

# Small Hydro Power and its Potentiality in Assam

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**Abstract**— Small Hydropower is a Renewable non-polluting and environmentally benign source of energy. This study is intended to illuminate in terms of technology, power generation and installation of small hydro power plants particularly in Assam, which is very much suitable as an alternative to big dams, detrimental to the sensitive ecosystem of the region. It is reported that Assam has a hydropower potential of the order of 541 MW against which only 2.00 MW has been harnessed. The hilly areas of the State have good hydro potential as small streams can be harnessed for decentralized power generation through small hydro development. Due to lack of road communication in the difficult terrains, where most of small hydro sites are located in the state, the tapping of this resource has become difficult.

**Keywords**— small hydro power, hydro power potential in Assam, installed capacity, megawatt (MW), renewable energy, power, Karbi Anglong

## I. INTRODUCTION

Small Hydro Power (SHP) projects are those that produce electric power not more than 25 megawatt (MW). It is further divided into three classes – small, mini and micro power plants. Power plants up to a capacity of 100 kilowatt (KW) are called micro power plants. Hydro power plants that are anywhere between 100 KW and 2 MW are termed as mini hydro power plants. Those that have a capacity more than 2 MW and up to 25 MW are small hydro power plants. SHP plants differ from bigger hydro power plants in terms of scale. While the large hydro power project needs huge area to create a captive lake that leads to displacement of people, small hydro do not have any such requirements – an entire SHP plant can be set up in a small area in the order of just 2 acres. In fact, the land requirement in SHP is never more than 3 to 4 acres.<sup>[1]</sup>

## II. TYPES OF SMALL HYDRO POWER

Mode of operation of Small Hydropower plant can be distinguished from the point of view of water flow in three Schemes<sup>[2]</sup>:

### A. Run Of River

- i. No storage
- ii. The output is subject to instantaneous flow
- iii. Reliability of discharge and geological conditions should be ensured

### B. Canal Based

- i. Utilizes the fall and flow in the canals
- ii. May be planned in main canal or in bye-pass canal

- iii. Nearby drops should be clubbed in existing canals
- iv. In canals under planning concentrated drops should be considered

### C. Dam Based

- i. Dam toe schemes are most common in India
- ii. Water stored during monsoon is utilized for power generation

## III. SMALL HYDRO POTENTIAL IN ASSAM

Development of small hydro in India dates back to 1897 with setting up of the first hydropower plant in India 130 Kilo Volt (kV) capacity in Darjeeling known as Sidrapong small hydro power station to supply electricity to the local areas in a decentralised manner<sup>[2]</sup>.

Assam is situated in the North-East of India and is the largest north eastern state in terms of population while second to Arunachal Pradesh in terms of area. Assam is encircled by six north eastern states, viz., Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, and another state West Bengal. Moreover, the countries Bangladesh and Bhutan share international borders with the state. The hilly areas of the State have good hydro potential as small streams can be harnessed for decentralized power generation through small hydro development. These hilly areas mainly fall within the two hill districts - Karbi Anglong and North Cachar Hills. The exact estimation of total potential of small hydropower development in the State is yet to be made. In Assam mainly two agencies, the Assam Power Generation Corporation Limited (APGCL), a corporation of Assam State Electricity Board (ASEB), and the Assam Energy Development Agency (AEDA), are involved in survey, preliminary investigation, preparation of Detailed Project Reports, and execution of small hydro projects.

The APGCL has so far identified 93 small hydro sites with a total potential of 159.37 MW, 1 of which has already been commissioned but has been inoperative since 1993 while 4 others are under various stages of execution details of which are given in Table I<sup>[3]</sup> and Table II<sup>[3]</sup>.

The AEDA has so far identified 6 small hydro sites having a total potential of 2.21 MW, 2 of which have already been commissioned while DPRs have been prepared for 3 sites. AEDA had also made a hydrological study of a site at Bichitur in Karbi Anglong District where a potential of generation of about 1.8 MW has been identified. The details and status of the small hydro projects identified by AEDA are given in Table III<sup>[3]</sup> and Table IV<sup>[3]</sup>.

TABLE I  
SMALL HYDRO SITES IDENTIFIED BY APGCL

Sl. No.	District	No. Of Sites Identified	Total Potential, MW	Remarks
1	Karbi Anglong	45	80.90	1 (2MW) commissioned but inoperative since 1993 2 (6MW) under execution 1 (6MW) under execution but work suspended
2	NC Hills	26	29.90	
3	Darrang	2	20.20	1 (20MW) under execution
4	Sivsagar	2	15.02	
5	Sonitpur	3	4.05	
6	Nalbari	1	3.00	
7	Nagaon	7	2.80	
8	Cachar	2	2.50	
9	Dibrugarh	4	1.30	
10	Kamrup	1	0.40	
	TOTAL	93	159.37	

TABLE II  
STATUS OF SMALL HYDRO PROJECTS OF APGCL

Sl. No.	Name of the Scheme	District	No. X KW	Status
1	Bordikharu	Karbi Anglong	4 x 500	Already commissioned but inoperative since 1993
2	Dhansiri	Darrang	5 x 3 x 1330	Ongoing under execution
3	Lungnit - I	Kabi Anglong	2 x 1500	Ongoing under execution
4	Lungnit - II	Kabi Anglong	3 x 2000	Works suspended for paucity of fund and other reasons

TABLE III  
SMALL HYDRO SITES IDENTIFIED BY AEDA

Sl. No.	District	No. Of Sites Identified	Total Potential, MW	Remarks
1	Karbi Anglong	3	1.90	DPR prepared for 2
2	Kamrup	3	0.31	Commissioned 2
	TOTAL	6	2.21	

TABLE IV  
STATUS OF SMALL HYDRO PROJECTS OF AEDA

Sl. No.	Name of the Scheme	District	No. X KW	Status
1	Kalmoni	Kamrup	2 x 50	Already commissioned
2	Nazirakhat	Kamrup	2 x 5	Already commissioned as demonstrated project
3	Thiapani	Kamrup	2 x 100	DPR prepared
4	Majar	Kabi Anglong	1 x 10.5	DPR prepared
5	Amlong	Karbi Anglong	1 x 90	DPR prepared
6	Bichitur	Karbi Anglong	1800	Survey and investigation completed

These data show that the district of Karbi Anglong has the largest small hydro potential, about 83 MW, so far identified followed by N.C. Hills district, 29 MW. As such it seems the potentiality of tapping small hydropower in these two districts to electrify some remote villages is quite large. However, due to many reasons, especially due to lack of road communication in the difficult terrains, where most of these small hydro sites are located, the tapping of this resource has also become difficult.

#### IV. POWER GENERATION

Hydroelectric power is the generation of electric power from the movement of water. A hydroelectric facility requires a dependable flow of water and a reasonable height of fall of water, called the head. In a typical installation, water is fed from a reservoir through a channel or pipe into a turbine. The pressure of the flowing water on the turbine blades causes the shaft to rotate. The rotating shaft is connected to an electrical generator which converts the motion of the shaft into electrical energy.

Small hydro is often developed using existing dams or through development of new dams whose primary purpose is river and lake water-level control, or irrigation. Occasionally old, abandoned hydro sites may be purchased and re-developed, sometimes salvaging substantial parts of the installation such as penstocks and turbines, or sometimes just re-using the water rights associated with an abandoned site. Either of these cost saving advantages can make the return of investment for a small hydro site well worth the use of existing site infrastructure & water rights.

##### A. Layout of a Small Hydro Scheme

The layout of a typical Small Hydro Power (SHP) scheme is shown in figure 1<sup>[4]</sup>.

The main components of a SHP Scheme are:

- i) Diversion Weir
- ii) Desilting Tank
- iii) Headrace Channel
- iv) Forebay Tank

- v) Penstock
- vi) Powerhouse
  - (1) Speed Governor
  - (2) Turbine
  - (3) Generator
- vii) Tailrace Channel



Fig 1. Typical Arrangement of SHP

### B. Selection of Technology

Selection of technology mainly is the selection of Hydro turbines. Hydraulic turbines are generally classified as high head, medium head or low head machines, but this is relative to the size of the machine. What is low head for a large turbine can be high head for a small turbine, for example a Pelton turbine might be used at 50 m head with a 10 kW system but would need a minimum head of 150 m to be considered for a 1 MW system.

Turbines are also divided by their principle of operation and can be either impulse or reaction turbines. The rotor of a reaction turbine is fully immersed in water and is enclosed in a pressure casing. The runner blades are profiled so that pressure differences across them impose lift forces, akin to those on aircraft wings, which cause the runner to rotate. In contrast, an impulse turbine runner operates in air, driven by a jet (or jets) of water, and the water remains at atmospheric pressure before and after making contact with the runner blades.

Type of turbines is selected from techno-economic considerations of generating equipment, powerhouse cost and relative advantages of power generation. Most of the hydro turbine manufacturers have developed standard turbine designs, which may be effectively employed. Factors like head, head variations, load variations, efficiency, turbine setting and excavation requirement, specific speed, pressure rise & speed regulation considerations, maintenance considerations etc. determines the type of turbine. A brief classification of turbines on the basis of applicable heads is given in Table V<sup>[5]</sup>:

TABLE V  
TURBINE CLASSIFICATION ON THE BASIS OF HEAD

Turbine Type	Head Classification		
	High (>50m)	Medium (10-15m)	Low (<10m)

Impulse	Pelton	Crossflow	Crossflow
	Turgo	Turgo	
	Multi-jet Pelton	Multi-jet Pelton	
Reaction		Francis (Spiral Case)	Francis (open-flume) Propeller Kaplan

### C. Formulation of Small Hydropower Potential

The basic equation for calculation of power is a relation between head and flow rate and is given as,

$$P = \rho g H Q \eta$$

Where,

P = Electric power output of the Scheme in watt

$\rho$  = density of water (1000 kg/m<sup>3</sup>)

g = gravitational acceleration (9.81 m/s<sup>2</sup>)

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 = Design flow rate or discharge in m<sup>3</sup>/s

$\eta$  = Overall efficiency of the Turbine, generator and gear-box (may be taken between 0.65 to 0.80)

The head is relatively constant in run-of river schemes except for variation in friction losses with varying discharge. In irrigation canal and dam toe based scheme head also vary depending on water releases and season of release. Weighted average is found out to design the head of turbine. The design head is so selected that turbine is operated to the maximum time giving optimum energy generation. Energy generation per year in kilowatt-hour can be calculated as given below

$$E = (\text{Installed Capacity, kW}) \times (\text{Time 8670 hrs/year}) \times (\text{Capacity factor})^{[2]}$$

The capacity factor is the ratio of the average output to the installed capacity over a period of usually one year. The capacity factor for a typical grid connected scheme is generally 50 % to 60 %. For the run-of river hydropower scheme, it is useful to know the variation of flow over the year to select the most appropriate turbine configuration and estimated power generation. Flow variation presented in the form of a flow duration curve is the most useful form. The firm power and secondary power can be easily estimated from the flow duration curve.

Power potential may not be necessarily developed fully as it all depends upon the economics of power project, power demand, and grid characteristics. If the small hydropower station is connected to the grid, the entire energy generated can be used by the system. For isolated operation load forecast is necessary<sup>[2]</sup>.

## V. INSTALLATION AND SUCCESS STORIES

### A. Mini hydropower plants brighten rural Tajakistan

The "Construction of Mini Hydropower Plants (MHPP) in Rural Areas of Tajakistan" project aims to reduce the country's overall energy shortage by constructing over 170 mini hydropower plants in rural areas. These plants will be the main source of energy not just for households but also



for critical social infrastructure such as schools, hospitals, agriculture and other social support and commercial activities. The initial phase of the project, which commenced in 2004, entailed constructing eight mini hydropower plants in various remote and rural areas of the country. To date, seven (including the five IsDB-financed) mini hydropower plants have been successfully constructed and launched in Aini (Marzich MHPP), Tajikabad (Fathobod MHPP), Nurabad (Shashboloi MHPP), Jirgatal (Pitavkul MHPP), Rasht (Sangikar MHPP) and Tursunzade (Shirkent MHPP) districts; in Shahrinav (Toj MHPP), the project is in its final stage of completion. When fully completed, all eight plants will together produce 7.75 MW electricity<sup>[6]</sup>.

#### B. Nepal Micro Hydro Project

In the Himalayan country, Nepal, the towering mountains are a formidable obstacle to the people who need modern energy. Only 20 percent of the mountain villages have access to electricity. Since 1996, UNDP, its partners and the Government of Nepal have worked together with local communities to provide energy to remote areas through one clean, simple and plentiful means: water. Nearly 400 micro-hydro power plants have been built bringing energy to roughly half a million people. Local communities themselves dig the channels to divert the water that powers the small plants. They also provide the labour to install the power lines and the light. Through these small hydro plants, big changes are happening. Clinics, schools, radio stations, businesses are all flourishing where once there was darkness and no electricity<sup>[7]</sup>.



Fig 2. Nepal Micro Hydro Installation

#### C. Nagaland Hydroger

Hydroger is a big dynamo-type generator of electricity that can produce power at an installed capacity of 3 and 5 Kilowatts from water running down a stream. It is an indigenous version of the Chinese hydroger which the Nagaland Empowerment of People through Economic Development (NEPeD) team got hold off in 1994. After a series of experiments with engineering and re-engineering, NEPeD and Dimapur-based Mini Tool Room (MTR) came up with their very own hydroger in 2008. The modified version in Nagaland has a durable magnet that wards off the need for an alternator. This also makes it handy, light and cost-effective<sup>[8]</sup>.



Fig 3. Hydroger machine at Logwesunyu village, Nagaland

#### D. Steps taken in Assam

Govt. of Assam has already taken steps to electrify 2145 un-electrified villages, declared remote by APDCL, through non-conventional sources of energy, viz., small hydro, solar photovoltaic and biomass gasification. A policy for small hydro power development up to 25 MW in the State of Assam has already been drafted and is in the pipeline for implementation to attract Independent Power Producers (IPP)<sup>[3]</sup>.

#### VI. CONCLUSIONS

It can be concluded that Assam has the potential for installation of Small Hydro Power Plants. Implementation of SHP plants can fulfil the power demand in the region, disregard of the limitation of conventional fossil fuels and also divert the controversial big dam projects which are being predicted risky for this earthquake prone region. There are certain constraints for tapping this huge mass of hydro resources like poor road condition to the site, extreme remote areas, lack of involvement of local people, lack of availability of discharge data, etc. These problems can be overcome by the interest of policy planners, political leaders and also technocrats who can study the pros and cons of such plants in a particular region.

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