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A Review on Small Hydro Power Plant Model

Akhand Pratap Singh[1], Atul Patni[2], Divyamohan Gupta[3], Dixit Malviya[4] , Gaurav Bansal[5]

Department of Electrical Engineering, Poornima College of Engineering, Jaipur, India

ABSTRACT: This small model of a hydro power plant that generate output of 120 watt . The cost of hydroelectricity is relatively low, making it a competitive source of renewable electricity. The hydro station consumes no water, unlike coal or gas plants. The project produces no direct waste, and has a considerably lower output level of greenhouse gases than fossil fuel powered energy plants. A generating station which utilizes the potential energy of water at a high level for the generation of electrical energy is known as hydro-electric power station. As we know that the power plant is defined as the place where power is generated from a given source, so here the source is hydro that's why we called it hydro power plant.

KEYWORDS: Small Hydro Power (SHP), water-flow rate, hydroelectricity, renewable, greenhouse

I. INTRODUCTION

A small hydropower plant cannot be considered as a smaller form of a large hydro power plant. The small hydropower plant construction planning requires a large number of technical analyses at different stages of the process with a view to determining whether a given location is technically usable, ecologically acceptable and economically justified for a project .The feasibility of a this project is specific for each location. Installed capacity of a small hydropower plant in one location depends on stream flow and water elevatation used at the location. This dependence contains some uncertainty because the amount of expected energy generation will be related to available water quantity or, will be related to the vary in stream flow duration the year. These changes have such strong impact to the generation value that they must be considered at daily and sometimes even hourly level, given the nature of the stream flow changes.

II. PROJECT SITE COMPONENT

All the following components are listed below in this section which in used in our project. Components are with their quantity and size as per our requirements.

S.No	Name of Component	Quantity
1	Water tank	1
2	Pen stock	1 (lenth-15 met.)
3	Turbine	1
4	Generator(Alternator)	(12 volt, 10amp.)
5	Transformer	As per requirement
6	Inlet and outlet valve	As per requirement
7	Exciter	1
8	Water pump	1(0.25HP)
9	Dam	250 ltr.

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10	Trash rack	As per requirement
11	Surge tank	150 ltr.
12	Draft tube	As per requirement

Table 1. Components list

III. METHODOLOGY

The definition of criteria under which it would be possible to develop small hydropower plants at the national level, does not give results matching the situation in the field, even at the water seam level . Initial step for planning of small hydro power plants is definition of effectively feasible projects of small hydropower plants development. As a next step it is proposed to overview the potentials for activities in the space in potential locations/water streams, bearing in mind already defined and examined views concerning levels of protection of specific areas and water streams – level of strategic assessment of environmental impact. The projects (locations) which do not meet these criteria shall be ruled out from further considerations and analysis. Namely, many countries have presented theirs endeavors for maximum possible protection of environment, especially referring to technically and economically justified protection of environment and accelerated introduction of economically viable new and renewable energy sources and energy efficiency enhancement. This determination is associated with the Spatial Plan, and is translated in to legislation concerning environmental protection

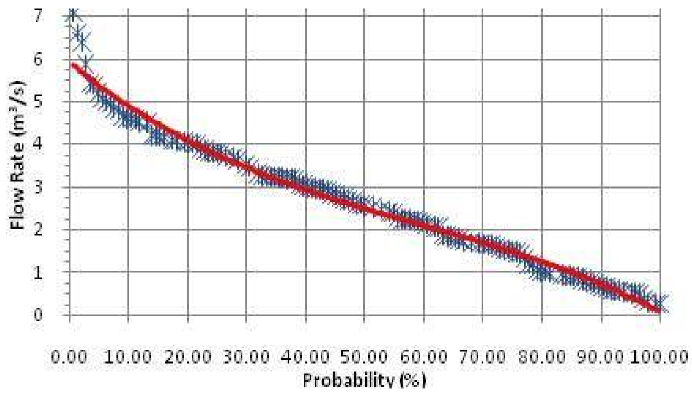

Fig-1, Flow duration curve

IV. POWER AND ENERGY POTENTIAL

Generally hydro turbines are optimized around an operating point defined by its hydraulic head, flow discharge and rotational speed. Since the design is run-of-the river type, constant head is assumed. Due to the high flow variation, the turbine would not be able to operate in the entire flow range. Therefore different flow ranges are chosen to calculate the power and energy generation potential of the project. Good turbine designs are capable of operating down to one fifth of the design flow maintaining its efficiency, so that the minimum flow rate of each window is chosen to be one fifth of the maximum.

In addition to this, an environmental release of $0.5m^3/s$ is selected to support surrounding environment between the intake and the powerhouse. The minimum flow rate for turbine operation is chosen to be $0.25m^3/s$ and after the exclusion of environmental flow the minimum stream flow rate for energy generation is $0.75m^3/s$.

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Overall system efficiency of 72.2% is expected based on machinery available in the current markets. The rated power outputs for different flow ranges are calculated from the following equation.

$$P = \eta \rho g QH$$

The peak energy generation for each system size is obtained from the following equation.

$$E_{max} = P_{max} \, 8$$

$$E_{avg} = \frac{1}{100} \sum_{k=n_1}^{n_n} P_k . t . \{N_k - N_{k+1}\}$$

The capacity factor of the power plant is an indication of the utilization of its total potential. This is also known as the pant factor and it is the ratio of average expected energy generation to the potential maximum energy generation.

The following table shows the calculated values for each flow window considered.

S.No	Max Turb Flow (m3/s)	Min Turb Flow (m3/s)	Flow Range (m3/s)	Rated Power (kW)	Max Energy Gen (GWh)	Est Energy Gen (GWh)	Capacity Factor (%)
1	1.18	0.25	0.93	752.20	6.59	0.75	11.45
2	1.61	0.32	1.29	1026.30	8.99	1.41	15.68
3	2.08	0.42	1.66	1325.90	11.61	2.51	21.59
4	2.50	0.50	2.00	1593.63	13.96	3.59	25.73
5	3.03	0.61	2.42	1931.49	16.92	5.10	30.16
6	3.56	0.71	2.85	2269.34	19.88	6.98	35.13
7	4.11	0.82	3.29	2619.94	22.95	9.02	39.32
8	4.32	0.86	3.46	2753.80	24.12	9.51	39.40
9	4.72	0.94	3.78	3008.78	26.36	10.19	38.67
10	6.59	1.32	5.27	4200.82	36.80	10.98	29.85

Table – 2, Power and energy generation

Based on above calculations, projected energy generation versus system size can be plotted as shown below. The gain in energy generation is less than the increase in capacity for systems above 3000kW.

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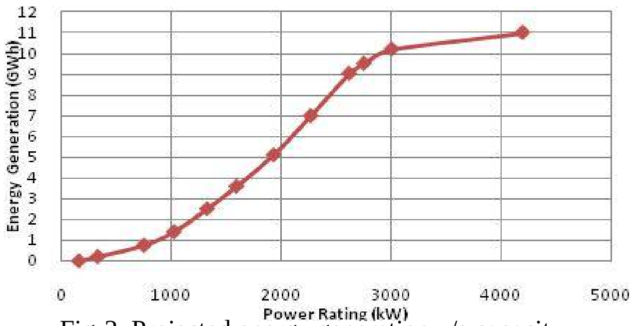

Fig-2, Projected energy generation v/s capacity

V .WORKING

plants capture the energy of falling water to generate electricity. A turbine converts the kinetic energy of falling water into mechanical energy. Then a generator converts the mechanical energy from the turbine into electrical energy.

Parts of a Hydroelectric Plant

Dam -Raises the water level of the river to create falling water. Also controls the flow of water. The reservoir that is formed is, in effect, stored energy.

Turbine - The force of falling water pushing against the turbine's blades causes the turbine to spin. A water turbine is much like a windmill, except the energy is provided by falling water instead of wind. The turbine converts the kinetic energy of falling water into mechanical energy

Generator - Connected to the turbine by shafts and possibly gears so when the turbine spins it causes the generator to spin also converts the mechanical energy from the turbine into electric energy. Generators in hydropower plants work just like the generators in other types of power plants.

Transmission lines. Conduct electricity from the hydropower plant to homes and business.

. VI. PROCESS DIAGRAM

Basic block diagram of hydro power plant model and process flow. Which is shows working, operation of power plant.

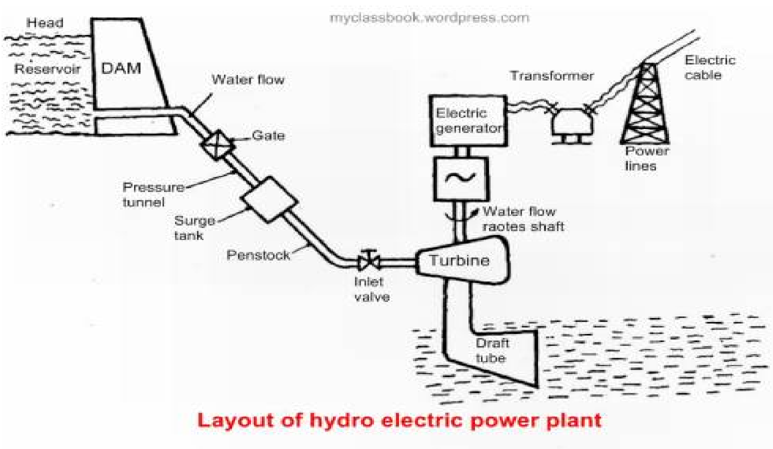

Fig.3 layout of hydro electric power plant

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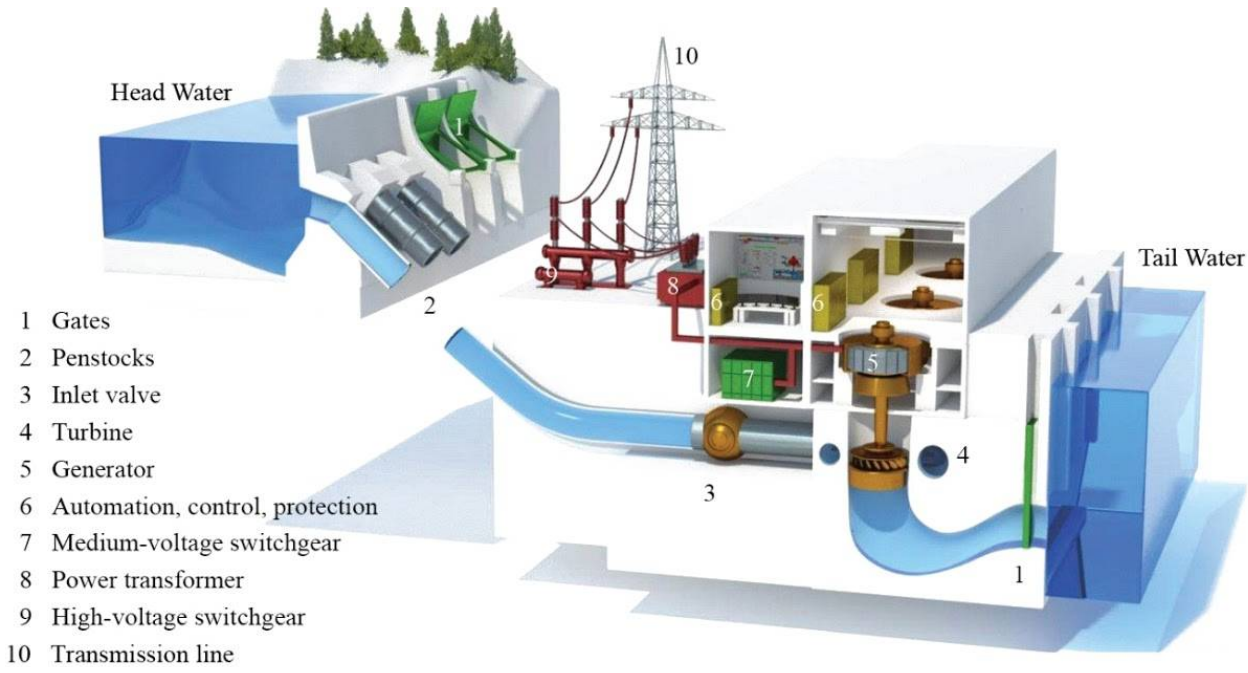

Fig 4. Process Flow

VII. COST ESTIMATION

As per our specification the cost of components that we used in this project is as following.

S.No.	Component Name	Rating	Component Requirement	Cost
1.	Water tank	50 lit.	1	200/-
2.	Mechanical Support	4feet	1	400/-
3.	Turbine	(35cm.,250-300rpm)	1	250/-
4.	Generator(Alternator)	12 volt, 10 amp,20W	1	2000/-
5.	Bearing	22-25mm	4	200/-
6.	Water Pump	As Per Requirement	1	800/-
7.	Shaft	25mm ,80cm	1	-
8.	Pulley	25mm	1	50/-
9.	U coupling	As Per Requirement	1	1000/-

Table 3. Cost table

VIII. CONCLUSIONS

SHP models were revealed inadequate for the proper modeling of the dynamic aspect of flowing water, gate controlling and others. System simulation was further reviewed and a common objective of this latter type of modeling was to look at the speed variation, the generated power and its stability and dependency on input parameters such as opening and closing valve which is use for variation in rate of flow of water on turbine, and the use of penstock and reservoir increase efficiency of plant modeling.

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Appendix

The notation used in this paper is as follows:

P – Power

E – Energy

η – Efficiency of the system ρ – Density of water (kg/m^3) g – Gravitational acceleration

Q – Volumetric flow rate of water (m^2/s) t – Hours per year

n_1 – Start of flow window (minimum) n_n – End of flow window (maximum)

N_k – Absolute probability of given flow rate occuring H_n – Net head

V – Water jet velocity N – Number of nozzles d_s- Water jet diameter

D – Turbine runner diameter Z – Number of buckets

U_n - Tangential speed of the turbine wheel in m/s. r – Radius of the turbine wheel.

ω – Rational speed of the turbine in rad/s.

E_{gen} - Annual Electricity Generation (GWh)

αCO_2 - Baseline CO_2 reduction factor for SHP in Sri Lanka

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