Performance Evaluation of Existing Mini Hydro Power Projects of Uttarakand – A Case Study

Jyothi Prasad[1], H J Shiva Prasad[2]

Department of Civil Engineering, College of Technology,
G B Pant University of Agriculture & Technology, Pantnagar-263145, Uttarakand State, India

Email:prasad_jyothi@lycos.com, hjs_prasad@yahoo.com

ABSTRACT

Uttarakand lies in the Northern part of India amidst the magnificent Himalayas and dense forests. The State today with 13 Districts can be grouped into three distinct geographical regions, the High mountain region, the Mid-mountain region and the Tarai region. Uttarakand has been richer in terms of wild-life and forest area. The thick forests and mountains house a variety of wild life and plant species. The total protected wildlife area of Uttarakhand would be 34,359 sq km, sq km. The ecological zones likely to fall in this zone are upper Himalayas called the snow-bound zones, lower Himalayas and Shivaliks. All these zones support many rare plants and animal communities.

Uttarakand has a hydropower potential of the order of 15,000 MW against which only about 1124 MW has been harnessed so far. The Government of Uttarakhand (GoUK) has decided to encourage generation of power through Small Hydropower Sources of energy. There are 17 hydro-electric projects already producing electricity and many ambitious power projects including Tehri Dam are under construction. In this paper selected Small 5 Micro Hydro power projects of Uttarakhand have been evaluated for their performances, based on projects efficiency and other factors. Suggestions for suitable remedies for improving the performance of these Mini Hydropower Projects have been discussed.

1 INTRODUCTION

Water mills popularly known as 'Gharats' have been playing a vital role in the day to day life of people of Uttarakhand for the last several decades although in recent times - with the advent of new technologies- Gharats have been neglected a lot. But with the intervention of a few NGOs, Gharats in Uttrakhand are now being upgraded. According to rough estimates there are nearly 500,000 water mills in the entire Himalayan region from the North Eastern states to Jammu and Kashmir. Uttarakhand alone has more than 70,000 water mills. These water mills or Gharats are of the vertical shaft type, evolved over thousands of years and are used essentially for grinding wheat, rice and maize and also to extract oil. "In the absence of appropriate technology, water mills were never used for any purpose other than grinding," says Dr. Anil Joshi of Himalayan Environmental Studies and Conservation Organisation [HESCO] adding, "the basic principle on which they run is the same as that of a hydro-electric project to produce power."

The Waiting Potential

With growing awareness among water-millers and persistent effort by HESCO & Uttarakhand Renewable Energy Development Agency (UREDA), around 150 water mills have been technically upgraded since 1989 in the Garhwal & Kumaun region of Uttrakhand. If all these water mills could be used to produce electricity with minor changes, not only the energy requirement of the region could be met, but also a transformation can take place in the development of the Himalayan region. Abundant power produced in a decentralised manner would result in the development of the mountains. Till date only 22% of the total water potential has been tapped to generate power. Interestingly, the country's power need is nearly 126,000

MW but the power generated from water sources by big or middle sized dams is about 78,000MW. HESCO points out that if water mills are used directly for power generation across the Himalaya, the local power needs can be met sufficiently. Being a traditional activity of the mountains, knowledge, skill and infrastructure are all ready. Studies conducted at different levels reveal that the 500,000 water mills dotting the entire Himalayan region can produce as much as 2500MW of power, assuming each generates 5kW. That is a cash generation of Rs.1200 million per hour! Not only this: it can give employment to 1,500,000 people.

Water wipes out darkness

The eco friendly water mills could easily generate enough power for a village unit. When the entire region was in the grip of floods and houses were in darkness, the only lights were from the water mills.

In **Lachiwala** near Dehradun one such upgraded water mill generates enough electricity to light home appliances along with grinding grains. Says Thakur Singh who has upgraded his Gharat, "Electricity generated from Gharat is enough to run TV, refrigerator, cooler, fans and light bulbs." The cost to upgrade the water mill was around Rs.10,000 as per the owner.

In another example P S Bhandari of village **Khod** in Rudraprayag district of Garhwal was able to generate 5MW of electricity for his village. Mr Bhandari designed his own turbine and started generating power by putting his water mill to use. Due to his excellent effort, all 51 houses of his village have access to light. Mr Bhandari has provided one bulb per household and charges Rs.10 per month for his service.

Mr Ramesh Dhobal, activist involved with water mill movement says, "negligence and failure to improve the capacity of the traditional Gharat has resulted in the decay and closure of Gharats." Still, in the backward hilly areas, these units are doing excellent work, he elaborates.

2 OBJECTIVE

In this paper the performance of the 5 small hydro power projects of Uttarakhand Viz _Lacchiwala micro hydro project, Ramgaarh laghu jal vidyut pariyojna, Niti micro hydel project , Khairana (ramgarh) micro hydro project and Malari micro hydro power project has been studied.

3 PROJECT DESCRIPTION AND THE OBSERVATIONS

3.1 Lacchiwala Micro Hydro Project

Lacchiwala is a village situated on the foothills of Mussoorie. It is alongside NH 74 and is 20 km from Dehradun towards Haridwar. Song is the river that provides all irrigation facilities to the farmers. Apart from irrigation facility it also acts as a source of hydro-electric power. The village has a capacity of 200 villagers. The micro hydro power plant is setup there by HESCO as an initiative to provide electricity to complete area. It was established on 28th of August, 2005. The micro hydro power has three turbines with two of them are in continuous operation. The micro hydro power is working on simple principles and machinery, hence doesn't have any significant effect on the environment. Though the generators and turbines produce noise but that noise is not loud to be termed as noise pollution. Still there is scope for minimizing the noise pollution by keeping the generators in the insulated room. The village has 200 people, but not all of them draw electricity from the micro hydro project. Few villagers take electricity from power grid, hence the hydro power always runs short of its capacity. The tail race water serves as

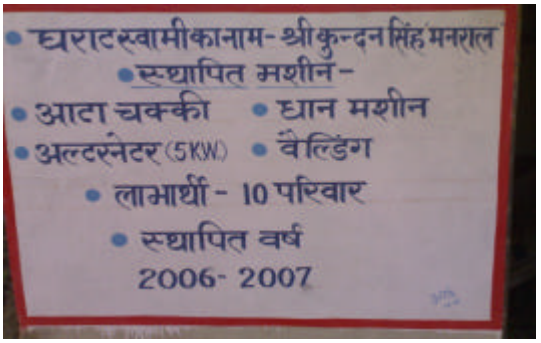
source of irrigation for the farmers and they buy electricity for their irrigation pumps and other heavy machinery. The hydro power has a capacity of 7.5kW but runs at capacity of 5 kW only, since the energy requirement in the locality is less.

Problems faced by the project:

During rainy seasons the water become violent and carries lots of sediment & boulders with it. These boulders and sediment effect the turbines hence the hydro power project has to be closed during the seasons of high discharge.

3.2 Ramgaarh Laghu Jal Vidyut Pariyojna

Ramgaarh project is situated on the banks of the tributary of river Kosi Ramgaarh. Its location is 30 km down towards Haldwani on Almora- Haldwani National Highway. The total capacity of the project is 5kW (1kW x 5). It was established during the year 2006-07 under UREDA. The project has been benefiting 10 families of the village Dopakhi (Bargal). It is a multipurpose project with electricity generation capacity as well as facility of flour mill (Punchakki) and Dhan machine. The owner of this project is Shri Kundan Singh Manral. The total number of 10 families are taking benefits from this micro hydro power project. The power project is situated on an isolated area so there is no problem of noise pollution or hazards to nearby villagers. The tailrace water adds to the stream flow of Ramgaarh thus enhancing the irrigation capacity for farming.



The problems observed during the site visit were

- There was breaching of the open channel just before the forebay tank which reduced the discharge.
- The channel is situated just downhill the road, so the slope lead to the direct dropping of leaves and other waste materials in the channel.
- This garbage material was blocking the way of penstock.

- The screening of materials has the temporary adjustments with wooden trap which was not efficient

3.3 Niti Micro Hydel Project

Niti Micro Hydel Scheme has been identified on the stream Ghat gadera in Chamoli district of the hilly region of Uttarakhand. The project is well connected by metalled road upto Gamashali and up to 200 metres foot track upto Niti. The diversion/intake site is about 0.75 km from Niti village. The power potential available with the project is 25kW (1 x 25).The preliminary investigation of the site was conducted by AHEC with UREDA, Chamoli and also the discharge of the stream was measured. The gross head has been found to be 74.0 mts. The discharge is 50 l/s at 90% dependable flow. The land for the project belonged to the people of Niti village which is free hold land. Since the land requirement is very small therefore there was land problem.

3.4 Khairana (Ramgarh) Micro Hydro Project

Khairna is a village situated on the foothills of Almora. It is alongside of NH 87 and is 20 km from Bhimtal towards Almora. Ramgaarh is the river that provides irrigation facilities to the farmers. Apart from irrigation facility it also acts as a source of hydro-electric power. The village population is about 400 in numbers. The micro hydro power plant is setup by UREDA, as an initiative to provide electricity to the area. It was established in the year 1990. The micro hydro power has three turbines two of them in operation.

Though the generators and turbines produce noise but that noise is not loud to be termed as noise pollution. The village has about 400 villagers but not all of them draw electricity from the micro hydro project. In total 372 families are taking benefits from this project.

The tail race water serves as source of irrigation for the farmers and they buy electricity for their irrigation pumps and other heavy machinery. The villages that are benefited from this scheme are Bargal, Garjoli, Khafulta, Jak, and Bhudlakot. The hydro power has a capacity of 100kW and runs at full capacity. Constant efforts are being made in tapping the full energy of micro hydro power. UREDA has come in front for this initiative.

3.5 Malari Micro Hydro Power Project

Malari is a village in hilly area, which do not have much of power requirement due to being undeveloped, since it is situated in a remote area. The village is cut of from the Ganges plain by the Garhwal range of greater Himalaya which comes under the great Himalayas. The village is 76 km from Joshimath and a single lane moterable road is the only connection from India. But the village is of vital importance for India, as it is situated near the China border and foreseeing the present claim of China over this territory, it is very important for India that the village maintains its identity. In to provide better living conditions to the residents of village, Government of India developed a micro hydropower plant with the help of UREDA.

The 50kW plant (2 x 25kW) has now become the life line of village as it caters to the need of 90 families of the village and a border outpost establishment of Indo Tibetan Border Police (ITBP) force. The power plant taps water from a local rivulet called Malari gaarh, though most of the time and only 25kW electricity can be produced due to paucity of water. 50kW is being produced only in the month of June, July and August. The power plant has to be stopped in the month of January, February due to freezing of water. Due to electrification of village the living conditions in the village has improved and the Government have succeeded to check migrating population from the village.

4 EVALUATION OF THE PROJECTS

Performance evaluation studies of the projects under taken are Environmental, Social and Technical aspects like Utilization factor, Plant outage factors are considered.

Sl.No	Name of the Project	Utilization factor	Plant outage factor
1	Lacchiwala Micro Hydro Project	0.66	0.37
2	Ramgaarh Laghu Jal Vidyut Pariyojna	0.80	0.33
3	Niti Micro Hydel Project	0.88	0.08
4	Khairana (Ramgarh) Micro Hydro Project	0.80	0.30
5	Malari Micro Hydro Power Project	0.54	0.65

In Lacchiwala Micro Hydro Project the utilization factor of the plant was found to be 0.667, due to the project not getting sufficient head. The flow of water is comparatively less, even there were friction losses due to mechanical wear and tear. The channel carrying water is not lined, thus results in loss of head. This can be improved by Lining of channel carrying water and timely maintenance of turbines and other mechanical devices. During rainy seasons the water become violent and carries lots of sediment & boulders with it. These boulders and sediment affect the turbines of this project, hence the hydro power plant has to be closed during the seasons of high discharge. The solution of this problem is providing sediment traps so that sediments and boulders do not enter into the turbine system. The plant outage factor comes out to be 37% which shows that efficiency of the plant decreases to 37%. It shows that there is mechanical breakdown in the turbine or other mechanical machinery.

In case of **Ramgaarh Laghu Jal Vidyut Pariyojna,** the utilization factor of the project is 0.8, but when there is loss due to unavailability of sufficient water discharge or any other functional or machine failure, the plant outage factor comes out to be nearly 0.33, which is too less. So measures are required to enhance the performance of plant in case of breakdown of any part, so that plant outage factor comes with a lower

value. In this project unavailability of the water is not due to the shortage of water in the stream, but due to garbage deposition and breaching. Continuous cleaning and proper care is required to ensure efficient working. Breached part must be repaired to prevent loss of water in the stream.

In Niti Micro Hydel Project the utilization factor of the project was found to be 0.88 but when there is loss due to unavailability of sufficient water discharge or machine failure, the plant outage factor comes out to be nearly 0.08 which is very less. Water conductor system of the plant has a length of 450m and care must be taken along the whole length in case of any damage to the pipe in any section of length.

Khairana (Ramgarh) Micro Hydro Project Utilization factor of plant found to be 0.8. This is because of the losses due to mechanical wear and tear and the penstock gets damaged because of boulder hitting the metal casing. Utilization factor can be improved by timely maintenance of turbines and other mechanical devices. During rainy seasons the water flow velocity is very high and it will carry lots of sediment & pebbles with it. These pebbles and sediment affect the turbines, hence the plant has to be closed during the seasons of high discharge. The solution of this problem is providing sediment traps so that sediments and pebbles do not enter into the turbine system. Plant outage factor comes out to be 30%. In this site there is a constant problem of penstock damaging as boulders from the hills fall on it during the rainy season. The remedy to this problem is to provide proper maintenance to the turbines and generators. The belt of turbine can be replaced with chain of a cycle with proper greasing done from time to time. The penstock should be cased with concrete or metal casing to prevent its damaging.

Malari Micro Hydro Power Project gave an utilization factor 0.54 and is due to the above mentioned reasons only. But sometimes plant has to be stopped for over hauling and repairing. Hence it is suggested that Utilization factor can be improved by relaying of pipes to get the desired head and the fragile ice can be avoided by building up turbulence where its deposition creates problem for ex. put ribs inside the penstock.

5 CONCLUSION

Uttarakhand have an immense scope of development of micro hydropower projects as large number of rivulets runs along its land. Moreover most of the villages are situated along these rivulets only and at many places there is even more than one, these are the lifeline of the villages. The local people call them gaarh and these gaarhs can be proved as the energy boosters of the villages.

The major problems faced by these projects due to which the plant outage factor is elevating are-:

1. Paucity of water.
2. Breaching of conduits.
3. Very high flow during rainy seasons.
4. Silt and muddy water during periods of high discharges.
5. Freezing of water.
6. Problem of fragile ice.
7. Non availability or inaccessible grids to tap up surplus energy produced.
8. Wear and tear of conveyor belt.
9. Large time lapsed in repair and replacement of parts due to remoteness of power plants.

Following remedial measures are suggested to minimize the plant outage factor.-:

1. Connecting two or more gaarh where available.
2. Lining of conduits, as it will also reduce losses as well as breeching will be checked.
3. Making proper arrangement for disposing surplus water during high discharge.
4. Installation of filters.
5. The fragile ice can be avoided by building up turbulence where its deposition creates problem. For eg. put ribs inside the penstock.
6. Foam method may also be used as in other countries to deal with ice.
7. Extending grids to the micro hydropower plants where surplus energy is produced.

REFERENCES

Student's B Tech Project unpublished report and site visits