower falls under clean energy, but the contribution of Small Hydro Power Projects become more significant as SHPs require minimal submergence, rehabilitation and minimal impact to Environment. Owing to the vast scope of SHP development and its established methodology for CDM registration, the Importance of SHPs has become more significant in Uttaranchal.

UJVNL is perhaps the only Hydro Power Company that operates as large as 30 SHPs and is therefore a representative of both Engineering, operating and commercial knowledge on SHPs. This year in the month of October, UJVNL is celebrating the centenary year of Galogi SHP and its premise is being developed as Galogi Complex.

PRESENT STATUS OF SHPS IN UTTARANCHAL

Today UJVNL operate Hydro power plants ranging in capacity from 0.2 MW to 240 MW totaling upto 1000 MW. The Government of Uttaranchal has decided to tap the available potential of small hydro power in the state and has framed a policy so that the development of this sector serves as an engine to achieve the objective of promoting the all round development of the region (source AHEC).

40 Small Hydro Power projects ranging from 0.05 MW to 6 MW were transferred to UJVNL at the time of formation of the state. Out of which 8 power stations have been declared unviable and 23 power stations are under operation including the projects commissioned after the formation of Uttaranchal with total capacity of 52.55 MW. Total SHP's Potential in Uttaranchal & UJVNL's Plan is shown here under:-

TOTAL AVAILABLE POTENTIAL -1478.00 MW		
UJVNL Projects under operation	52.55 MW	Details as per Table-1
Projects under RMU		
To be commissioned in 2006-07	2.55 MW	Pandukeshwar (0.75 MW), Chamoli & Chamoli Extn(0.80 MW), Gangori (0.80 MW), Koti (0.20 MW)
Projects under Rehabilitation		
To be commissioned in 2006-07	3.0	Urgam (Capacity included in projects under operation)
To be commissioned in 2007-08	8.0	Sobla-I (8MW)
Projects under Construction		
being commissioned in 2006-07	1.20 MW	Jummagad(1.20 MW)
being commissioned in 2008-07	9.00 MW	Asiganga-I(4.50 MW), Asiganga-II(3.00 MW) , (Dunav-1.50 MW)
being commissioned in 2009-10 under ADB financing	29.00 MW	Kaliganga-I(4.00 MW), Kaliganga-II(6.00MW), Madhyamaheshwar(10.00 MW), Kaldigad (9.00 MW)
Projects Under Devalopment		
Likely to be commissioned by June 2010	38.20 MW	Asiganga-III (3.0 MW), Urgam-II (3.80 MW), Painagad (4.0 MW), Kalsa (1.00 MW), *Tankul (12.00MW), Bhilangna-II (11 MW-Capacity under revision*) & Suringad-II (3.40 MW)
Total SHP Capacity under UJVNL Operations by June 2010	**140.50**	*The total capacity may increase due to revision in the capacity of Bhilanga-II*
Other developments to the capacity of 267.70 MW is being done by IPPs		

Table-1: Projects under Operation

IMPEDIMENTS/PROBLEMS IN OPERATING THE SHP'S

UJVNL has vast experience in the operation and maintenance of SHPs. The 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 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 critical size in case of SHP & also varying hydrological and climatic conditions for year to year.

vii. 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.

viii. 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.

ix. Many a times the telephone lines remain interrupted that create lack of communication, especially during monsoon.

x. Long transmission lines are prone to frequent damages.

Damaged Transmission line of Urgam (3000 kW) SHP

Damaged Headwork of Chirkilla (1200 kW) SHP

S. No	Name of Project	District	Installed Capacity (MW)
1	Urgam	Chamoli	3.00
2	Kotabag	Nainital	0.20
3	Kanchauti	Pithoragarh	2.00
4	Kulagad	Pithoragarh	1.20
5	Barar	Pithoragarh	0.75
6	Chirkila	Pithoragarh	1.50
7	Sapteshwar	Champawat	0.30
8	Chharandeo	Pithoragarh	0.40
9	Taleshwar	Pithoragarh	0.60
10	Garaon	Pithoragarh	0.30
11	Gauri	Champawat	0.20
12	Harsil	Uttarkashi	0.20
13	Suringad	Pithoragarh	0.80
14	Tharali	Chamoli	0.40
15	Tilwara	Rudraprayag	0.20
16	Sonprayag	Rudraprayag	0.50
17	Relagad	Pithoragarh	3.00
18	Pilangad	Uttarkashi	2.25
19	Badrinath	Chamoli	1.25
20	Tapowan	Chamoli	0.80
21	Galogi	Dehradun	3.00
22	Pathri	Haridwar	20.4
23	Mohammadpur	Haridwar	9.30
Total			**52.55**

IMPEDIMENTS/PROBLEMS IN DEVELOPING/CONSTRUCTING THE SHP'S

The problems faced in the construction of SHPs are:

i. Lack of Hydrological data: SHPs are constructed mainly on small streams (called gad in local language) or on the tributaries of rivers, whereas the hydrological data is available for major rivers. So the hydrological data for SHPs is interpolated/correlated which can not be very accurate. The occurrence of flash floods can not be ascertained due to non availability of this data and also it creates problem to optimize the design. It may also lead to under utilization or over estimation of the available potential.

ii. Seismic Zone: As we all know that major part of the Uttaranchal state is under seismic Zone-V and the remaining in zone-IV. So it is always susceptible to Earthquakes and the structural design has to take care of this, which in turn increases the cost.

iii. Uncertain Geological Conditions: Himalaya is among the youngest mountains so the Geological Conditions are very uncertain. Loose River bed Material (RBM), Unstable Slopes, Land/Avalanche Slides is encountered frequently.

iv. Tunneling (especially small sized, as applicable for SHPs) a new practice being adopted, is very difficult due to the uncertainty of Geology.
v. Unpredictable Geographical Conditions: Cloud bursting and slope failures have to taken care while constructing the SHPs. This is responsible to increase the cost as certain safety/protection works are to be done.
vi. To overcome the above problems the detailed investigation as required for LHPs is also required for SHPs. So the cost/MW as well as the time for construction increases.
vii. Remote Locations: Due to the remote locations, that to in the hilly terrain, big initial investment is required for the construction of approach roads and in the transportation of construction material, subsequently increasing the cost.
viii. Requirement of long transmission lines.
ix. Due to all the above reasons the capital investment required is of range Rs 5 to 7 Cr/MW, this is quite high than as required for LHPs (4 to 5 Cr/MW).

STRATEGY PLANNED BY UJVNL TO OVERCOME THE PROBLEMS IN THE OPERATION/DEVELOPMENT OF SHPS

To overcome the problems in Operation and Development following measures are being taken:

(a) Detailed Topographical Survey and Investigation considering various alternatives.
(b) Detailed Design and Engineering. Proper protection is provided against the Natural calamities while designing the Structures to construct the robust SHPs.
(c) Collection of discharge data. For this Gauges are being mounted on the streams and regular reading is being taken.
(d) Detailed Geological investigations (Surface as well as drilling/drifting).
(e) Detailed Study of the Power Evacuation System.
(f) To reduce the time for Procurement of Hydro-Electro Mechanical Equipments a separate pool is being created among the manufactures/Suppliers/Consortium. For this an Expression of Interest has already been floated.
(g) Have Established an Engineering Design and Development Division.
(h) Simple Design of machines is being adopted for smooth Operation and Maintenance.
(i) Open Power Channel is being replaced by Small sized Free Flow tunnels on the unstable or RBM/Overburden Zones.
(j) Common Governors and AVRs are being designed for easy operation.
(k) Weak/Unstable Grid/Distribution lines are being Stabilised/strengthened.
(l) Staff posted at these power stations is being given proper training in the operation & maintenance so as to minimize the down time.

TARIFF STRUCTURE FOR SHPS IN UTTARACHAL

The SHPs owned by UJVNL earlier had a tariff of Rs.1.70 per kwh. This rate was notified by the Government of Uttaranchal and adopted by the Commission for revenue requirement computations of Uttaranchal Power Corporation Ltd.(UPCL). Corresponding tariff paid to IPPs was Rs. 2.50 kwh. The Uttaranchal Electricity Regulatory Commission vide its

regulation of Apr 2005 had instructed to apply the regulations of 2004 (applicable for LHPs) on SHPs. On November 2005 hon'ble UERC has issued the relaxed regulations for initial tariff separately for SHPs less than 1 MW and for SHPs more than 1 MW but less than 25 MW. The salient features are as follows:

For SHPs less than 1 MW:

1. Relaxing the requirements of Uttaranchal Electricity Regulatory Commission (Terms and Conditions for Determination of Hydro Generation Tariff) Regulations, 2004 read with Commission's notification no. F-9(3)RG/UERC/2004/842 dated 03.01.2005, their tariff will be determined as the weighted average cost of power allocated to the State from central generatingstations. All other related provisions of these Regulations will continue to be applicable.
2. However, if a generator or any other stakeholder so chooses he will be free to seek determination of his tariff in accordance with the provisions of the Uttaranchal Electricity Regulatory Commission (Terms and Conditions for Determination of Hydro Generation Tariff) Regulations, 2004 read with Commission's notification no. F - 9 (3) RG / UERC/2004/842 dated 03.01.2005, without any relaxations.

For SHPs more than 1 MW but less than 25 MW:

i) The actual capital cost of such project will not exceed Rs. 5.5 Crore/MW.
ii) The actual PLF for a project will not be less than 45% determined on annual basis. As stated in the Approach paper, PLF means annual saleable energy as %age of the energy generated annually at plant's full installed capacity.
iii) In relaxation of Regulation 26 (2), the actual O&M expenses shall not be more than 3% of the capital cost. In addition actual insurance charges will be allowed subject to a ceiling of 1% of the capital cost.
iv) The Annual Fixed Charges (AFC) of such stations will be recovered from saleable energy available at 45% PLF through a single part tariff.
v) Electricity sold over and above the minimum PLF level of 45% will earn the generator only incentive calculated as per the rates given below.

Year after Commissioning	1	2	3	4	5
Rate (p/u)	26	26	25	24	24

vi) All other related matters will be decided in accordance with the Regulations already notified by the Commission.
vii) A generator will have the option to get its tariff determined in accordance with the Regulations as relaxed above but subject to the normative ceiling of the capital cost, O&M expenses and minimum PLF stipulated above. Alternatively, a generator could get its tariff determined strictly in accordance with the Regulations without any relaxations or normative ceiling or minimum stipulations. The generator will exercise this option at the time of determination of its first tariff and the options so exercised willbe valid for

the initial five years. Thereafter, tariff for all such projects will be determined only in accordance with the Regulations already notified.

viii) For projects which do not meet the normative ceiling of capital cost or the normative minimum PLF of 45% the tariff shall be determined in accordance with the notified Regulations without any relaxation, unless their tariff is determined through competitive bidding envisaged in section 63 of the Act or the Government could come forward to subsidise such projects.

ix) In case of more than one beneficiary, each beneficiary will bear the AFC and the incentive payable to the generator in proportion to its share in the total generation.

x) These provisions will apply only on a developer who enters into a power supply contract with the distribution licensee valid for a period of at least 20 years for entire or committed capacity.

IMPROVING THE VIABILITY OF SHPS USING CDM BENEFITS

The SHP is a renewable energy project and its operation can provide energy for social and sustainable development without contributing to GHG emissions is eligible for financing under CDM facility as envisaged in Article 12 of the Kyoto Protocol. The CDM has the following three stated objectives:

- To assist Parties not included in Annex-I i.e. Developing Countries in achieving Sustainable Development;
- To contribute to the ultimate objective of the Convention (i.e. stabilize Green House Gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system); and
- To assist Parties included in Annex-I (Developed Countries) in achieving compliance with their quantified emission limitation and reduction commitments under Kyoto Protocol.

UJVNL has prepared the PDDs for four SHPs for CDM benefits to be constructed with the financial assistance of ADB. SHPs require heavy initial Capital investment distracting investors as well as there are several other problems that have been discussed earlier that distract the development of SHPs and the CDM can be a good tool to increase the viability. It is expected that with availing CDM benefits for these projects a role model for the viability of SHPs would be set by UJVNL in the state of Uttaranchal.

As of now four SHPs that are being constructed with the financial help of ADB, are being covered by CDM. The Project Design Documents for them are ready and they are on the process to be Validate by the National Designated National Authority (DNA). The projects are:

1. Kaliganga-I (4MW) & Kaliganga-II (6MW) bundled together.
2. Kaldigad (9MW)
3. Madhyamaheshwar (10MW)

The PDD of above projects have been submitted to DNA and were presented for host country approval in Aug 2006. The clearance for Kaliganga and Madhyamaheshwar SHPs is expected

earlier as their land acquisition approval has been accorded and the clearance for Kaldigad SHP is expected later. After the approval from host country (India) the credits will be validated by validator (DNV-India) and will be registered by the Executive Board. The returns expected with the Sale of Certified Emissions Reductions from all the four SHPs would be around Rs 7.00 Cr per annum as per the table given below:-

Sl No	**Project**	**Annual CERs (tCO_2 eq = 1 CER)**	**Expected realization (Rs. Cr. Per annum)**
1.	Kaliganga I & II (10 MW)	53349	2.4
2.	Madhyamaheshwar (10 MW)	55742	2.5
3.	Kaldigad (9 MW)	50711	2.28
	Total	**159802**	**7.18**

BENEFITS OF SHPS

Govt. of Uttaranchal and Govt. of India are facilitating the development of small hydro projects in the state of Uttaranchal and UJVNL has been nodal agency for this development. 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 Uttaranchal 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.
11. The viability can be improved by incorporating the benefits of Carbon Trading.
12. A very good example of the SHP utilization is our Badrinath (2x1125 kW) SHP which is catering the power requirement of the holy Badrinath Temple and its habitation.

Badrinath (1250 kW) SHP responsible for the power supply to the Holy Badrinath Temple area

CONCLUSION

Small hydro power is a class in itself and is instrumental in the development of remote areas of the state. The future of development of small hydro projects in Uttaranchal state is bright and many power stations shall come up in future which will facilitate the development of rural areas of the state and will provide quality power to the people of area. As we have seen that out of 1478 MW of available potential only 404.80 MW shall be utilized till June 2010. 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 recur. UJVNL is spear heading the present URJA revolution in the state and helping in making it a URJA Pradesh in the true sense as well as the availability of good quality and reliable power will definitely improve the quality of life in far of regions. Thus SHPs can be the harbinger of development for rural and remote area of Uttaranchal.