Prospect of Small Hydro Power in Uttarakhand

Awadhesh Kumar[1] Dr. ShriRam[2]
[1]P.G. Student [2]Associate Professor
[1,2]Department of Civil Engineering
[1,2]Madan Mohan Malaviya University of Technology Gorakhpur- 273010 (U.P.), India

Abstract— Uttarakhand is riched with natural renewable resources for generating electricity. As we know that Uttarakhand is about to fully hilly areas. Due to the fully hilly regions, the hydro power available in Uttarakhand can be harnessed by installing the small hydro power plant. The estimated potential of this state for small hydro power plant is more than 1708 MW. The installed capacity of small hydro power is 174.82 MW and under implementation capacity is 174.04 MW. Therefore in this state a large amount of small hydro power is yet to be harnessed by the small hydro power plant. Uttarakhand has a large network of rivers and canals which provides an immense scope for hydro power energy. In India, the Development of Small Hydro Power Projects was started in the year 1897. In India, the first hydro power station was a small hydro power station of capacity 130 KW commissioned at Sidrapong near Darjeeling in West Bengal in 1897.

Key words: Hydro power, small hydro power plant, layout of small hydro power plant, components of small hydro power plant, analysis of small hydro power project Ramgarh, Nainital Uttarakhand

I. INTRODUCTION

Hydro power is defined as the source of renewable energy which is pollution free and environmentally benign. Hydro power is the oldest technique for conversion of the mechanical energy into electricity generation. As we know that, petroleum products, coal etc. will be exhausted in future time. Therefore for decreasing the dependence on these resources for power, it is very necessary of the development of hydro power. Hydro power is cost effective form of energy. It has additional benefits like irrigation, flood control, tourism etc.

In Uttarakhand, due to the hilly areas the supply of power by the grid systems to the villagers or community situated in hills are very difficult and also very costly. Therefore, the supply of power to these peoples becomes very easy by installing the Small Hydro Power Plant. By this hydro power plant the supply of power up to 10 villages or up to 300 families can be completed easily. An additional benefit of this hydro power plant is the employment to the local peoples. Because these hydro power plants are operated by the Local Urja Samiti. Local Urja Samiti maintain the hydro power plant, operate it and the charge of electricity is taken by the Samiti from the consumers. The extra power after supplying the power to the villagers and towns is given to the grid of the state. The government helps to the Local Urja Samiti only in case of happening disaster. Therefore in Uttarakhand the power generation can be completed easily by installing the small hydro power plant.

II. HYDRO POWER

Hydro power is defined as the power which is derived from energy of falling water at high elevation. A power station in which potential energy of water is converted into electrical energy is called hydro-electric power station. In this type of station, a large quantity of water must be available at the sufficient head. So it is located in hilly areas where dams can be built at suitable place to store large -

III. SMALL HYDRO POWER

Hydro power projects up to 25 MW capacities (i.e. 25000 KW) are known as Small Hydro Power (SHP) Projects. The classification of hydropower system is not same all over world. A list of capacity of small hydropower defined in different countries is given in following table:

Country	Capacity of Plant
USA	≤ 5 MW
UK	≤ 5 MW
Sweden	≤ 15 MW
Colombia	≤ 20 MW
Australia	≤ 20 MW
Canada	≤ 20 MW
India	≤ 25 MW
China	≤ 25 MW
Philippines	≤ 50 MW
New Zealand	≤ 50 MW

IV. HYDRO-ELECTRIC POWER STATION (A SCHEMATIC DIAGRAM)

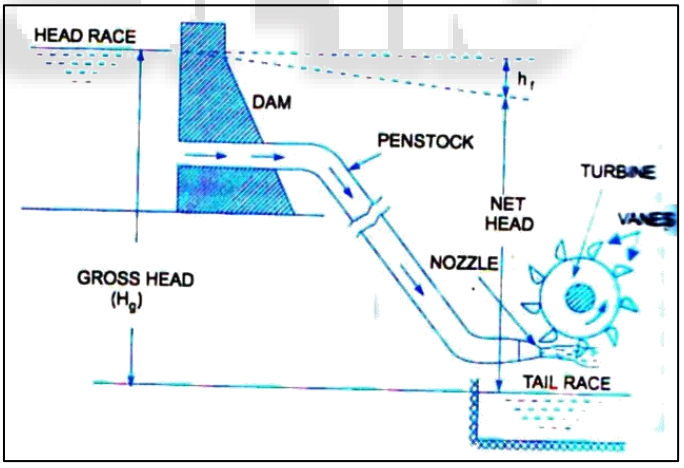

Fig. 1: Hydro-electric power station

V. BASIC EQUATION FOR CALCULATING SMALL HYDRO POWER

The basic equation for calculating small hydro power is as following:

$P = \rho g H Q \eta$ (1.1)

Where, P = Electric power generated in watt
ρ = Density of water (1000 kg/m^3)
g = Acceleration due to gravity (9.81 m/s^2)
H = Net Head (height difference between the water levels at the Intake and the tailrace minus all head losses in headrace and Penstock) in meters.
Q = Discharge or design flow rate in m^3/s

η = Overall efficiency of the turbine, generator and gearbox (may be taken between 0.65 to 0.80)

VI. Components Of Small Hydropower Project

The important components of small hydro power project are as following:

A. Civil Work Components

1) Dam

Adam is a hydraulic structure constructed across a river to store water on its up-stream side.

2) Weir

The function of a weir is to obstruct water flow and raise the water level significantly and sometimes to allow water storage

3) Intake

The water is conveyed from the forebay to the penstocks through the intake structure.

4) Desilting tank

Out of all the essential civil components, the desilting tank is one of the most vital part of SHP schemes, which rejects the sediment (silt) and foreign particles carried by water through the conductor system and protects the hydro mechanical equipment's from the harmful silt carried by the conducting system.

5) Forebay

It is like a pond at the top of the penstock, which serves as a final settling basin for suspended matters in the water. It also provides submergence for the penstock inlet and accommodates overflow and trash rack arrangements.

6) Conveyance line or Headrace

It conveys the water from the intake to the Forebay. A typical headrace is made of pipes of good quality materials.

7) Penstock

Water from the storage reservoir (Forebay) is carried through penstock or canals to the power-house. Penstocks are the pipes of large diameter, usually made of steel in various forms, reinforced concrete or wood stave, which carry water under pressure from the storage reservoir to the turbine.

8) Tailrace

Tailrace is the channel into which the draft tube discharges.

9) Powerhouse

The powerhouse provides shelter to the electromechanical equipment (Turbine, Generator, Control and Panels).

10) Substation

It consists of switchgear and transformers to transform the voltage from the small hydro generator to the higher voltage transmission lines.

11) Spillway

A spillway is a structure constructed at a dam site, for effectively disposing of the surplus water from upstream to downstream.

B. Electro-Mechanical Components

1) Turbines

Turbines are defined as the hydraulic machine which converts hydraulic energy (energy of water) into mechanical energy.

2) Generator

Generator converts the mechanical energy input from the turbine into electric energy output.

3) Governor

The governing of a turbine is an operation through which the turbine speed is kept constant under all working conditions. It is completed automatically by means of a Governor, which regulates the rate of flow through the turbines according to the changing load conditions of the turbine.

4) Control System

These are required to monitor and regulate the power produced from the generators in powerhouse.

5) Transformer

The transformer inside the powerhouse takes the AC and converts it to higher voltage current.

C. Distribution System

The size and types of electric conductor cables required, depends on the amount of electric power to be transmitted and the length of the power line. For most SHP systems, power lines are single phase. However, sometimes three phase power lines are used.

VII. Analysis of Small Hydro Power Project Ramgarh, Nainital Uttarakhand

Ramgarh Small Hydro Power Project, Nainital is established on the "River Ramgarh", which originates from the "Gadera Hill", which is situated near (very close) to Haldwani – Almora National Highway. The Gadera hill is situated about 2.5 KM from the Haldwani – Almora National Highway. The site is located in Ramgarh, vikas khand Betalghat. The distance of this power plant from Haldwani District is about to 65 KM. The distance of this power plant from the Nainital District centre is about to 35 KM. The distance of this power plant from Haldwani Railway Station is about to 70 KM. In the flow of Ramgarh river four dhar confluence

The geographical coordinates of the Ramgarh Small Hydro Power Plant are as under:

Latitude: $29^0 27'$, Longitude: $79^0 28'$

1.	Ramgarh SHP	65 KM	From the Haldwani District Centre
2.	Ramgarh SHP	70 KM	From the Haldwani Railway Station
3.	Ramgarh SHP	35 KM	From the Nainital District Centre
4.	Ramgarh SHP	35 KM	From the Almora District Centre
5.	Ramgarh SHP	308 KM	From Dehradun Capital of Uttarakhand

Fig. 2: Ramgarh small hydro power project Nainital Uttarakhand

Ramgarh River is a perennial river, originating from Gadera Hill. This power plant is located near the highway of Haldwani Almora District. The main occupation of habitants of living of the people of this area is agriculture.

This power plant was established by the Uttarakhand Renewable Energy Development Agency (UREDA), Nainital with the help of "Ramgarh Urja Samiti" in the year 1990. Due to the mountainous region, the supply of power from grid was very difficult and also very costly. And by this Ramgarh power plant it becomes very easy to supply the power to the villagers of this area.

By the, Ramgarh Small Hydro Power Project, the electric power is supplied to the villages named as, "Kafulta, Bargal, Garjoli, Jakh and Bubhlakot" and also a mobile tower and a maximum power of 54 KW is given to the UPPCL. The total benefited family by this power plant is 372.

The Ramgarh Small Hydro Power Plant is of 100 KW (2x50 KW) capacity. In this power plant, there are two units each of 50 KW. The total head of this power plant is 53.8m. The discharge of this power plant is 306 lps (litre/second).

The operation, maintenance and work of care are completed at local level by the selected Urja Samiti. By these Samiti, production of energy, distribution, to fixation of electric charge, to take charge of electricity, distribution of new connection, operation of projects and maintenance work is completed at local level. On the happening of any type of harm by the disaster, the financial support is provided to the Urja Samiti by UREDA. In case of other type of damage, like problem in transformers, control panel repair and other works, total expenditure is paid by the Urja Samiti self. Besides this, three trained operators are appointed for the operation of project by the Urja Samiti. Their salary to these operators is given by the Urja Samiti itself by the income of power plant. The power supplied to the UREDA by this power plant at the rate 2 rupees and 20 paise per unit and rate for villagers is charged by the Urja Samiti itself.

A. Ramgarh Small Hydro Power plant in a view:

- Capacity – 2x50 kilowatt
- Total head – 53.8 m
- Discharge – 306 lps
- Benefited villages – Kafulta, Bargal, Garjoli, Jakh and Budhlakot
- Total benefited family – 372

B. Technical Detail

- Length of the dam – 25m
- Power canal – 780m
- Desilting tank – (4x2.4x2.0)m
- Forebay tank – (6.5x5x2.75)m
- Powerhouse – 12x6m
- Turbine – 62.5 KVA x2
- Alternator – 62.5 KVA x2
- Hydraulic Governor – 62.5 KVA x2
- Electric line – HT-12Km, LT-24Km
- Transformer – 160 KVA- 2No
- Transformer - 25 KVA-7No
- Transformer – 5 KVA-2No

C. Detail about Component of Ramgarh SHP

1) Turbine

- Type – Turgo Impulse (350T) Jyoti make
- Number – Two (S.N.247/439 & 247/440) Year 1988
- Capacity – 50 KW each, RPM – 750, Head – 50 m, Discharge – 145LPS

2) Generator

- Type – Synchronous (SESR) Jyoti make
- Number – Two (S.N. – 6775 & 6776), Year – 1988
- Capacity – 62.5 KVA, RPM – 750, PF – 0.8
- Voltage level – Three phase, 415V, 50Hz, Star connection

3) Hydraulic Governor

- Type – Oil Pressure, Jyoti make
- Number – Two (S.N.-247/359 & 247/359)
- Capacity – 125Kg-m

4) B/F Valve

- Type – Solenoid coil
- Number – Two (S.N.-247/522 & 247/523)
- Size – 300mm
- Opening system – By Hand Pump
- Closing system – Automatic assisted by counter weight with limit switch

5) Sluice Valve: 300mm

6) Control panel

- Type – Cuboids

7) Penstock

- Type – ERWMS-5
- Diameter – 450mm
- No – 1
- Thickness – 4.00mm

VIII. Advantages of Small Hydro Power

The advantages of small hydro power are following:

1) Hydro power consists a clean process of electrical power generation
2) It strong the financial condition and standards of living mainly inaccessible and hilly areas where limited or no electricity at all.
3) Low investment is required which can easily be affordable by private entrepreneurs.
4) It is a renewable source of energy and contributes to the upliftment of the rural masses, especially projects located in remote and inaccessible areas.
5) Operation, running and maintenance costs of Small Hydro Power are low.
6) Once the dam is constructed, the hydro energy is almost free.
7) Since in hydro power plant burning is absent, therefore plant is very clean and neat.
8) Generating plants have a long lifetime.
9) Hydro power is more reliable than solar, wave and wind power.
10) It helps in promoting the local industries in remote areas
11) Electricity can be generated constantly
12) Small hydro project helps in generating self-employment in remote areas of the states.

IX. DISADVANTAGES OF SMALL HYDRO POWER

The disadvantages of Small Hydro Power are as following:

1) Power generation is based on the water availability.
2) Small hydro power plant is also a reason of flood for large regions.
3) Dam construction cost is very high.
4) Large dam are the reason flood during upstream. It is harmful to human being.
5) Selection of place for dam construction is very difficult.
6) The overflow of water is also affect the plants life.
7) Environmental problems are also arises due to the construction of the dam.
8) The power generation depends on nature and in dry season the generation of power reduces.

X. CONCLUSIONS

Uttarakhand is a more suitable place for installing small hydro power plant for the electricity generation due to the fully mountainous regions. In Uttarakhand there are large number of small rivers in which water availability is throughout the year. Due to this a large number of small hydro power can be installed for supply the electricity to the remote and inaccessible are of Uttarakhand. In this state total estimated potential for small hydro power is 1708 MW, installed capacity is 174.82 MW and under implementation capacity is 174.04 MW. On the basis of these data, we get that, in this state, there are large amount of hydro power which are yet to be harnessed. This work can be completed easily by installing the small hydro power plant.

In the analysis of Small Hydro Power Project Ramgarh, Nainital, we get that, this hydro power plant is very economical for providing the electricity to the villages near about this. In this hydro power plant, there are only three operators which operate the power plant efficiently. Therefore, it is clear that this type of small hydro power plant can be installed in great number in Uttarakhand for harnessing the available hydro power. Therefore, in Uttarakhand large bright scope is available for small hydro power plant.

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