

**Critical Review on Small Hydropower Plant Technology,
Environment Issues, Government Policies and Current Scenario of
Power Production In India****Sanjeev Kumar¹, Dharminder Kumar²**^{1*} Assistant Professor, School of Mechanical Engineering, Lovely Professional University,
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Abstract

This paper provides a review of technology, environmental issues, challenges and government policies of a small hydropower plant. As it is known that conventional methods like thermal power generation require fuel to produce energy, which leads to a negative effect on the surroundings. So to get neat and clean energy, renewable energy sources should be used to produce energy. In renewable energy, hydropower is also an important technique. To design an effective and efficient small hydropower plant various parameters should be taken into consideration so there will be no harmful effect of a hydropower plant on the environment or society and maximum benefit taken from the small hydropower plant.

1. Introduction

Hydropower is the power that is produced by the potential energy of the water with the help of turbines and generators. Water available at high head flows through the penstock from the reservoir to the turbine where a nozzle is attached to increase the velocity of the flow and High-velocity water strikes on turbines blades which result in shaft rotation and this mechanical energy further converted into the electrical energy with the help of a generator. [1] And generators are connected to the power stations with the electrical wires.

Generally, hydropower plants are categorized into three types

- Impoundment: In this type of hydropower system, dam is used to store the river water in the reservoir. Stored water is used to generate the electricity.[1]
- Diversion: This system does not require a dam. In this type of system, a diversion facility like a channel or portion of river through canal or penstock is used.[1]

- Run-of-river: The system used water in natural flow range and not required any impoundment.

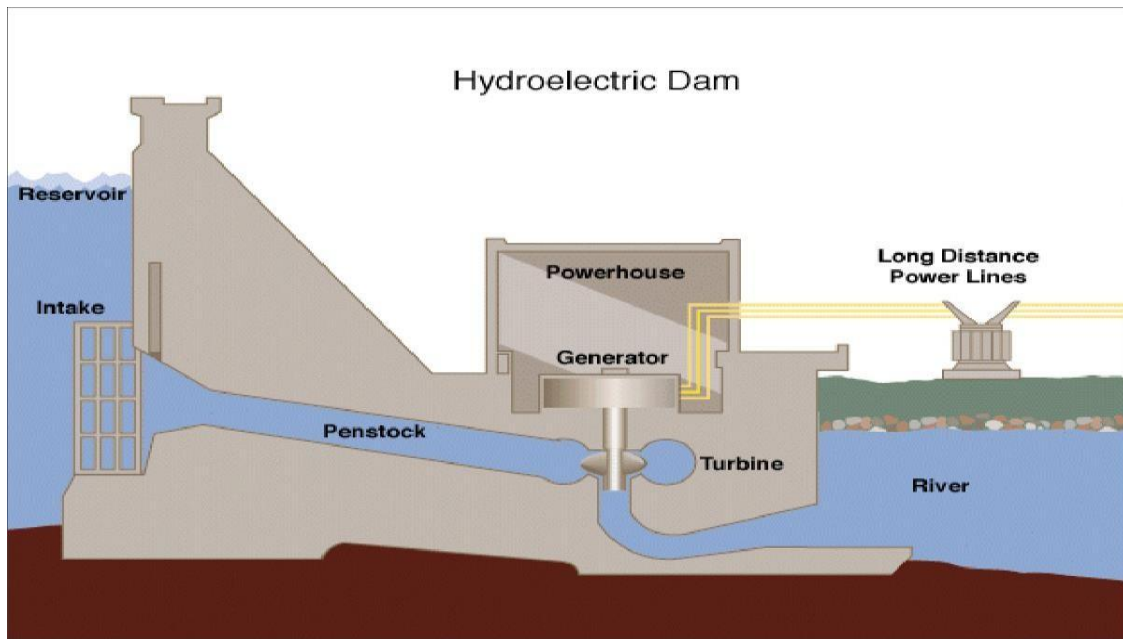


Figure 1 Typical small hydro site layout []

2. Technology used in the small hydropower plants

Small hydropower technologies are generally divided into three main parts conventional hydropower technologies, hydropower's untapped potential and new hydropower technologies [2]. Conventional technology includes conventional way like forming dams, run-off rivers plants and pumped storage [3]. The following are the few researchers, who study hydropower technologies in detail and conclude the following result based on various parameters. Campbell [4] has worked on small hydro and low head hydro power technologies. The author has considered conventional hydropower technologies like small and low head hydropower.

D. kilama [3] has worked on the different technology on small hydropower like Small hydro site characteristics, small hydropower working principle and types of turbines used in hydropower. Small hydropower can be used in developing countries to slowdown the climate change and creating new employment opportunities. O. paish[1] provided a review on small hydro power:

technology and current status, the author has focused on technology, economics, future directions. He has concluded that hydropower have many advantages over wind and solar energy. It almost has no effect on environment. P. Punys [5] has discussed the various tools used for small hydropower plant resources planning and development. The author has discussed on geographical information system. Author has suggested that with the help of GIS system, the environmental impact assessment is improved. It also increases the availability of high quality topographic and hydrologic data.

3. Environment aspects of hydropower plants

Hydropower is an easy and cheap source of power. It has many advantages over other renewable energies but it also has some disadvantages. The environment is the main concern in the case of hydropower. Environmental impact assessment (EIA) is an important process to determine environmental consequences (positive and negative) of a hydropower plant [6]. Clouds bursting, land sliding and flash floods are the main environmental problem related to the hydropower plant. There are also some possibilities of emission of poisonous gases such as an oxide of sulphur and nitrogen that can affect the quality of water. [7] The reservoir may destroy the ecosystem, destroy infrastructure, and displace settlements due to the inundation of land. To avoid the noise problem which is due to the operation of turbines and generators, there should be proper insulation of the powerhouse.[7]. The various researchers have discussed the environmental issues of hydropower plants. The details of the some of them have been discussed. Kunda et.al. [8] Has discussed the environmental issues like pollution in water, biodiversity loss, infrastructure destruction, landscape change. S. Singh [9] studies the issues and challenges of small hydropower plants. He has also discussed the various parameters like Hydrology and sediment effects, temperature of water and quality, effects on ecology, biology and landscape and culture assets. M.Zelen[10] has discussed the environmental impact of small hydropower plants like impact on the biodiversity, land diverted for the project activities and Fragmentation of forests.

4. Challenges in small hydro power plants

Conventional energy sources are the main sources of energy production or power production in the last century. This energy is produced by using coal, oil and natural gases which leads to harmful effects on the environment.[8] According to the Kyoto protocol conventional energy source produce a large number of harmful gases during the combustion of oil, coal and natural gases.[11] So to overcome environmental problems and produce clean energy hydropower is a better choice than conventional energy sources. But producing power through hydro energy is not an easy task there are many challenges which is faced during the construction and operation of the hydropower plant [12]. S. Singh [9] has discussed the challenges like geographical ship financing, environmental impact assessment, civil work design challenges. C.S kunda[8] has been discussed on key challenges to expanding renewable energy.

5. Government policies for small hydropower

Hydropower is the power generation process with the minimum effect on the environment and society. Due to environmental pollution, greenhouse gas emission, and global warming, Countries need a renewable source of energy.[14] To improve and encourage small hydropower plant installation government provides policies for easy loans and sources to set up a hydropower plant to the private sector.[15] The Indian government provides a subsidy for the power generating companies for establishing new hydropower plants. Indian government is planning to increase the power generation from small hydropower projects to 7000 MW by the end of the 12th five-year plan[11]

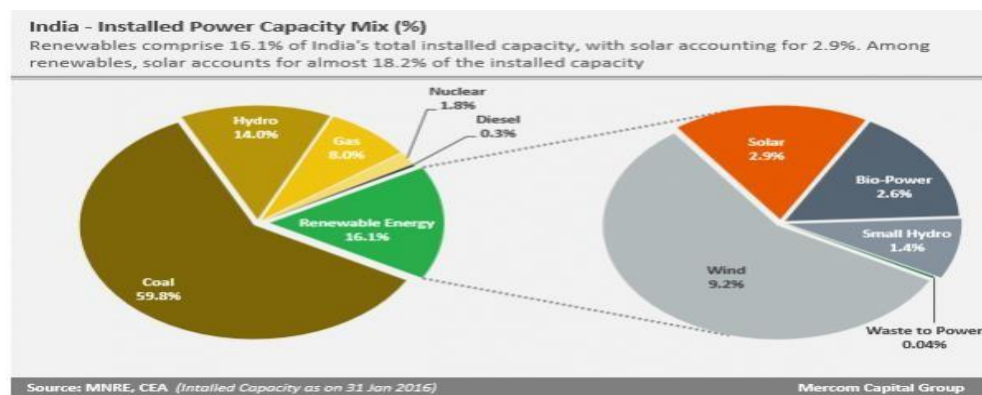


Figure 2 Renewable power generation In India

From the above figure it is shown that 16.10 % of the total energy is produced by the renewable energy source in India. From renewable sources of energy, 14% energy is produced by the hydropower plants across the India and it is increasing.[15]

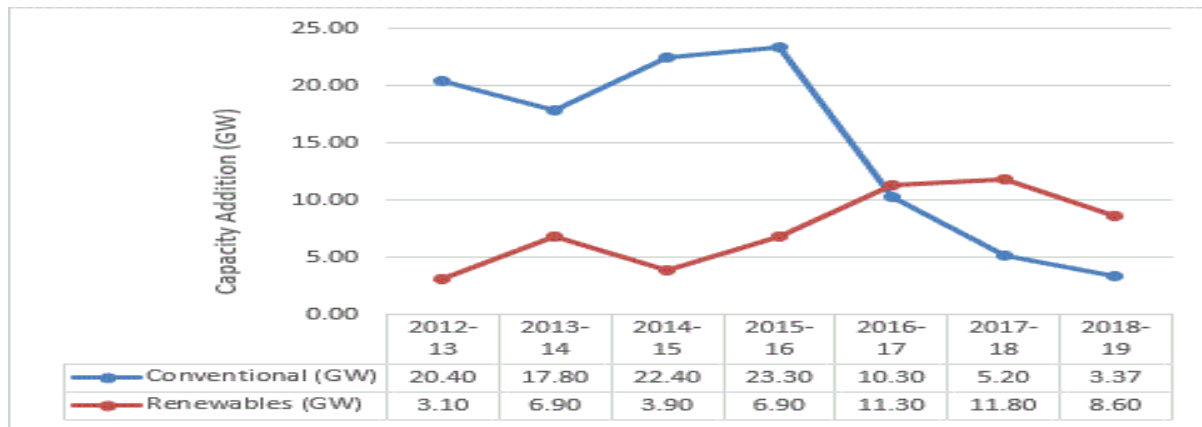


Figure 3 Capacity Addition of Conventional Energy and RE (2012 - 13 to 2018- 19)

The first small hydropower plant is established in 1897 at Darjeeling, West Bengal. After 1947, India needs a new source of energy so new thermal and large hydropower plants. To obtain more hydropower alternate hydropower energy center is established in the IIT, Roorkee in 1982. The hydro plants control extends up to 3 MW limits and was moved to MNRE from the ministry of Power [16]. GOI welcomed private division interest in SHP in 1993 [16] and 24 states have reported approaches for private area support in SHP improvement up until now. GoI reported first hydro control approach in 1998 under which hydro control venture up to 25 MW limit were moved to MNRE (at that point MNSE) from MoP in 1999. The Indian Electricity Act 2003 21 started changes in the power area in India and has uncommon arrangements for support of the improvement of the sustainable power source and country electrification.

The intensity measure which is essential be bought from sustainable power sources by dissemination organizations are known as RPO. Levyet.al. [17] commanded the excellent duty to be fixed by SERC and CERC for the sustainable power source known as feed-in-tax. According to the Tariff Policy 2006 stipulates that "According to arrangements of segment 86(1)(e) of the Electricity Act 2003, the Appropriate Commission will fix a base rate for acquisition of vitality from sustainable power sources considering the accessibility of such assets in the locale and its effect on retail duties".

Table 1: Incentives/Subsidies Schemes available to Develop Small Hydropower

Activities Type	States	SHPP Capacity	Incentives
Preparation of DPR & DSI	All States	Up to 1MW	Rs. 6.00 Lac
		Above 1MW	Rs. 10.00 Lac
State Govt SHPP (New).	Special Categories States (Uttarakhand, NE states, J&K and H.P.)	100KW – 1000KW	Rs. 75,000 per kW
		1MW-25MW	Rs.7.5 Crores/MW Maximum upto Rs. 20.00 Crore per SHPP
	Others States Rs.	100KW – 1000KW	35,000 per KW
		1MW-25MW	Rs. 3.5 Crores/MW Maximum upto Rs. 20 Crore per SHPP
Private/Co-operative Mode New SHPP	Special Categories States (Uttarakhand, NE states, J&K and H.P.)	0.1MW-25MW	Rs. 1.5 Crores/MW maximum upto Rs. 5.00 Crore per SHPP
	Other states		Rs. 1.00 Crores/MW maximum upto Rs. 5.00 crore per SHPP
Modernization & Renovation of old SHPP in Public Sector	All States	Up to 1000kW	Rs. 10,000 per kW
		Above 1MW25MW	Above 1MW25MW Rs. 1.00 Crore/MW maximum upto Rs. 10.00 Crore per SHPP

6. Conclusions

Small hydropower plants are the effective and non-pollutant source of energy. In conventional methods, fuel is used to produce energy which emits poisonous gases and harmful to the environment. But in small hydropower, there is no environment pollution. So countries like India, China need to focus more on the hydro energy so clean energy should be produced and there should be no effect on the environment. To establish a new hydropower plant all the parameters should be considered like technology, environmental issues, challenges, and government policies. It helps to establish, maintain an efficient hydropower plant.

References

- [1] O. Paish, "Small hydro power: technology and current status," vol. 6, pp. 537–556, 2002.
- [2] V. K. Singh and S. K. Singal, "Operation of hydro power plants-a review," *Renew. Sustain. Energy Rev.*, vol. 69, no. November 2015, pp. 610–619, 2017.
- [3] D. Kilama, "Review of small hydropower technology," *Renew. Sustain. Energy Rev.*, vol. 26, pp. 515–520, 2013.
- [4] R. J. Campbell, "Small Hydro and Low-Head Hydro Power Technologies and Prospects," 2010.
- [5] P. Punys, A. Dumbrasukas, A. Kvaraciejus, and G. Vyciene, "Tools for Small Hydropower Plant Resource Planning and Development: A Review of Technology and Applications," pp. 1258–1277, 2011.
- [6] E. Resources, "Hydropower Projects: Environmental & Social impacts Management & Mitigation measures," 2015.
- [7] G. P. Note, "Environmental , Health , and Safety Approaches for Hydropower Projects," no. March, 2018.
- [8] C. S. Kaunda, C. Z. Kimambo, and T. K. Nielsen, "Hydropower in the Context of Sustainable Energy Supply: A Review of Technologies and Challenges," vol. 2012, 2012.
- [9] V. V. L. Ruj and P. R. Q. X. J. Frp, "6wxg\ ri 'liihuhqw ,vvxhv dqg &kdoodqjhv ri 6pdoo +\gur 3rzh 3odqvv 2shudwlrq," pp. 88–91, 2014.

- [10] M. Zele, “Environmental Impact of Small Hydro Power Plant — A Case Study,” 2018.
- [11] N. Kumar, P. K. Tiwari, and Y. R. Sood, “A comprehensive analysis of strategies , policies and development of hydropower in India : Special emphasis on small hydro power,” *Renew. Sustain. Energy Rev.*, vol. 18, pp. 460–470, 2013.
- [12] G. Ardizzon, G. Cavazzini, and G. Pavesi, “A new generation of small hydro and pumped-hydro power plants: Advances and future challenges,” *Renew. Sustain. Energy Rev.*, vol. 31, pp. 746–761, 2014.
- [13] B. N. Stram, “Key challenges to expanding renewable energy,” *Energy Policy*, pp. 1–7, 2016.
- [14] S. Mishra, S. K. Singal, and D. K. Khatod, “Optimal installation of small hydropower plant — A review,” *Renew. Sustain. Energy Rev.*, vol. 15, no. 8, pp. 3862–3869, 2011.
- [15] M. N. Rao, “Implementation of a small hydro power project in India : issues and lessons,” vol. 2, no. 1, 2011.
- [16] M. K. Kesharwani, “Overview of Small Hydro Power Development,” *Himal. Small Hydro Power Summit*, pp. 44–57, 2006