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Survey and Analysis about the Status and Future Trends of Hydropower Development in Nepal

Birendra Sharma[1], Yuan Shouqi[2], Fang Yujian[3] and Zhang Jinfeng[4]

[1,2,3,4]Research Centre of Fluid Machinery Engineering and Technology, Jiangsu University, Zhenjiang 212013, China

ABSTRACT

Nepal is a small mountainous Country lying between India and China. The geographical coordinates are $28^0$00N $84^0$00E. Nepal's falls in the temperate zone north of the tropic of cancer. The Country can be dividing into three main geographical regions; Himalayan region, mid-hill region and Terai region. The highest point in the Country is Mt. Everest (8, 848m) while the lowest point is the terai plains of Kechana Kalanin, Jhapa (60 m). The hydropower sector of Nepal was recognized as one of the most feasible and potential sector for green economy. In Nepal, approximately 10% of the population has access to electricity from the national grid till date. Nepal has huge capacity to generate Hydro Electricity. The Benefit of hydropower are, it is non-polluting in the since it does not release any heat and gases. It has low operating and maintenance cost. The most important benefit is that hydropower plant's produce electricity without consuming power. This paper is written to find out the future scope of Hydropower in Nepal and to provide information for foreign Investors and domestic investors to invest in Nepal's hydropower. Primary data were collected through news magazine/daily newspapers, journals and books. This paper presents the hydro-power potential, current utilization and future plan of hydro-power development in the Nepal. The government policy in hydropower its issue and barriers for the development in Nepal are discussed.

Keywords Energy Market, Hydropower, Developing Country Nepal

Introduction

Nepal, officially the Federal Democratic Republic of Nepal, is landlocked Sovereign state located in South Asia with an area of 147, 181 square Kilometers and a population of approximately 27 million.

In principle, Nepal can be divided into three regions: mountainous region (15%), hill region (68%) and the plain region (17%). So in total 83% of the Nepal is made of mountains and hills, 8 of 10 highest mountains are located in Nepal. Figure 1 shows the topographic map of Nepal. There are over 6000 small and big rivers that drain the Nepal Himalayas in Nepal into the Ganges. Almost 50% of the total annual flow of the Ganges and 70% in dry season flows from the Nepal river systems. Around 220 billion cubic meters of water flow annually (Pokharel 2001). Figure 2 shows these rivers and labels the main river basins. The mountains in the glacial areas provide the sustainable runoff for all the rivers throughout the year. And climate from the tropical to the arctic within the 200km span from south to north provides abundant rainfall within the monsoon region with regional climate. Thus Nepal has abundant source of water, together with favorable hill region slope, so Nepal has a huge potential for clean and renewable hydro power development.

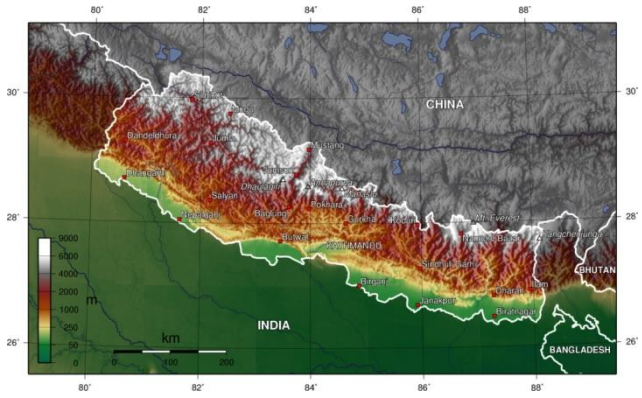

Figure 1:Topographic map of Nepal [1]

Figure 2:River Basins of Nepal (Sangroula 2009) [3]

In 1966, i. e. 48 years ago, Dr. Hari Man Shrestha assessed the total theoretical hydropower potential in Nepal as 83, 500MW. He did so during the research work for his PHD thesis (1966) from Moscow Power Institute USSR on Cadastre of potential water power resources of less studied high mountains region, with special reference to

Nepal. Dr. Shrestha is known as the pioneer hydropower engineer of Nepal. Since then, no further study has been done in this field. Nepal has huge capacity to generate 83, 500MW of hydroelectricity out of this about 43, 000MW is economically feasible. Despite having abundant potential, Nepal only has an installed capacity of 700MW (~1. 6% of total economically feasible potential) till 2013.

Status of Power Generation and Transmission

The hydropower development in Nepal began in 1911 with the development of 500KW Pharping Power plant. Until 1990, hydropower development was under the domain by government utility, Nepal Electricity Authority (NEA) only, in 1992, the sector was open for private sector, now the private sector produces 148 MW of power.

Fig 3: First hydropower plant in Nepal (Source: Nepal Electricity Authority, Aug. 2005, Generation, Third Issue, Kathmandu, Nepal.)

There are currently 1956 micro-hydro schemes in Nepal of which 810 are peltric and 347 are non-peltric. The new hydropower policy 2001 seeks to promote private sector investment and aims to expand the electrification with the country and to export. NEA is planning to expand its transmission line to 3277 kilometers. This includes 78 kilometers of 33 KV, 1409 kilometers of 132 kV, 7555 km of 200 KV and 1030 Kilometers of 400 KV in the coming ten years. The cost of the project will be 1. 27 billion dollars. Out of this NEA has just 18 percent of amount. Asian Development Bank and World Bank expressed their commitment to arrange necessary funds for project.

After generation of electricity, it needs to be transmitted to areas with high demand for which an elaborated network of transmission lines are essential Transmission over long distance is carried out by means of high voltage overhead power lines called transmission lines. The electricity can be transmitted as either alternating current (AC) or direct current (DC). Nepal's Transmission system consist of 1, 178 km single circuit 132 KV line, 27km of double circuit 132 KV line, 179 km of 66 KV single circuit, 153 km of double circuit 66 KV line and 1216 km of 33 KV single circuit transmission line. The country's geographical feature makes the extension of grid-based electricity nearly impossible

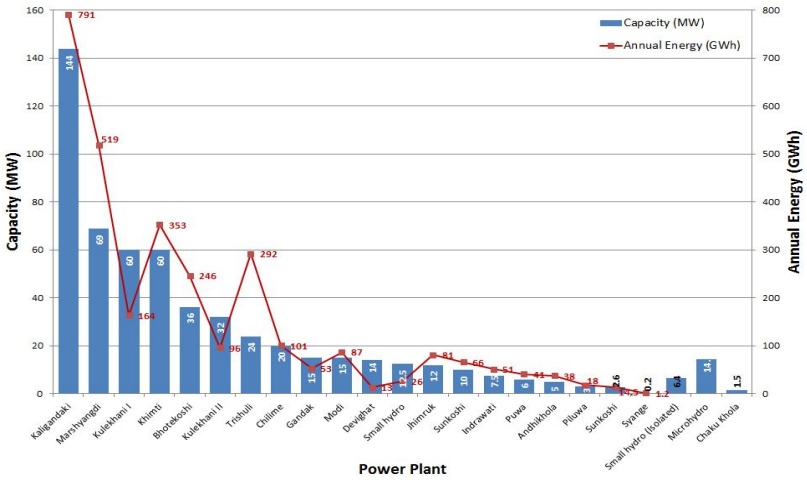

Fig. 5: Data of hydropower in Nepal Total capacity: 568. 7MW (Sources: Dwarika Adhikari: Sustainability Analysis of Hydropower in Nepal page 71)

There are many projects which have been identified for generation electricity. Some of those identified promising project are in the following table:

Table 1: Identified hydropower project (Source: Nepal Electricity Authority)

Project Name	Capacity (MW)	Dam ht (m)	Year of Study
Koshi Multi Purpose	3400	269	Feasibility study 1993
Karnali (Chisapani)	10, 800	270	Feasibility study 1974, Updated in 2001
Pancheswor	6, 480	315	1995
West Seti	750	195	1997
Arun-III	402		1991
Upper Tamakoshi	309		May-05
Upper Karnali	300		1998
Dudhkoshi	300		1998
Andhi Khola	176		1997
Tamur-Mewa	101		1998
Total	23018		

In 2015, Nepal's demand for electricity is estimated to be more than 2200MW and installed capacity will be probably be 1653 MW even if everything goes well for the completion of Chamelia 30 MW, Kulekhani –III, 14 MW, Upper Tamakoshi 456MW, Upper Trishuli-III-B, 40 MW, Rahughat 30MW, and Upper Modi-A 42MW. Despite having massive amounts of hydroelectricity potential, Nepal only produce a few megawatts which is not even sufficient to fulfill domestic demand. The hydropower system in Nepal is dominated by run-of-rivers project. There is only one seasonal storage project in the system. There is shortage of power during winter seasons.

Problems in development Hydropower

During the wet seasons Nepal faced the problem of flood which resulted in loss of life and as well as property in the hilly areas and terai in western Nepal. However, these rainy seasons even in the abundance of water NEA imposed a load shedding of 2 hours each day, two days a week. Nepal didn't get to implement a hydropower plant that's estimated cost per KW was more than $ 5, 000. While average cost of hydropower projects implemented so far in Nepal is in range of 2, 500$ KW. The construction of Hydropower had not completed within time. For example The middle marsyangdi project commissioned in December 2008 with cost and time overruns. NEA officialdom defensively says that this particular projects from which to draw inference. The Nepal hydrocracy is one of biggest problem in development of hydropower. The cancellation of Arun –III in 1994 by World Bank is example of hydrocracy in Nepal. The Government of Nepal has executed a memorandum of understanding (mou) with Satluj Jal Vidyut Nigam Ltd (SJVNL) on March 12. 2008 for the implementation of Arun –III hydro projects.

There should be space for projects of all size small, medium and big. It is the only way to provide electricity to remote mountains and hills in the first half of the 1990 S Nepal's energy demand was increasing at rate of approximately 15% i. e. about 40 MW annually. Arun-III has a lesson if only we are prepared to learn it. Therefore, the challenge for policy makers and planners is developing projects of all size and from all sources-private, public, internal and external.

Nepal receives between 350-400 million dollars of official Development Assistance annually, Donors financial support has not been utilized properly in Nepal, there is misuse of funds. Controversies over monopsony buyer and the fact that large project rely on expensive foreign direct investment have raised opposition against large-sale hydropower projects in Nepal. Nepal's power supply and demand patterns have noticeable seasonality characteristic of imbalance in the form of power shortage during dry month (mid December through mid April) and surplus during wet months.

The existing hydropower projects are expensive due to heavy reliance on bilateral and multilateral financing agencies, costly foreign consultants and contractors, limited manufacturing capability of power generation, transmission and distribution and related equipments. The power transmission network seems to be the major bottle neck in the Nepalese electricity sector. The Nepalese electricity sector is currently struggling with low generation capacity and a poor transmission network, resulting in long and frequent power cuts in area of high demand. The most critical impact of climate change in Nepal is related to its water resources and hydropower generation from glacier retreat, expansion of glacial lakes.

Electric power transmission and distribution losses in Nepal are 981000000 KWH in 2009, according to a World Bank report published in 2010. Electric power transmission and distribution losses include losses in transmission between sources of supply and points of distribution.

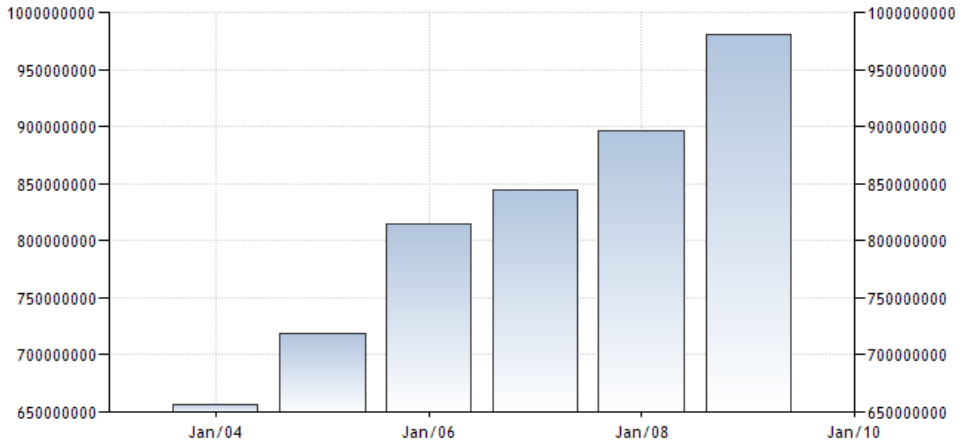

Fig. 6: Electric Power Transmission and Distribution losses (KWH) in Nepal (sources NEA)

Government policy

The first comprehensive regulations for the hydropower sector were the hydropower regulations 1992. They were introduced with related legislative instruments, the water resources act 1992 and regulation 1993. The primary intensions were to address the growing demand for electricity and to reduce the populations dependency on firewood to protect forest resources. They also aimed to create an investment friendly environment to encourage the rapid development of hydropower. In 1992, Nepal Government adopted a national hydropower development policy with the following four objectives:

1. To supply electricity as per the demand of the people in urban and rural areas by exploiting the high potential of water resources.
2. To enhance hydropower to meet industrial needs.
3. To promate national and foreign private sector investment in hydropower development.
4. To conserve the environment by supplying clean hydropower.

One of biggest weakness of Nepal is it doesn't have any geographical connection with Sea so it can create difficulties in goods export trade. Lack of infrastructure, political dispute and epidemic corruption are other considerable weakness in Nepal for the development of hydropower. Following the amendment to the hydropower policy 2001. The government of Nepal introduced in July 2006 negating all previous relevant policies and making value added tax (VAT) applicable to all hydropower project above 3MW. This ordinance resulted is an immediate 13% escalation of the costs of all hydropower project above 3 MW. The government has adopted the hydropower development policy of 2001 for attracting both local and foreign investment the following are the main highlights of this policy.

- To generate electricity at low cost by utilizing the water resources available in the country.

- To link electrification with economic activates.
- To render support to the development of rural economy by extending rural electrification rural electrification and
- To developed hydro power as an expandable commodity.

Investment in hydropower sector

The domestic investment is $ 75. 5million and foreign Investment is $ 233. 6 million in the hydro power in Nepal. Nepal's micro hydro development is supported by a host of international donor agencies including the UNDP-Financed Rural Energy development program (REDP) and the World Bank through the micro hydro village electrification (MHVE). Nepal hydropower projects come up through bilateral donor financing in combination with soft loan financing from multilateral development financing institutions. In Nepal it is estimated that the government developed medium-sized hydropower cost an average of US $ 2, 800/KW, while Private generators are producing in US $ 1000/KW. Making Nepal one of the safest and business destinations in the world. Besides this Nepal became a member of multilateral Guarantee Agency (MIGA).

There are about 905 foreign direct investment project in Nepal that worth approximately US $ 1. 65 billion. Foreign direct investment (FDI) is defined as cross-border investment done by foreign companies in host country. Nepal has good investment prospects in hydropower, tourism, agriculture and information and technology. Hydropower is one of the areas with immense potential to attract FDI. Nepal's hydropower sector has been attractive to FDI particularly after the construction of large Khimti and Bhotekoshi hydropower projects that were funded primarily by foreign investment.

Table 2: Data of Foreign direct investment in Nepal (sources: HYDRO NEPAL VOL 1 ISSUE 1 JUNE 5, 2007)

S. N	Top countries	No of project	Total project cost NPR Million	Total fixed cost NPR Million	FDI	Employ-ment
1.	India	501	62725. 01	51118. 64	323290. 31	56407
2.	China	401	13547. 54	10899. 31	7036. 17	23325
3.	Canada	25	5081. 87	4892. 78	2166. 54	1926
4.	Japan	154	3195. 03	2713. 48	1171. 24	6683
5.	Norway	12	8116. 59	6766. 8	1135. 83	726
	Gross total	2108	152181. 75	129116. 4	68049. 97	15543. 2

As we can see in the table, India has the largest share of investment (47. 66%) in Nepal due to the geographical and political intimacy and followed by China with (10. 34%). Nepal government should have balanced approach to facilitate foreign investment which creates win-win situation for Nepal and foreign investors. Current and future demand hydro electricity in India and China makes secure future for the

hydropower investors in Nepal. There is more chance of getting profit in hydropower business. For example US developed 36 MW Bhotekoshi which generated NRS 1 Billion annual income while investment cost was almost 5 Billion. Likewise some other investors are making alluring profit from hydro power.

Water resources agreements with India

Nepal and India cooperation on hydropower (NICOH) has looked into the historical background on hydropower development and power exchange. The co-operation in the hydropower sector between the two countries began with the Koshi and Gandak project in the late 1950, Kataiya power house of capacity 6. 8 MW was built by India for Nepal on the Koshi canal at that time power exchange between Nepal and India began in 1971 with limited low capacity exchange at various locations along the border currently. The treaty between Nepal and India are as follows

1. Binational sharda treaty for irrigation in 1920
2. Bilateral agreements Koshi agreement in 1954 and revised in 1966
3. Gandak treaty in 1959 and amended in 1964.
4. Binational mahakali –Pancheshwar treaty in 1996.
5. The cost of project to be share by Nepal and India in proportion to the benefit equal to them (50-50)

Conclusion

Hydro power development in Nepal can play an important role in the overall development of Nepal. There is strong evidence that electricity has positive impact on the poor, through improvement in children's education, better communication. Hydropower development is not necessarily a zero carbon technology but as discussed above it can save significant amount of Co_2 emissions and other energy sources. The hydropower of Nepal is huge and the sustainable hydropower development becomes the key to make Nepal's growth and reduction of poverty. Hydropower production has to be cheap, reliable and environmentally and socially sustainable for it to meet the domestic as well as export markets. concerted efforts have to be made in terms of study project selection and implementation to make hydropower competitive and affordable. Finally, it is hoped that this report world prove beneficial to anyone who has got interest on hydropower most especially, on hydropower generation on Nepal. The storage type hydropower plant helps reduce floods and landslide because water is stored during the rainy seasons in mega dams and released during the winter seasons.

Private hydropower developers also started financing in this sector after 1992 when the government adopted new hydropower policy and electricity act. Nepal needs to formulate a policy to choose to implement project estimated to cost at reasonable level. The total generation capacity of the hydropower project owned by the private sectors is more than 120 MW. Small hydropower plants also play an important role in Nepal's future energy supply. Micro-hydro system is particularly suitable for power supplies in rural and isolated, as an economic alternative to extending the electricity grid.

The present circumstance and statically data in this paper about the scope of hydropower development in Nepal shows that there is an enormous opportunity for foreign investor in hydro power sector. Eventually Nepal is becoming an international trade hub located between emerging market India and China. Nepal finally opened its door for foreign investment by adopting the most liberal economic policies. The Government of Nepal has also created a competitive and investment policy by making the administrative procedure simple and easy and also providing attractive incentives and facilities to the foreign investors, making Nepal one of the safest and suitable business destinations in the world.

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