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Assessment of Hydro- Electric Power Potential from Streamflow Data

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***Abstract**: Hydroelectric power is the most economical, clean renewable energy available in the world in places of abundant rainfall and flow of water in streams. Places endowed with enormous economically exploitable and viable high power potential from water; there is no question of the thrust to hydropower taking a back seat. In this paper an attempt is made to understand how the streamflow data can be used to evaluate the amount of power generated by conducting power potential studies and there by suggesting a suitable capacity of turbine to be installed for generating power.*

1. Introduction

All sources of renewable energy like wind, solar, hydropower play an important role in providing technical solutions for reducing greenhouse gas emissions and air pollution. Importance of small hydroelectric power plant has increased more and more because of fast increasing electrical energy demand. Hydropower currently contributes to around 20% of the global electrical output. Hydroelectric power plants do not use up resources to create electricity nor do they pollute the air, land or water as other power plants do. Water that flows by gravity can be used to turn turbines to produce electricity. Excess water that flows through the streams during monsoon season can be stored in reservoirs and used for power generation.

2. Types of hydropower schemes

There are basically three types of hydropower facilities: run of river, storage and pumped storage hydropower scheme. Run of river scheme sometimes called diversion scheme, channels a portion of the river through a canal or penstock. The guided water will be taken to generate the power. In storage scheme it uses a dam to store water in a reservoir. The water will be released from the reservoir, guided through a penstock to be delivered to a turbine which spins and activates a generator which in turn generates electricity. In pumped storage scheme water will be cycled between two reservoirs one a lower one and another upper one. Water from the lower reservoir will be pumped and kept in the upper reservoir. During period of shortage of power, water stored in the upper reservoir will be utilized for power generation.

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3. Forms of Energy

The basic forms of energy are kinetic, gravitational, electrical and nuclear. When we convert energy from one form to another, the useful output is never as much as the input. The ratio of useful output to the required input is called the efficiency. The efficiency is as high as 80% to 90% in water turbines.

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4. Data required for power potential study

The hydroelectric power potential is calculated from available daily streamflow data and head. The required daily stream flow data can be obtained from a stream gauging station relevant to the site considered. The data must be collected for a period of at least five years. Longer the period of data available greater will be the accuracy. Contour surveying of the land has to be conducted as to determine the height of fall available at the site for power generation.

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5. Power Potential Studies

The essential characteristics of a hydro site are the effective head (the height 'H' through which the water falls) and the flow rate (the number of cubic meters of water per second, Q). When water is stored at a height 'H' it carries potential energy and the theoretical power generated can be obtained as the product of the effective head and the rate of flowing water.

Power in KW, $P = \eta \rho Q H$.

In any real system, the water will lose energy due to frictional drag and turbulence and the effective head will thus be less than the actual head. Accounting for the above, an efficiency of 80% is assumed and the power generated in KW is calculated as 8QH.

The power generated for turbine capacities of 100kW, 200kW, 300kW etc using the discharge data for each day and an effective head of 10m is to be tabulated first. The tabulation has to be made corresponding to every month for the entire period the data is available .It has to be then consolidated for every water year (i.e., June to May) N_1, N_2, N_3 …..etc during the entire period of study. Table 1 shows the consolidated working table for the water year N_1.

Table 1. Working table for no. of units of power water year N_1.

Month	Installed turbine capacities			
	100 kW	200 kW	300kW	400kW
M_1	67866.67	96844.44	111111.11	120844.4
M_2	72355.56	106444.44	127600.00	146800.0
M_3	73466.67	126666.67	170088.89	206400.0
M_4	69511.11	113466.67	146622.22	173555.5
M_5	74222.22	131466.67	169688.89	200088.8
M_6	66222.22	104444.44	136088.89	160400.0
M_7	2400.00	35111.11	35111.11	35111.11
M_8	16888.89	16888.89	16888.89	16888.89
M_9	9111.11	9111.11	9111.11	9111.11
M_{10}	21333.33	23777.78	23777.78	23777.78
M_{11}	11777.78	11777.78	11777.78	11777.78
M_{12}	31022.22	34666.67	34666.67	34666.67
Total	473377.8	810666.7	992533.3	1139422

Table 1. Working table for no. of units of power water year N_1 continued….

Month	Installed turbine capacities			
	500 kW	600kW	700kW	800kW
M_1	128444.44	133066.67	134666.67	134666.6
M_2	164444.44	175200.00	180266.67	183866.6
M_3	240000.00	270222.22	292133.33	306533.3
M_4	194666.67	212133.33	228133.33	241022.2
M_5	224666.67	241111.11	249511.11	255644.4
M_6	179777.78	196622.22	208088.89	217688.8
M_7	35111.11	35111.11	35111.11	35111.11
M_8	16888.89	16888.89	16888.89	16888.89
M_9	9111.11	9111.11	9111.11	9111.11
M_{10}	23777.78	23777.78	23777.78	23777.78
M_{11}	11777.78	11777.78	11777.78	11777.78
M_{12}	34666.67	34666.67	34666.67	34666.67
Total	1263333	1359689	1424133	1470756

Table 1. Working table for no. of units of power water year N_1 continued….

Month	Installed turbine capacities			
	900 kW	1000kW	2000kW	3000kW
M_1	134666.67	134666.67	134666.67	134666.6
M_2	184222.22	184222.22	184222.22	184222.2
M_3	320933.33	332888.89	423111.1	487111.1
M_4	249244.44	256000.00	304000.00	339777.8
M_5	258044.44	260444.44	262000	262000
M_6	227288.89	234666.67	261111.1	261111.1
M_7	35111.11	35111.11	35111.11	35111.11
M_8	16888.89	16888.89	16888.89	16888.89
M_9	9111.11	9111.11	9111.11	9111.11
M_{10}	23777.78	23777.78	23777.78	23777.78
M_{11}	11777.78	11777.78	11777.78	11777.78
M_{12}	34666.67	34666.67	34666.67	34666.67
Total	1505733	1534222	1700444.4	1800222

Table 1. Working table for no. of units of power water year N_1 continued….

Month	Installed turbine capacities			
	4000 kW	5000kW	6000kW	7000kW
M_1	134666.67	134666.67	134666.67	134666.6
M_2	184222.22	184222.22	184222.22	184222.2
M_3	320933.33	332888.89	423111.1	487111.1
M_4	249244.44	256000.00	304000.00	339777.8
M_5	258044.44	260444.44	262000	262000
M_6	227288.89	234666.67	261111.1	261111.1
M_7	35111.11	35111.11	35111.11	35111.11
M_8	16888.89	16888.89	16888.89	16888.89
M_9	9111.11	9111.11	9111.11	9111.11
M_{10}	23777.78	23777.78	23777.78	23777.78
M_{11}	11777.78	11777.78	11777.78	11777.78
M_{12}	34666.67	34666.67	34666.67	34666.67
Total	1848000.02	1872000.0	1872000.0	1872000

Table 1. Working table for no. of units of power water year N_1 continued….

Month	Installed turbine capacities
	8000 kW
M_1	134666.67
M_2	184222.22
M_3	558888.9
M_4	339777.80
M_5	262000
M_6	261111.1
M_7	35111.11
M_8	16888.89
M_9	9111.11
M_{10}	23777.78
M_{11}	11777.78
M_{12}	34666.67
Total	1872000.02

6. Results & Discussions

The consolidated working table prepared has to be used for generating a characteristic curve as shown in figure1. Analyzing the characteristic curve, it is observed that the power generated is increasing as the turbine capacity increases. But the increase is not significant after 750kW. Hence it can be inferred that with the available streamflow data and the effective head at the site the most suitable capacity of turbine to be installed is 750kW which can be used as a single unit or for technical and economic reason as two units one of 250kW capacity & the other of 500kW capacity. The ideal case would be to use the latter combination since a breakdown in one of them will not shut down the entire power generation.

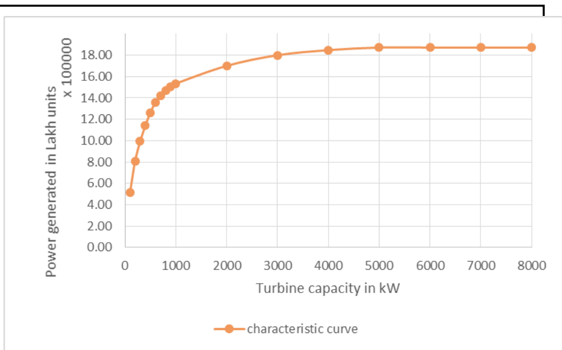

Figure 1. Characteristic Curve for year N_1.

7. Acknowledgements

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