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SCENARIO OF HYDRO POWER SOURCES IN HIMACHAL PRADESH-A REVIEW

Engineering

KEYWORDS: Hydropower, Renewable Energy, Mini Hydro, Micro Hydro

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ABSTRACT

Most of the energy we use today comes from fossil fuels. Coal, oil and natural gas are all fossil fuels created several millions of years before by the decay of plants and animals. These fuels lie buried between layers of earth and rock. While fossil fuels are still being created today by underground heat and pressure, they are being consumed more rapidly than they are created. For that reason, fossil fuels are considered as non-renewable; that is, they are not replaced as soon we use them. Moreover burning fossil fuels leads to pollution and many environmental impacts [1].

Hydro sources are one of the most usable renewable energy resources for the generation of energy in the form of electricity.

Himachal Pradesh is one of the states in India which is extremely rich in its hydel resources.This paper reflects some light on the presence and conditions of Hydro power sources in Himachal Pradesh.

I. INTRODUCTION

Renewable energy systems use resources that are constantly replaced and are less polluting. All renewable energy sources – solar, hydropower, biomass and wind have their origins in activities of the sun. Hydropower plants are coming under increasing pressure for development. Worldwide, the total hydropower capacity in operation is 848 GW, with annual generation of 3045 TWh/year. The contribution of small hydropower (SHP) hydropower installed capacity is about 5% with 34,000 MW. Presently, hydropower is contributing more than 50% of electricity supply in about 5 countries (World Atlas and Industry Guide, 2008). In India a potential of 15,000 MW has been estimated in small hydro. About 5,403 potential sites, each having capacity up to 25 MW, have been identified in various parts of the country. Already 611 small hydro schemes with a total installed capacity of nearly 2,045 MW are under operation and 225 schemes with another 669 MW are under various stages of implementation (MNRE 2008) [2, 3, 4].

In 2007, India had approximately 159 Gigawatts (GW) of installed electric capacity and generated 761billion kilowatt hours. Nearly all electric power in India is generated with coal, oil or gas. Conventionalthermal sources produced over 80 percent of electricity in 2007. Hydroelectricity, a seasonally dependentpower source in India, accounted for nearly 16 percent of power generated in 2007. Finally, nuclear energyproduced roughly 2 percent of electricity during the same year, while geothermal and other renewablesources accounted for approximately 2 percent.[5]

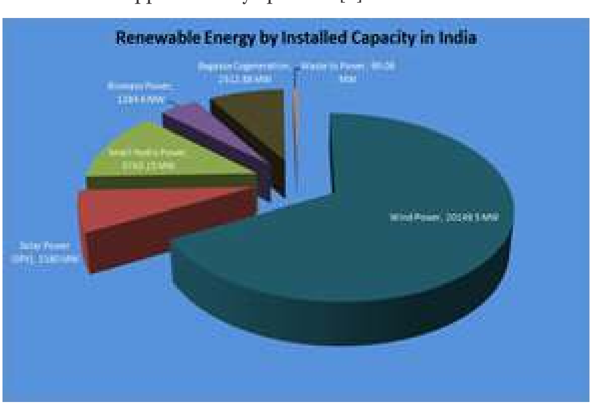

Figure 1: Electricity generation by type in India

Hydropower is a mature technology developed for more than 100 years. The criterion generally adopted to define the type of hydropower plant is based on installed capacity as follows:

- Micro hydropower plants: up to 100 kW
- Mini hydropower plants: 101 to 2,000 kW
- Small hydropower plants: 2,001 kW to 2,5000 kW
- Large hydropower plants: >25,000 kW

India is blessed with immense amountof hydro-electric potential and ranks 5th in terms of exploitable hydro-potential on global scenario (Fig. 2) [6]. And Fig.3 shows the Energy demand projection in India. [7]

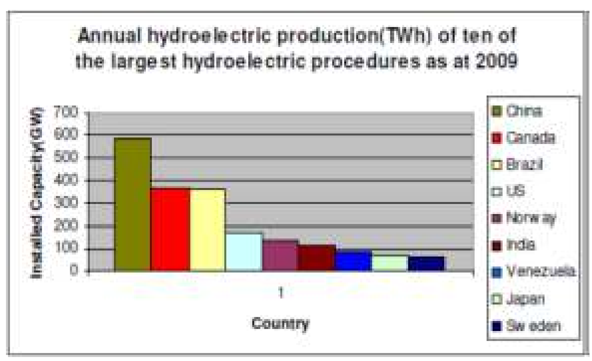

Figure 2: Annual hydroelectric productions (TWh) of ten of the largest procedures as at 2012

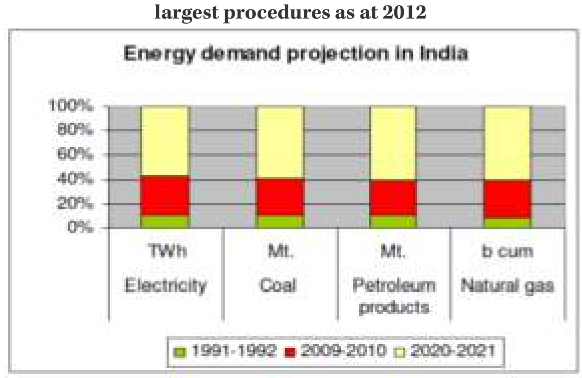

Figure 3: Energy demand projection in India

Small Hydropower (SHP)

Small hydropower plants can be classified according to their function and based on source of water, as run-of-river, canal-based and dam toe schemes. [8, 9].

A weir or a barrage is constructed across the river simply to raise the water level slightly and divert water into a conductor system for power generation. Such a scheme is adopted in the case of a perennial river which has minimum dry weather flow of such magnitude that makes the development worthwhile.

Canal-based small hydropower schemes are planned to generate power by utilizing the flow and fall in the canal. These schemes may be planned in the canal itself or in the by-pass channel. These are low head and high discharge schemes. These schemes are associated with advantages such as low gestation period, simple layout, no submergence and rehabilitation problems, and practically no environmental problems.

In dam toe SHP plants, head is created by raising the water level behind the dam by storing natural flow and the powerhouse is placed at the toe of the dam or along the axis of the dam on either side. The water is carried to the powerhouse through a penstock. Such schemes utilize the head created by the dam [9].

Basic Components of SHP Schemes

There are two basic components in all three types of SHP schemes; i.e., civil works and electro-mechanical equipment. Most of the components are same in different types of schemes; some components, however, are different based on the specific type of scheme.

The components of civil works in run-of-riverschemes are more or less same for low head or high head schemes. The basic and common civil works components of run-of- river schemes are discussed below. A typical layout of run- of-river SHP scheme is shown in Fig.3. The key parts of this system include the following:

1)Diversion and intake
2)Desilting tank
3)Power channel
4)Forebay
5)Penstock
6)Powerhouse building
7)Tail race channel

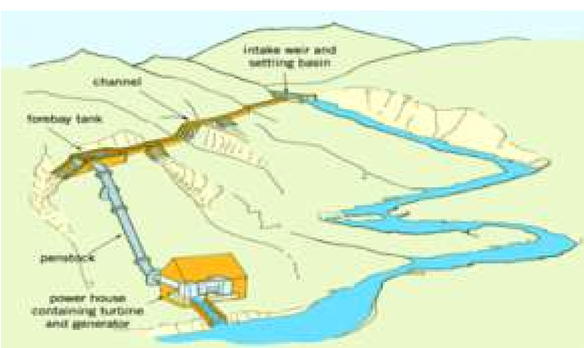

Fig.3. Schematic of typical run of river SHP Scheme

PERFORMANCE TESTING OF SHP STATIONS [10]

In the hydropower the energy transformation process is highly efficient, usually with well over 90% mechanical efficiency in turbines and about 98% in the generator. The inefficiency is due to hydraulic loss in the water circuit (intake, turbine, tail-race), mechanical loss in the turbo-generator group and electrical loss in the generator. Old turbines can have lower efficiency, and it can also be reduced due to wear and abrasion caused by sediments in the water. The rest of the potential energy (100% - η) is lost as heat in the water and in the generator. Thus energy efficiency measurement is one of the key issues.

The efficiency in electromechanical equipment, especially in turbines, can be improved by better design and also by selecting a turbine type with an efficiency profile that is best adapted to the duration curve of the inflow.

The biggest challenge for the performance testing was observed the absence of availability of provisions required for such tests in majority of the commissioned SHP plants. With such initiative SHP developers have started taken keen interest by way providing the necessary provisions in the civil structure/equipment for facilitating the testing. Needless to say that such evaluation shall help SHP plant owners regular monitoring of performance of their plants. However there is no mandatory condition for performance testing for large hydropower projects until the owner wishes to do so as per contractual conditions. Electricity regulators and financial Institutions are being followed up to adopt conditions for remunerative tariff from Hydropower.

HYDRO ENERGY

Hydro energy is simply energy that is taken from water and converted to electricity. Hydro energy can be obtained by using many methods of capture. The most common method of using energy from water is a hydroelectric dam, where water coming down through an area causes turbines to rotate and the energy is captured to run a generator. Power can also be generated from the energy of tidal forces or wave power, which uses the energy created by waves.

Many want to use hydro energy is that it is cheaper than using other methods to convert energy to electricity. It is also reliable and can be used almost immediately when turned on to meet the demand for electricity. Therefore, one must weigh the pros and cons before deciding to use hydro energy to supply their demand for electricity [11].

How hydropower works

Hydroelectric power comes from water at work, water in motion. It can be seen as a form of solar energy, as the sun powers the hydrologic cycle which gives the earth its water. In the hydrologic cycle, atmospheric water reaches the earth's surface as precipitation. Some of this water evaporates, but much of it either percolates into the soil or becomes surface runoff. Water from rain and melting snow eventually reaches ponds, lakes, reservoirs, or oceans where evaporation is constantly occurring. Moisture percolating into the soil may become ground water (subsurface water), some of which also enters water bodies through springs or underground streams. Ground water may move upward through soil during dry periods and may return to the atmosphere by evaporation. Water vapour passes into the atmosphere by evaporation then circulates, condenses into clouds, and some returns to earth as precipitation. Thus, the water cycle is complete. Nature ensures that water is a renewable resource.

The hydrologic cycle involves the continuous circulation of water in the Earth-Atmosphere system as shown in the Fig.4. At its core, the water cycle is the motion of the water from the ground to the atmosphere and back again.

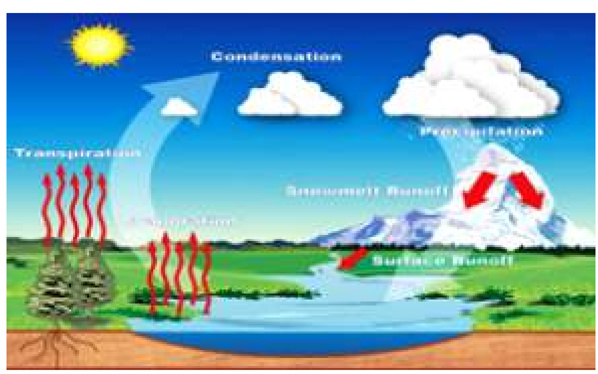

Fig.4. Hydrologic cycle

Generating Power

In nature, energy cannot be created or destroyed, but its form can change. In generating electricity, no new energy is created. Actually one form of energy is converted to another form.

To generate electricity, water must be in motion. This is kinetic (moving) energy. When flowing water turns blades in a turbine, the form is changed to mechanical (machine) energy. The turbine turns the generator rotor which then converts this mechanical energy into another energy form -- electricity. Since water is the initial source of energy, we call this hydroelectric power or hydropower for short.

At facilities called hydroelectric power plants, hydropower is generated. Some power plants are located on rivers, streams, and canals, but for a reliable water supply, dams are needed. Dams store water for later release for such purposes as irrigation, domestic and industrial use, and power generation. The reservoir acts much like a battery, storing water to be released as needed to generate power.

Power Transmission

Once the electricity is produced, it must be delivered to where it is needed -- our homes, schools, offices, factories, etc. Dams are often in remote locations and power must be transmitted over some distance to its users.

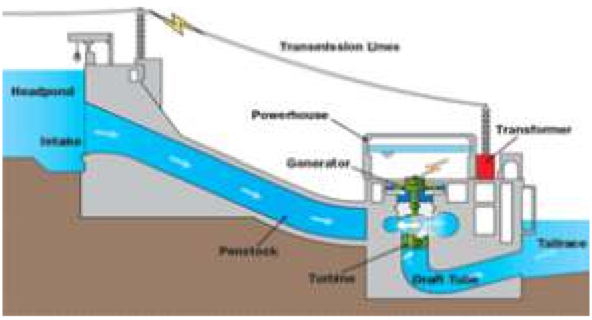

Fig.3. Generating electric power

Vast networks of transmission lines and facilities are used to bring electricity to us in a form we can use. All the electricity made at a power plant comes first through transformers which raise the voltage so it can travel long distances through power lines. (Voltage is the pressure that forces an electric current through a wire.) At local substations, transformers reduce the voltage so electricity can be divided up and directed throughout an area.

MINI HYDRO POWER

Hydropower is energy from water sources such as the ocean, rivers and waterfalls. "Minihydro" means which can apply to sites ranging from a tiny scheme to electrify a single home, to a few hundred kilowatts for selling into the National Grid. Small-scale hydropower is one of the most cost-effective and reliable energy technologies to be considered for providing clean electricity generation. The key advantages of small hydro are:

High efficiency (70 - 90%), by far the best of all energy technologies.
High capacity factor (typically >50%).

High level of predictability, varying with annual rainfall patterns.

Slow rate of change; the output power varies only gradually from day to day (not from minute to minute). A good correlation with demand i.e. output is maximum in winter.

Micro Hydro:

The term 'micro-hydro' is usually taken to mean schemes with a power output less than 100kW. Hydroelectric installations convert potential energy of water at height into kinetic energy in a turbine.Micro hydro can roughly be split into two categories, low head (<5m head) and medium to high head.

Several different types of hydraulic turbine can be used in micro hydro installations, selection depending on the head of water, the volume of flow, and such factors as availability of local maintenance and transport of equipment to the site. For mountainous regions where a waterfall of 50 metres or more may be available, a Pelton wheel can be used. For low head installations, Francis or propeller-type turbines are used.

For high head applications, where there is a considerable difference in head height between the intake and the powerhouse, construction costs for the penstock can represent the bulk of the project costs for the particular installation.

HIMACHAL PRADESH HYDRO POWER SOURCE [12]

Himachal is extremely rich in hydel resources. The state has about 25% of the national potential in this respect. It has been estimated that about 20,300MW of hydel power can be generated in the State by constructing various major, medium, small and mini/micro hydel projects on the five river basins. The state government has been giving the highest priority for its development, as hydel generation can not only meet the growing need of power for industry, agriculture and rural electrification, but can also be the biggest source of income to the state by way of sale of electricity to the neighbouring states.

That private sector is seen as an important driver for hydropower development in the future is best witnessed in the states where a bulk of the hydropower potential exists: Arunachal Pradesh (34% of the total potential in India), Himachal Pradesh (13%), Uttarakhand (12%), and Sikkim (3%). A significant share of new hydropower projects in these "hydropower states" are to be developed through the private sector (Table 1).

The most prestigious and major project on river Sutlej in the state is the NathpaJhakri (1500M.W). It is constructed in collaboration with the central government. The project is funded by the World Bank.
The foundation stones were laid of 300MW Chamera II Hydel Project in June 1999, of 2051 MW ParbatiHydel Power Project in December 1999, and of 800 MW Kol Dam project in June 2000. Other major ongoing projects are:

Table 1: Hydropower development plan in the "hydropower states" of the country [12]

State	Arunachal Pradesh	Himachal Pradesh	Uttrakhand	Sikkim
Total Hydropower Potential (in MW)	57072.5	23000	25000	8000
Total Hydropower Potential realised [Under construction/operation] (in MW)	59.215	6728	3163.85	100.7
Total hydropower projects under Central Sector (in MW)	8735	9095	7302	1300
Total hydropower projects under State Sector (in MW)		3428	2815.3	24.5
Total hydropower projects under Private Sector/JV (in MW)	32253.4	8192	2118.4	3820

Bhaba Augmentation Scheme, Ghanvi Hydro Electric Project (22.5 MW), LarjiHydel Project (126MW) and Khauli Hydro Electric Project (12MW). The state government has given eight hydel projects for private sector participation. These are Baspa Hydro Electric Project (300MW), Holi Hydro Electric Project (231 MW), DhamwariSunda

Hydro Electric Project (70MW), Project (15MW), AllianDuhangan Hydro Electric Project (192 MW), Swara-Kuddu (162MW) and Budhil (70MW).

The state has electrified each one of its 16,807 inhabited villages. It is very impressive, looking at the location of its villages in far off areas and their isolation.

Himachal Pradesh is extremely rich in its hydel resources. The state is having about twenty five percent of the national potential in this aspect. It has been estimated that about 21,244 MW ofhydel power can be generated in the state by the construction of various hydel projects on the five perennial river basins no matter they are major, medium or small. Out of total hydel potential of the state, 3934.74MW is harnessed so far, out of which only 7.6% is under the control of Himachal Pradesh Government while the rest is being exploited by the Central Government. The state government has been giving the highest priority for its development, since hydel generation can meet the growing need of power for industry, agriculture and rural electrification. It is also the biggest source of income to the state as it provides electricity to the other states also.

SMALL HYDRO DEVELOPMENT PROGRAMME IN HIMACHAL PRADESH

A) PRIVATE SECTOR PARTICIPATION

The State Government has taken several initiatives to encourage private sector participation in small hydro power development. Himachal Pradesh is among the few States, which has streamlined and is continuously refining the various procedures/processes to minimize the bottlenecks.

The process of exploitation of hydel potential in small hydro sector through private sector participation began during 1995-96. Since then, the allotment of project sites has been a continuous process. Till 30th November, 2011, 468 Small hydro Electric Projects (up to 5MW capacity) with an aggregate capacity of 1176 MW have been allotted. A goal of 500 MW through Small Hydel Projects by the end of 2014 has been fixed.

B) PROJECTS TO BE OFFERED FOR PRIVATE SECTOR PARTICIPATION

Projects up to 5.00MW are handled by HIMURJA in following modes.
a) Projects Identified by HIMURJA.
b) Projects Identified by the IPPs designated as self-identified projects.

i) Small Hydro Project up to 2.00 MW capacity shall be exclusively reserved for the Himachalis. Whereas while allotting projects upto 5.00 MW, Himachali shall be given extra 30 marks in addition to the marks obtained by them for financial strength.

ii) Not more than 3 projects shall be allotted for implementation to an IPP including the already allotted projects.

Demand and Supply in Himachal Pradesh State

Himachal Pradesh, being mostly a hilly terrain State and located in the far North end of the country, considerably away from the coal fields, has little prospect of having thermal projects. Having considerable hydropower potential, which is generally found to be more economical for development than thermal power, power generation in the future for Himachal Pradesh has to be essentially from hydropower sources.

As per the 14th Electric Power Survey of India, carried out by the Central Electricity Authority (CEA), the energy requirement of Himachal Pradesh for 1990-91 was 1487 GWh. This demand was projected to increase to 2536 GWh in 1994-95. Similarly, the peak load requirement for 1990-91 was 325 MW, which was expected to increase to 541 MW in 1994-95.

Table 1 shows the supply of energy and power as well as future demand during the period 1990-91 to 1994-95 as projected by Central Electricity Authority (CEA) in the 14th Electric Power Survey of India.

Power Supply and Demand for Himachal Pradesh

The year wise data on power generation and power purchase by the HPSEB from outside w.e.f. 1980-81 has been depicted in the following table:-

Table 2.Energy and Peak Load Demand for Himachal Pradesh Period 1995 to 2010

Period	Energy Demand (Gwh)	Peak Demand (MW)
1995-96	2879	609
1996-97	3254	683
1997-98	3662	763
1998-99	4103	848
1999-2000	4576	939
2004-05	7378	1457
2009-10	10606	2020

Conclusion

- Hydropower is the cheapest way to generate electricity today. No other energy source, renewable or nonrenewable, can match it. Producing electricity from hydropower is cheap because, once a dam hasbeen built and the equipment installed, the energy source-flowing water-is free. Although Hydropower does present a few environmental problems the inherent technical, economic and environmental benefits of hydroelectric power make it an important contributor to the future world energy mix.
- A hydroelectric plant uses water to make electricity. Water flows through turbines (wheels) that spin with the flow of the water. The power in the spinning wheels is channeled to give people electricity.
- Hydropower is important from an operational standpoint as it needs no "ramp-up" time, as many combustion technologies do. Hydropower can increase or decrease the amount of power it is supplying to the system almost instantly to meet shifting demand. With this important load-following capability, peaking capacity and voltage stability attributes, hydropower plays a significant part in ensuring reliable electricity service and in meeting customer needs in a market driven industry. In addition, hydroelectric pumped storage facilities are the only significant way currently available to store electricity.
- Hydropower's ability to provide peaking power, load following, and frequency control helps protect against system failures that could lead to the damage of equipment and even brown or blackouts. Hydropower, besides being emissions-free and renewable has the above operating benefits that provide enhanced value to the electric system in the form of efficiency, security, and most important, reliability. The electric benefits provided by hydroelectric resources are of vital importance to the success of our National experiment to deregulate the electric industry.

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