Development of Small Hydro Power in India

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Abstract— Hydro power is known as the source of renewable energy, which is pollution free, economical and environmentally benign. Small and mini hydro power projects have the potential to provide electrical power in inaccessible and mountainous region where supply of power by grid system is uneconomical and difficult. 19% of the total planet's electricity is provided by the hydro power plants. Small-scale hydro is in most cases "run-of-river", with no dam or water storage. Small hydro power is most cost-effective and environmental friendly technology of energy for both the hilly and rural areas of the maximum country of the world. Energy produced by the falling water in hydro power plant can provide a high sustainable, non polluting alternative to fossil fuels, along with other types of renewable sources of energy, such as solar, wind and geothermal energy. Among all the sources of renewable energy, small hydropower is considered as one of the most successful energy. Much of small hydro potential is in the remote, hilly and inaccessible regions of India, where generation from other sources or transmission of power up to long distance would not be feasible. In India, the development of Micro, Mini and Small Hydro Power (SHPs) Projects started in the year 1897. In the hilly areas, there are a large number of rivers and canals which provides a bright future in hydro-power energy. All hydropower falls in category of clean energy, but the small hydro power projects provide more significant contribution as SHPs require minimal rehabilitation, submergence and minimal impact to the environment. Therefore in the SHPs, there are more scope for harnessing sustainable hydro energy.

Keywords: Hydro power, small hydro power plant, layout of small hydro power plant

I. INTRODUCTION

The world is currently suffering from energy crisis. Increasing prices of petroleum products and projections that petroleum resources will be exhausted in a relatively short period of time are adversely impacting the economic condition and development of social worldwide. For decreasing the dependence on the imported fuels with huge price voltality, maximum countries of the world have started the programs for developing, alternate sources of energy based on the domestic renewable resources. Renewable sources of energy are wind, geothermal energy, biomass, solar energy, hydro power etc. Hydropower is a key source for renewable electricity generation and has an important potential to be marketed as green power. But the construction and operation of hydropower plants may cause some environmental impacts on the local and regional level.

Hydropower is defined as the renewable source of energy which is pollution free and environmentally benign. This is the oldest technique for renewable energy known to the human being for conversion of mechanical energy into the generation of electricity. Hydropower represents use of water resources towards inflation free energy due to absence of fuel cost.

Water has always been one of mankind's most vital resources. While human body can go weeks without food, it can only survive for a couple of days without water consumption. Crops in the field will shrivel and die without a readily available supply. We use it for cleaning, we use it for cooking. The benefits from the power of water are taken by the human being from greater than two thousand of years. Water wheels were used for grinding wheat into flour as early as 100 B.C. Water wheels was used for the production of electricity during the 19th century. At the end of 19th century, the water wheels were replaced by the water turbines, and for controlling the flow of water, the rock and soil dams were built .Since then, the hydro power potential of rivers are continuously developing. 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. In hydro power plant, the potential energy of water falling from a higher level is converted into electricity. Hydro turbines convert hydraulic energy of water into mechanical shaft power, which are used for driving the generator. Hydro power is very clean source of energy and only uses the water, the water after generating electrical power, is available for other purposes.

II. HYDRO POWER

Hydro power is defined as the power which is derived from energy of falling water at high elevation. The hydro power plant is defined as the power plant where electricity is generated by the potential energy of water at high level. For the production of hydro power it is necessary that the sufficient quantity of water must be available at the sufficient head and at the suitable site. A dam is constructed across a river for creating the head. The water from the dam comes to the turbine. The turbine changes the hydraulic energy of water into the mechanical energy. A generator is used, which converts the mechanical energy from turbine into the electrical energy output.

III. DEVELOPMENT OF SMALL HYDRO POWER PROJECTS

Hydro power projects are generally classified into the two types, known as Small Hydro and Large Hydro. The hydro projects of capacities up to 25 MW are known as Small Hydro Power (SHP) Projects. The hydro power projects above 25 MW capacities are known as large hydro power project. Ministry of New and Renewable Energy (MNRE) is responsible for the subject of small hydro power (up to 25 MW), while Ministry of Power, Government of India is responsible for the development of large hydro power projects. Depending upon the capacities, SHP projects are categorized as Micro, Mini, and Small hydro projects .SHP is known as the reliable option for the development of hilly

and rural areas where the power by the grid system is very difficult and costly. It has been recognized that small hydro power projects can play a critical role in improving the overall energy scenario of the country and in particular remote and inaccessible areas.

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

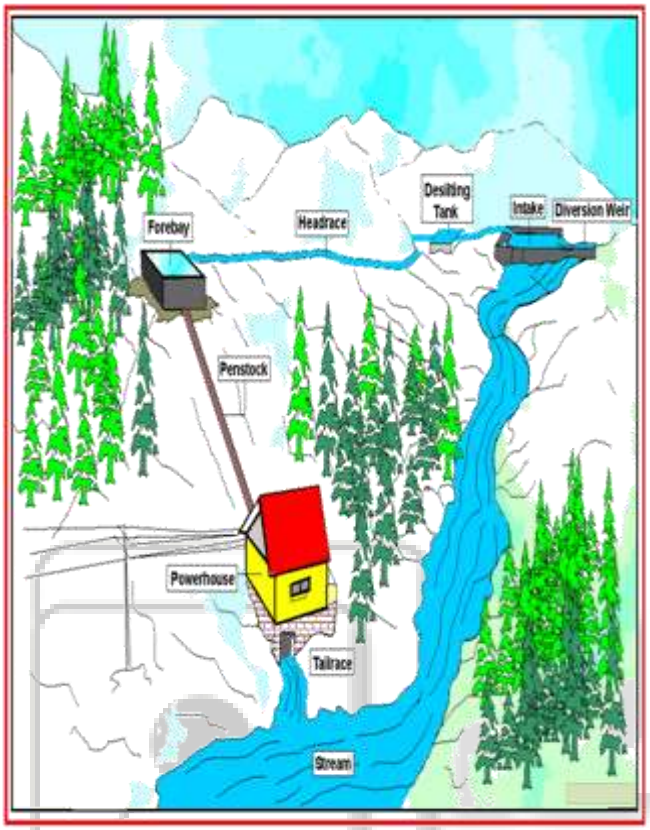


Fig.1: Hydro-electric power station

V. POTENTIAL AND INSTALLED CAPACITY OF SMALL HYDRO POWER IN INDIA

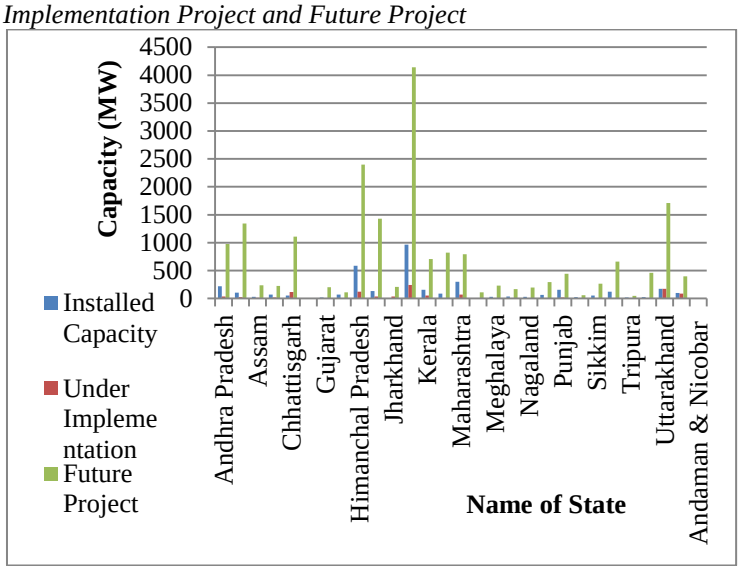
The estimated potential of small hydro power of the World is about to 180000 MW. India has an estimated potential of about 20000 MW with perennial flow rivers, streams and a large irrigation canal network with dams & barrages. State-wise Small Hydropower identified sites (SMALL HYDRO PROJECT UP TO 25 MW) and installed capacities are given in Table1

S. No.	State	Installed Project Capacity (MW) No	Under Impletion Project Capacity (MW) No	Future Projects Project Capacity (MW) No	Total Project Capacity (MW) No
1	Andhra Pradesh	75	219.03	47	34.04	387	978	509	1231.07
2	Arunachal Pradesh	80	103.91	25	22.22	677	1341	782	1467.13
3	Assam	3	31.11	17	15	119	239	139	285.11
4	Bihar	8	70.70	13	17.7	93	223	114	311.4
5	Chhattisgarh	5	52.00	36	115.25	200	1107	241	1274.25
6	Goa	1	0.05	0	0	6	7	7	7.05
7	Gujarat	2	15.60	0	0	292	202	294	217.60
8	Haryana	5	70.10	5	3.35	33	110	43	183.45
9	Himanchal Pradesh	62	587.91	19	122.2	531	2398	612	3108.11
10	Jammu & Kashmir	31	130.53	8	34.65	245	1431	284	1596.18
11	Jharkhand	6	4.05	8	34.85	103	209	117	248.35
12	Karnataka	90	963.76	39	240.992	834	4141	963	5345.752
13	Kerala	18	158.42	22	52.75	245	704	285	915.17
14	Madhya Pradesh	9	86.16	5	4.9	299	820	313	911.06
15	Maharashtra	33	299.93	4	71.2	274	794	311	1165.13
16	Manipur	11	5.45	4	2.75	114	109	129	117.2

17	Meghalaya	3	31.03	9	1.7	97	230	109	262.73
18	Mizoram	17	36.47	5	0.5	72	169	94	205.97
19	Nagaland	9	28.67	6	4.2	99	197	114	229.87
20	Orissa	6	64.30	10	3.6	222	295	238	362.9
21	Punjab	33	154.50	12	21.15	259	441	304	616.65
22	Rajasthan	9	23.85	0	0	66	57	75	80.85
23	Sikkim	16	52.11	1	0.2	88	267	105	319.31
24	Tamil Nadu	14	123.05	0	0	197	660	211	783.05
25	Tripura	3	16.01	0	0	13	47	16	63.01
26	Uttar Pradesh	6	25.01	0	0	251	461	257	486.01
27	Uttarakhand	93	174.82	38	174.04	448	1708	579	2056.86
28	West Bengal	45	98.40	17	84.25	203	396	265	578.65
29	Andaman & Nicobar	5	5.25	0	0	7	8	12	13.25
	Total	698	3632.25	350	1061.502	6474	19749	7522	24442.75

Table 1: State-wise small hydro projects (up to 25 MW)

A. Comparison between Installed Project, Under Implementation Project and Future Project



From the above figure, we get that some states like Karnataka, Himanchal Pradesh, Uttarakhand, Jammu and Kashmir, Arunachal Pradesh, Chhattisgarh, Andhra Pradesh, Madhya Pradesh and Maharashtra are such that, which have the very high future project. But there are very small number of states (Karnataka, Himanchal Pradesh, Andhra Pradesh, Maharashtra), which have utilise their available small hydro power. Some states are of such type, which have the future potential, but they are not using available hydro power. Maximum states are of such types where gap between future project and installed project are very large. Therefore, we get conclusion that if the policies, regulations, incentives and subsidy schemes are reviewed for all states, then there will be fast and great development in the small hydro power of the country. In, India there are a large number of states, which have the future project but their under implementation project are negligible. Therefore, if the small hydro power available in the country is installed, then there will be a great development in the hydro power sector of the country.

VI. Formulation of Small Hydropower Potential

The power generated by the hydro power plant is calculated by the following formula given as:

$$\mathbf{P = \rho\, g\, H\, Q\, \eta} \qquad \mathbf{(1.1)}$$

Where P = Electric power output in watt

ρ = Density of water (1000 kg/m^3)

g = Gravitational acceleration (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 = Design flow rate or discharge in m^3/s

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

VII. System Components Required for Small Hydropower Project

System can be divided in three major parts as Civil Works, Electro-Mechanical Components and Distribution System. Civil works may include construction work required for dam, weir, intake, desilting tank, forebay, conveyance line or headrace, penstock, tailrace, powerhouse, substation etc. Electro-Mechanical Components include Turbines, generator and governor or control system and Transmission / Distribution System.

A. Civil Work Components

The following components fall in this heading:

- Dam
- Weir
- Intake
- Desilting tank
- Canal
- Forebay
- Conveyance line or Headrace
- Penstock
- Tailrace
- Powerhouse
- Substation
- Spillway etc.

B. Electro-Mechanical Components

The following components fall in this heading:

- Turbines
- Generator
- Governor
- Control System
- Transformer

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.

VIII. Advantages of Small Hydro Power

The advantages of small hydro power are following:

(1) It is benign source of power generation, harnessing only gravitational potential of water to make it yield energy in a continuum.
(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) Small Hydro is suitable for, rural, inaccessible area applications for isolated communities having no chances of grid extension for years to come.
(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) Irregular breakdowns are relatively very less and short in duration because the equipment is very simple.
(11) Electricity can be generated constantly

A. Disadvantages of Small Hydro Power

The disadvantages of Small Hydro Power are as following:

(1) Generation of power depends on the water availability.
(2) It may cause of flood for large regions.
(3) Cost for dam construction is very high.
(4) Large dam are the reason flood during upstream. It is harmful to human being.
(5) It is very difficult to obtain the place for dam construction.
(6) The overflow of water is also affect the plants life.
(7) The construction of dam may cause environmental problems.
(8) Fish migration is restricted.
(9) The power generation depends on nature and in dry season the generation of power reduces.
(10) It takes long time for erection.

IX. Conclusions

Small hydro power is the power obtained from a limited capacity up to 25 MW and instrumental in the development of the hilly and remote area of the country. The future of the small hydro power plant is bright all over the country and a large number of small hydro power plants shall come in future which will provide the key for development of the remote and hilly areas of the country. These small hydro power plants will provide the quality power to the people of the inaccessible and hilly areas. As we get that, out of 24442.75 MW available small hydro power potential, only 3632.25 MW are in use in present time in the country. It is the need of time that the SHP development must take place keeping all the parameters of quality management and safety in the place, so that the problems of constraining the operation and maintenance of existing power station may not occur.

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