A REVIEW ON SMALL HYDRO POWER POTENTIAL IN VIDARBHA REGION ACROSS CENTRAL INDIA

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Abstract

Availability of fossil fuels is real struggle now days as it is of limited in nature on Earth. Renewable energy sources are available with ample of amount with different sources like solar, wind etc. One of such renewable energy is Small Hydro which is the most emerging technology for survival and generation of electricity. Therefore Small Hydro needs to be utilized for power development. Small Hydro Power (SHP) is one of the resources available for hilly region as well as other parts of the country. SHP plants are the need for today. India has around 20000 MW potential for large number small hydel plants in various states. Cost calculation for different SHP components has been covered in the current paper for collected data in Vidarbha region of Maharashtra State. The equation for design discharge has been formulated by considering the rivers with width, depth and the flow of water.

Key Words : Small Hydro Power Plants (SHP), renewable resources, cost analysis.

1. Introduction

The conventional sources of energy which are finite and therefore we must utilize the renewable sources like small hydro and solar. One of such source is SHP besides Solar, Wind, Biomass, Geothermal and Fuel Cell etc. There is tremendous scope in developing small hydro plants by constructing power projects on rivers and canals or at small dams.

The thesis in [1] covers the estimation of small, mini, micro hydro power potential in Vidharbha region of India. But the cost benching is not covered for this work. References [2] presents the cost effective designs for small hydro plant. Also civil structures are also discussed [3]. The details of SHP is mentioned in [4]. The data for work is presented in [5-6] for analysis of present work. Grid connected SHP development presented in [7-8] provides the idea for grid interfacing and rural electrification. Similar case study for river hydroelectric power plant is done in [9]. The turbine selection can done with the presented studies. The mathematical foundations for small hydro power cost analysis is presented in [10]. The vertical axis power turbine is presented in [11] and many such work are now attracting the interest of the researchers. The case study on Indian irrigation project is presented in [12]. The overall literature gives the idea to review the small hydro power potential in Vidharbha region across central India.

Installed capacity of power projects decides the type of hydro power plant. Table 1.0 shows the maximum Installed Capacity of SHP.

2. Review of Small Hydro Power Plants

Table 1

Maximum installed capacity for SHP in different regions of the world.

Sr.No.	Country/ Region	Installed Capacity (MW)
1	India	<25
2	China	<25
3	Sri Lanka	<10
4	Sweden	<1.5
5	France	<5
6	European Union	<10
7	USA	<30
8	Brazil	<30

The Small Hydro in India is classified as bellow by Ministry of New and Renewable Energy (MNRE) and Central Electricity Authority (CEA) according to Power generation.

Table 2

Classification of SHP in India [5]

Sr. No.	Classification of Small Hydro	Power (kW)
1	Micro Hydro	Upto 100 kW
2	Mini Hydro	101-2000 kW
3	Small Hydro	2001-25000 kW

Following table shows region wise installed hydro capacity.

Table 3
Installed hydro capacity

Region	Installe capacity (mw)
Northern	18376.78
Eastern	4378.12
Western	7447.50
Southern	11689.03
North eastern	1242

In Maharashtra State 255 sites are identified with the 732.63MW potential of SHP. Out of it 39 sites are already installed with 263.825 MW potential and 15 sites for 51.7 MW, according to MNRE. Looking at this, there are different programs are carried out for the development of SHP. Financial assistance is given for resource assessment of new sites, setting up new SHP, renovation and modernization of project and research and development etc.

1.1 Central Government Policy for SHP

India is the 3rd largest energy generator in the world, accounting for 4.8% of the global energy generation. Government is promoting in many ways to the SHP installation and operation. Government seeks private involvement in this sector by providing institutional mechanism.

1.2 Government of Maharashtra Policy for Private sector about SHP.

Govt. of Maharashtra is promoting the SHP through private partnership involvement. The new policy of Govt. has encouraged private participation of both the Captive Power Producers (CPPs) and Independent Power Producers (IPPs) in development of SHP in State.

The main objectives for the policy are:

1. Involvement of private sector
2. Harness green power

The list of sites of SHPS to be offered for privatization is available with (Govt. of Maharashtra, Water Resources Department (GoMWRD).

The Small Hydro Power allotted under the policy shall be on Build, Operate & Transfer Basis (BOT). This BOT period starts from commissioning of the project and of 30 years duration. At the end of BOT the absolute ownership of SHP along with land, switchyard & allied equipment shall automatically stand transferred to Govt. of Maharashtra (GoMWRD).

The letter of permission (LoP) will empower the developer to prepare Techno-Economic Feasibility Report (TEFR). Developer need to submit the TFER to

GoMWRD within three months. After Letter of Allotment (LoA) developer shall sign the Hydro Power Development Agreement. After this he shall sign Energy wheeling agreement with Transmission entity/ distribution licensee.

Alternate Hydro Energy Centre (AHEC) is the unique research centre as well as consultancy in India which is established by the Ministry of New and renewable resources at I.I.T.Roorkee. It deals with the renewable energy resources available & emerging technologies. In India AHEC specifically deals with the Small Hydro development and installation as well as testing. The first real time SHP simulator is installed in country at AHEC.

Following are the working areas of AHEC:

- a) Survey and investigation
- b) Preparation of Detailed Project Report (DPR)
- c) Project design
- d) Installation and commissioning of SHPs etc.

Selection of Turbine for SHP based on N_s i.e. Specific Speed

While selection of turbine at potential site we need to be very careful, so some standard values of specific speed are given for selection. Fig.1. shows the application of Turbine.

Table 4
Selection of Turbine based on Specific Speed[9]

Sr.No.	Turbine Type	Specific Speed N_s
1	Pelton	12-30
2	Turgo	20-70
3	Cross Flow	20-80
4	Francis	80-400
5	Propeller	340-1000

Table 5
Selection of Turbine based on range of Head[10]

Sr. No.	Turbine Type	Head (M)
1	Kaplan and Propeller	$2 < H_{net} < 40$
2	Francis	$25 < H_{net} < 350$
3	Pelton	$50 < H_{net} < 1300$
4	Crossflow	$5 < H_{net} < 200$
5	Turgo	$50 < H_{net} < 250$

Fig. 1 : Application of Turbine[10]

1.3 ComponentsofSHPprojects:[4]

1.3.1 Diversion Weir

Diversion Weir is constructed to divert the river water towards intake channel. It must be constructed in such a way that it diverts all the lean season flows and structure stands safe during floods.

1.3.2 Feeder cum Power Channel

1.3.3 Disilting cum Forbay tank

It is constructed to remove pebbles and coarse suspended material to prevent erosion of turbine blades.

1.3.4 Penstock Pipe

The penstock is used to feed water to power house. Penstock is made up of mild steel, fibre glass or PVC depending upon conditions.

1.3.5 Power House

In Power House following equipment are installed:

- Turbine generation control panels
- Auxiliary equipment.

1.4 Equation to calculate the discharge.

The equation for calculating the discharge is given below:

Discharge = $(26.11 * \text{width} * \text{depth}) / \text{time for float (1)}$

1.5 Discharge calculation with available data

Refer Table 1.0 where the data is collected for various potential available for Vidarbha in Maharashtra State which includes seven districts.

1.6 Cost Calculations

The cost of various components mentioned above is calculated based on the reference paper and then the cost approximate for the SHP with some constraints is calculated. Table 2.0 gives the details. Cost per kW is calculated for small hydro power potential of Vidarbha region based on following formula [11] and accordingly different graphs are plotted.

$$C = 6.882H^{-0.0782}P^{0.6369} \quad (2)$$

Where,

C= Cost per kW in Indian Rupees

H=Head in meter

P= Capacity in kW

2. Result and Discussion

Approximate cost of given components of small hydro power plants which can be installed are calculated for identified sites of Vidarbha.

Fig. 2 : Relational Graph

Relational Graph shown in Fig. 2 is obtained by the calculation of cost per kW using formula (1-2) which indicates the variation of Power with respect to Cost.

Fig. 3 : Cost per unit length of Diversion Weir

Fig. 4 : Cost per m length of Feeder

Fig. 5 : Cost of Disilting Tank

Fig. 6 : Cost per m length of Penstock

Fig. 7 : Cost of Power House

Figures 3,4,5,6 and 7 gives the details of the cost of various components against the locations of SHPs located in Vidarbha region.

Fig. 8 : Discharge Vs. Cost

Fig. 9 : Power Vs. Cost

Fig. 10 : Head Vs. Cost

Figures 8, 9 and 10 compares the values of Head, Power and Cost which are calculated using equation (2).

3. Conclusion

Based on the study done and observations obtained with various references the small hydro power sites i.e. the sites which are below 25 MW are identified and the potential are known. The review has taken based on various references to obtain various parameters. In this paper attempt is made to calculate cost of components and cost per kW for 39 SHP sites

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