Hydro Energy Development in Nepal: A Path from Deficit to Surplus

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Abstract

This paper reviews Nepal's hydro power potential, current and future energy demand and the strategy needed to develop the hydro power plants to meet the demands. Nepal's economically feasible hydropower generation capacity is one of the highest in the world. However, this huge hydropower potential is still untapped. The country has harnessed only about 2% of its economic potential of 42,000 Megawatt (MW). By harnessing the hydro resources, Nepal can meet its domestic demand, create a surplus for export. The projected demand of the country to Fiscal Year 2030 is 4,200 MW which is 10% of the total economic potential. The strategy of development of the hydro power plants to shifted to storage type plants as the dry season output of the run of the river plants are just half of the total installed capacity.However,Nepal has made a remarkable progress in clean energy development and has a great prospect for the development of hydro energy fulfilling the energy deficit of the country in few years and will export the surplus energy to the neighbouring countries.

Keywords

hydro power potential, power deficit, hydropower development strategy.

I. INTRODUCTION

Nepal has the highest altitude variation in the world ranging from 60 m to 8,848 m (Mt Everest), the highest altitude in the planet earth within 170 km distance. It has been estimated that there are more than 6,000 rivers (including rivulets and tributaries) in Nepal and drainage density is about 0.3 km/km^2. The cumulative length of rivers is 45,000 km. There are 1000 rivers longer than 10 km and about 24 of them are more than 100 km [6]. It has four large river systems originate from the Himalayas: a) Koshi River system, b) Narayani (Gandaki) River system, and c) Karnali River system d) Mahakali River system. Total estimated catchment area within the country of all river system is around 146 km^2 and total average discharge is 7122 m^3/s [6].

The Koshi river system is the largest river system in Nepal. It lies in the Eastern part of Nepal. It encompasses a catchment area of 61,000 km^2, of which 27,816 km^2 (i.e., 45.6%) lies in Nepal and the rest in Tibet of China. The highest altitude in the region is 8848 m, the peak of the world; i.e., Mount Everest. The Koshi River constitutes seven major tributaries; i.e., Indrawati, Sunkoshi, Tamakoshi, Likhu, Dudhkoshi, Arun and Tamor, from west to east. Out of these, three major rivers or tributaries originate in Tibet of China; the Sunkoshi, Tamakoshi, and Arun. The Narayani river system is the second largest river system of Nepal. It lies in the western part of the country covering a catchment area of 31,890 km^2. The basin incorporates the districts of Manang, Nawalparasi, Baglung, Chitwan, Makawanpur, Mustang, Parbat, Palpa, Gorkha, Lumjung, Myagdi, Gulmi, Syangja, Dhading, Rasuwa, Kaski, Arghakhanchi, Tanahu, and Nuwakot. It ranges from the higher Himalayas to the Terai. The highest elevation in this basin is 7163 m at Ganesh Himal and the lowest is 73 m at the Indo-Nepal Border. The Kamali River system is the third largest river of Nepal. It originates from the south of Mansarovar and Rakas lakes in Tibet of China and enters Nepal near Khojarnath flowing in the southern direction. The drainage area of Karnali River in China is approximately 2500 km^2 and that in Nepal is approximately 41500 km2. The total drainage area of the river is approximately 44000 km^2. The catchment area of Mahakali River system is approximately 15,260 km^2, out of which about 5400 km2 (35%) are located in Nepal. The river has its origin in Api Himal within the Himalayas. It serves, for most of its length, as the western border between Nepal and India. The river starts from Milan glacier of India and from the Lipulekh of Nepal and after flowing for a length of 223 km as a border river and making numerous oxbow lakes it finally enters India from the southwest corner of Nepal. Its main tributaries in Nepal side are the Surnagad River and the Chamelia River.

All these major river systems possess multiple tributaries rising in or around the high Himalaya maintaining substantial water flows during summer and spring. These rivers finally discharge water into the Ganges River system to the Bay of Bengal (Indian Ocean). The tributaries of these river systems cross the highest mountains in deep gorges, flowing south through the Middle Hills, cross the Mahabharat Range and emerge onto the plains. These river systems with high altitude variation and discharge have created a huge potential of hydropower in the country. However, only around 1000 MW power plants have been installed which is around 2 % of the economically and technically viable potential in spite of huge demands. The huge energy potential is basically untapped. But, the country is being starved by energy deficit. Adequate and reliable electricity supply is the pre-condition for any economy's prosperity and sustainability. Agriculture, manufacturing and service sector all rely heavily on the adequate supply of electricity. Electricity is an essential factor of production nowadays. There is a great imbalance between supply and demand of electricity in Nepal. To ease the demand, the economy is forced to seek alternative sources of electricity increasing the import bill of fossil fuel which in turn leading to an increase in the trade deficit of the country. The government is spending its revenues by paying for energy to other countries rather than putting it in development activities. This deficit has hampered the development activities of the country and has resulted in a sink in the economy. However, efforts have been made to fill the deficit gradually by hydropower energy. The installed capacity is expected to be doubled within two years as construction of the hydropower projects are undergoing. There is an ambitious plan of the Nepal government, construction of 10,000 MW power plants within 10 years period [8]. The success of the plan will change the scenario of the energy supply of Nepal from energy deficit country to energy surplus country within a decade. It's noteworthy that 10,000 MW is just less than 20% of the economic hydropower potential of Nepal.

The purpose of the paper is to review the existing situation of hydropower development in the country and identification of possible measures to tackle the current energy crisis and the future demand. The potential of the hydropower in the country and current status of the development is presented in section 2. Section 3 presents the energy forecast for the country. The energy deficit of the country is presented in section 4. Section 5 explores the way forward to meet the energy requirement of the country. Finally, section 6 concludes the issues rose in the paper with policy implications.

II. POTENTIAL OF HYDROPOWER AND STATUS OF THE DEVELOPMENT

Natural steep gradient due to mountainous topography and the huge discharge of the rivers have made the country having huge hydropower potential in the world. The first study on the hydropower potential of Nepal was carried out by Dr. Hariman Shrestha. According to his research work, the total hydropower potential of Nepal was assessed as 83,500 MW in 1966 during his Ph.D. research work in former USSR. This data has been heavily referred as hydropower potential of Nepal. Since then, no further study has been noted in this field in details. However, the research work was accomplished with the limited tools available at that time. Also, the hydrological, meteorological and topographical data available at that time were very limited.

Computer-aided technology can be applied to assess the hydropower potential of any region provided the hydrological and geospatial data of a region. The Geographic Information Systems (GIS) is one of the tools which has many applications and can be used in similar studies utilizing its powerful features. GIS in conjunction with the Hydropower Model could be used in a variety of hydrologic applications like delineating the drainage patterns, catchment areas and assessing hydropower potentials of the river reaches. With all these understandings, a study has been carried out with the objective of calculating the theoretical hydropower potential of the entire country of Nepal by using ArcGIS and Hydropower Model [11] which is very useful for the panning of hydropower plants in the country.

The study has estimated the power potential and energy estimates of the Koshi, Narayani, Karnali, Mahakali and other rivers. The findings of the study have been summarized in Table 1 which give the hydropower potential and annual energy estimates of the Koshi, Narayani, Karnali and Mahakali Rivers, including their major tributaries at 40% flow exceedence and 80% efficiency. It is estimated that the power potential and annual energy of the Narayani, Koshi and Karnali River systems are 17,800.2 MW, 17,008.3 MW, 15,661.16 MW and 113,373.3 GWh, 108,816.9 GWh, 102,324.03 GWh, respectively. The Mahakali River would yield only 2,261.83 MW of hydropower and 14,980.9 GWh of energy annually. The other water sources in Nepal would have a total power potential of 1,105 MW and a combined annual energy of 7,043 GWh. Thus, the study shows that the total hydropower potential and corresponding annual energy capacity of Nepal on run-of river basis at 40% flow exceedanceand 80% efficiency is 53,836 MW and 346,538 GWh, respectively. In the same study, it was also estimated that at 50%, flow exceedance and 80% efficiency, total hydropower potential and corresponding annual energy capacity of Nepal on run-of-river basis is 36,247 MW and 256,256 GWh, respectively. Similarly, 60%, flow exceedance and 80% efficiency, total hydropower potential and corresponding annual energy capacity of Nepal on run-of-river basis is 27,544 MW and 211,561 GWh, respectively according to the study.

TABLE I: POWER AND ENERGY ESTIMATES AT Q40, ADAPTATION FROM [11]

River system	Power Potential (MW)	Dry Energy (GWh)	Wet Energy (GWh)	Total Energy (GWh)
Koshi	17,008	16,488	92,329	108,817

Narayani	17,800	16,261	97,113	113,373
Karnali	15,661	16,658	85,666	102,324
Mahakali	2,262	2,551	12,430	14,981
Total	52,731	51,958	287,537	339,495

According to Independent Power Producers' Association of Nepal (IPPAN), the country's four major river systems and their smaller tributaries offer Nepal to produce economically and technically feasible nearly 40,000 MW power [5]. Estimates of the feasible hydropower potential of Nepal have been found varied. The agreed figures of the potentials are 80,000 MW of theoretical potential and about 42,000 MW of technically and economically viable [1]. This is one of the largest hydropower resources in the world. However, despite having such huge hydropower potential in the country, Nepal has only generated around 919 MW [2] till now from its abandon hydro resources.

Nepal's hydropower development started with 0.5 MW plant in Pharping near Kathmandu, 103 years ago (one of the earliest in Asia). At present, Nepal's total power generation is around 919 MW power of which Nepal Electricity Authority (NEA) generates 539 MW (485 MW from hydro and 54 MW from thermal plants). Independent Power Producers (IPP) generates 441 MW from the hydro [3]. There are 88 hydropower plants in the operation of which 60 hydropower plants belong to the IPP. There are over 100 micro hydropower plants (not connected with the grid) generate around 5 MW in total [2]. The total installed capacity of power plants is 968 MW as shown in Table 2 which includes all hydro, solar and thermal power plants. The share of the solar plant is not significant. In spite of huge hydropower potential and the huge demand for energy, the progress of hydropower development in Nepal is very less during the past 100 years. The development rate is just 10 MW per year. However, more than 1000 MW power plants are being completed within two years period.

TABLE II: INSTALLED CAPACITY OF POWER PLANTS, ADAPTED FROM [2, 3, 4]

Generation	Capacity (MW)
Major Hydro (NEA)-Grid Connected	473
Small Hydro(NEA)-Isolated	5
Hydro(NEA)	478
Hydro(IPP)	441
Total Hydro	919
Thermal(NEA)	53
Solar (NEA)	0.1
Installed Capacity	972
Total Installed Capacity (NEA & IPP)-Grid	968

III. ENERGY DEMAND FORECAST

Despite having huge hydro energy potential, currently, only around 2% energy need of country is fulfilled by the hydropower. The energy mix of the country is dominated by fuel wood (68%), agricultural waste (15%), animal dung (8%) and imported fossil fuel (8%) [5]. Today nearly 25% of Nepal's population have no access to grid connected power and the energy demand is very high in domestic and industrial sectors. Out of the total electricity supplied by NEA, 93.96 percent of electricity is consumed for domestic purposes. There is merely 1.42 percent in industry and 0.45 for commercial purposes and 4.04 percent by others.

The energy forecast has been made by the NEA for the fiscal year 2017 to the year 2034 [2] as shown in Figure 1.

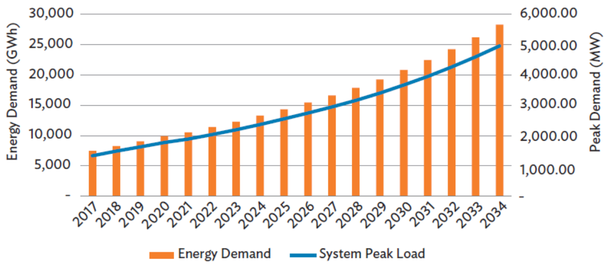

Fig. 1: Electricity Load Forecast, Fiscal Year 2017–the Fiscal Year 2034 [2]

Figure 1 shows that the peak load in the system, the peak demand is forecasted as 2200 MW in 2020 to 4300 MW in 2030 which doubled within one decade. Similarly, energy demand will also be doubled in that period from 10000 GWh to 2100 GWh.

To meet the demand, sufficient numbers of power plants to be installed to meet the requirement as shown in Table 3 [2]. Even for a low economic growth, the power plant requirement is projected as 1496 MW for FY2020 and 3868 MW for FY2030. The power requirement has been estimated for three levels of economic growth, low, medium and high. The economic growth rate has been considered as low for a growth of 4.5% whereas the economic growth of 7.2% is considered as a medium growth and 9.2% rate as the high economic growth. By 2020, construction of at least 1000 MW under construction hydropower plants will be completed which will yield total 2000 MW including the power producing by the current running power plants. At that time, the total installed capacity even meets the forecasted demand of the high economic growth. However, forecasted system peak load for FY2020 is 2200 MW as mentioned above. It has been already mentioned that the total hydropower generation is around 919 MW currently which is far below the requirement facing a deficit of around 500 MW as of now.

TABLE III: POWER PLANT REQUIREMENT IN MW, ADAPTED FROM [2]

Growth	FY2010	FY2020	FY2030
Low Economic Growth	1,272	1,496	3,868
Medium Economic Growth	1,272	1,975	4,131
High Economic Growth	1,272	**2,015**	**4,472**

IV. ENERGY DEFICIT

A typical scenario of energy demand of Nepal is shown in Figure 2, where system load curve of peak load day (October 30, 2016) is presented. The load has been reached to 1,445 MW. Due to domestic loads basically for lighting and cooking, generally from 5 pm to 10 pm in a day is the highest energy demand period. This situation shows that the rationing of energy is obvious.

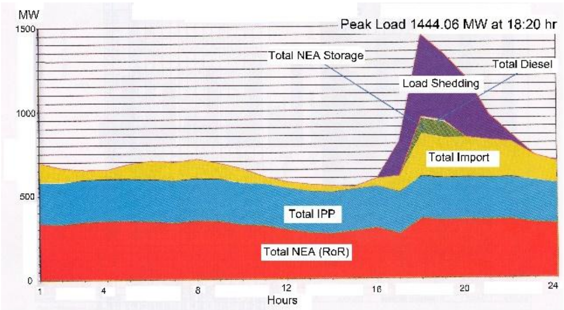

Fig. 2: System Load Curve of Peak Load Day

In the previous years (2006-2016), the power shortage was so acute that the load shedding is over 4 to 5 hours each day even in wet season. The shortfall of power (to meet the grid connected load requirements) is over 500 MW as peak power demand reaches over 1,400 MW. During lean season, the shortage of power becomes more severe. Although the current installed hydro plants capacity is 919 MW, the production from these plants drops down to one-third of installed capacity in dry seasons from both NEA plant and the IPP. This is due to the hydropower system in Nepal is dominated by run-of-river projects. There is only one seasonal storage project in the system Kulekhani I (60 MW). This is the main cause of the shortage of power during winter and situation of the spill during the wet season. On the other hand, the load factor is quite low as most of the consumption is dominated by household use. The problem would not be solved adding and adding more run of river type power plants. Storage type plants are necessary to minimize the huge imbalance of supply and to cope the demand for energy in the dry seasons.

Nepal has suffered seriously by power shortage for a decade from 2006-2016, and was told over and over again that it was because of the gap between demand and supply. However, from the end of 2016, the country got a pleasant surprise getting 24 hours of power supply in the domestic sector. It was just a matter of "better management of demand and supply". In the winter of 2014, the Nepalese were enduring 14 hours of power outage every day. At the same time, the NEA was supplying uninterrupted electricity through dedicated feeders to selected cement factories, cotton mills, and steel manufacturers.

As a strategy, NEA has decided to cut the dedicated feeders to industrial plants and made sure electricity was distributed evenly to the domestic sector. The load shedding has been shifted from domestic sector to industrial sector during peak demand period. Along with this strategy, NEA also imported more electricity from India to fill the gap caused by the increase in suppressed demand. Cutting off dedicated feeders to industries and importing more electricity from India were not the only factors leading to an end to power cuts, NEA has also cut leakage. Furthermore, use of inverters to store power in batteries was discouraged, and this has also reduced demand.

Besides the import of electricity, there is a critical scenario of fossil fuel energy imports of Nepal. Nepal has no fossil fuel resources, hence, is totally depended on other countries. The average increase in imports of petrol by 20.37 percent, diesel 20.24 percent and LPG by 15.77 percent. This shows Nepal's energy is heavily dependent on import with high energy security risk. Nepal imported 400,000 metric tons of LPG, over 400,000 kiloliter of petrol and 1.5 million kiloliter of diesel. Given the increase in imports of automobiles, Nepal's reliance on the imported oil is likely to increase in the future as well. From the fossil fuel energy consumption side, Nepal is in total deficit and forced to use hard-earned foreign currency to import fossil energy. In spite of the huge potential for clean hydro energy, Nepal is heavily depended on fossil fuels. However, Nepal can reduce imports of petrol, diesel, and LPG by producing the hydropower green energy.

V. THE WAY FORWARD

To meet the existing gap in the supply of hydropower energy, new and cheap hydropower generation plants must come on national grid very fast. Currently over 12 hydropower projects are under construction in Nepal. Some major under-construction projects are shown in Table 4. The total installed capacity of major under construction project will be 1047 MW [2,3,4]. Most of the projects were supposed to be completed in 2016/2017. Due to severe earthquakes in 2015, most hydro projects have been delayed [4]. In the meantime, the government of

Nepal has developed a plan "2016–2026 National Energy Crisis Reduction and Electricity Development Decade in February 2016. This plan aims to end the current power shortages within three years and to generate surplus power even for exports [4,9]. To move to meet the plan, the under-construction projects are to be speeded to complete the construction of power plants in time.

TABLE IV: MAJOR HYDROPOWER PLANTS UNDER CONSTRUCTION, ADAPTED FROM [2, 3, 4]

S.N.	Project	Capacity (MW)	Expected completion year
1	Upper Tamakoshi Hydropower Project	456	2018
2	Tanahu Hydropower Project	140	
3	Chameliya HEP	30	Completed
4	Kulekhani III HEP	14	2018
5	Upper Trishuli 3A HEP	60	2018
6	Rahughat HEP	40	
7	Upper Sanjen	15	2019
8	Sanjen	43	2019
9	Rasuwagadi	111	2019
10	Madhya Bhotekoshi	102	2020
11	Upper Trishuli 3B	37	2020
	Total	1,047	

It may be noted that most of the power plants installed are "Run-of-River" type. All the under construction hydropower plants are also run-of-the-river. As a result, electricity generation is highly seasonal and fluctuates. Nepal's power supply and demand patterns have a noticeable seasonality characteristic of imbalance in the form of power shortages during dry-months (mid-December through mid-April) and surpluses during wet-months. Hence, they generate power well during the monsoon season and less power during the dry season. NEA has to address these imbalances in hydropower production and is coming up with some prospective (future) power plants as shown in Table 5 which can reduce the imbalances between the run-of-river and the storage type plants. However, NEA should go for storage type hydropower plants to fill the current deficit during the peak loads for a secured and reliable supply of energy.

TABLE V: MAJOR PROSPECTIVE HYDROPOWER PLANTS, ADAPTED FROM [2, 3, 4, 5]

S.N.	Project	Capacity (MW)
1	Upper Arun HEP	335
2	Upper Modi A HEP	42
3	Upper Modi HEP	18
4	Dudh Koshi Storage HEP	300
5	Tamor Storage HEP	762
6	Uttar Ganga Storage HEP	828
7	Tamakoshi V HEP	95
8	Chainpur Seti HEP	210
9	Andhikhola Storage HEP	180
10	Budigandaki storage HEP	1,200
11	West Seti Storage HEP	750
	Total	4,720

Referring the above Table 3, these power plants will meet the projected energy demand for FY2030 if constructed within 10 years and has a mix of storage type and run of river type power plants which is necessary to tackle the peak demand loads. Moreover, attention will be required to the storage type power plants. Some of those identified promising storage power plants are West Seti, Burigandaki, Dudh Koshi, Andhi Khola, Tamor and Uttar Ganga for development as shown in the following Table 6. Construction of storage projects should be started immediately to meet the peaking hour energy demand in near future.

TABLE VI: MAJOR PROMISING STORAGE HYDROPOWER PLANTS, ADAPTED FROM [5]

S.N.	Project	Capacity (MW)
1	West Seti Storage HEP	750
2	Budhi Gandaki Storage HEP	1200
3	Dudh Koshi Storage HEP	300
4	Andhikhola Storage HEP	180
5	Tamor Storage HEP	762
6	Uttar Ganga Storage HEP	828
	Total	4020

Furthermore, the country is richly endowed with other renewable energy resources, comprising solar, wind, biogas, and various forms of biomass energy. The country can transform its energy supply system into a more sustainable system using clean and renewable energy resources, given the high costs of grid connection, the low consumption rate, and the scattered population, especially in remote areas. Decentralized renewable energy supply systems, such as micro-hydro, solar Photo Voltaic (PV), biogas, and improved cooking stoves, can provide feasible and environment-friendly supply options.

Nepal's energy supply is highly reliant on hydropower for electricity generation, and biomass for meeting cooking energy demands. There is considerable danger of depending on only a few energy sources. This is why energy sources should be diversified. Nepal has considerable solar, biomass and wind energy potential. However, the contribution of solar and wind energy is negligible in the total energy supply within the country. Nepal should ensure that 10 to 20 percent (or more) of its electricity comes from sources other than hydropower to ensure the sustainable supply of energy. Solar resources will no doubt be a potential source for the future because of its declining price trend in the world market.

Renewable energy technologies can be used to harness renewable energy resources. The technologies that can be used include (i) micro hydro (up to 100 kW); (ii) biomass and biogas (coal briquettes, gasifiers, improved cooking stoves); (iii) solar PV (solar home systems, solar water pumps, solar battery chargers); and (iv) solar thermal energy (solar water heaters, solar dryers, solar cookers). This part of energy harnessing should not be forgotten and is also to be emphasized for sustainable and accessible energy development in the country.

Also, the system loss is one of the major issues to be addressed to improve the power system which accounts to be 25 % including technical and non-technical losses like pilferage [5]. For effective development, operations and maintenance of the hydropower sector continuous research activities are evidently promoting hydropower research and development (R&D) through academic institutions.

Construction of transmission line is another important issue to be addressed in time to connect the power plants in the national grid. The total Circuit Length of the transmission system is 3,465.76 km, and an additional 3,205 km is under construction. Nepal and India have developed a large-capacity power interconnection between Muzaffarpur of Bihar (India) and Dhalkebar of Nepal to exchange/trade power up to 1,000 MW [4]. Currently, Nepal imports power 496 MW from India through this interconnector. However, the current capacity of Nepal's national transmission grid is an impediment as Nepal's national transmission grid capacity is only 132 kV. The NEA had planned to upgrade the capacity of the line to 220 kV by the end of 2016 and finally its full capacity of 400 kV by the end of 2017 through World Bank commitment for the interconnector project [4].

Furthermore, the transmission lines (765 kV) is being constructed with priority parallel to East-West Highway and Rasuwagadi-Kathmandu-Birgunj as per the commitment of the present government. The lines will be extended to Karnali, Gandaki and Kosi corridors and along the Mid-hill highway [8]. This will improve the grid connectivity within the country and the neighbouring countries.

There is a need for seriously pushing forward a strong hydropower development program that matches Nepal's own power demand growth. The challenge facing Nepal is to generate sufficient financial resources to develop its hydropower to meet the national needs. Hydropower projects are more capital intensive. Financing and cost considerations provide major challenges in the process of materializing the hydropower potential of Nepal. The major strategies of the power sector have been appropriately identified as promoting private sector participation in power generation and distribution.

The most crucial part of the hydropower development is financing. The Government of Nepal envisaged the program, Electricity for all Households, Share for All People (Ghar Ghar Ma Bijuli Jan Janma Share) [8,10] under which the program will be implemented in order to construct the hydropower projects with comparatively attractive return on the investment of the people and government. An arrangement has been identified for maintaining minimum 51 percent shareholding of the government and maximum 49 percent of the shareholding of the interested Nepali citizens and Non-Resident Nepali (NRN) for such projects. In order to construct the hydro projects like, Tamor, Sunkoshi, Dudhkoshi, Those, Khimti Shiwalaya, Naumure, Sharada-Babai, Nalsing Gad, Uttarganga, are identified under this model [8, 9].

Also, the remittance received is used for daily consumption and real estate sector, which is less productive, absorbs a large portion of the investments. The resources could be diverted to the development of hydropower ensuring the attractive return on the investment of the people.

The country can attract Foreign Direct Investment (FDI) for the development hydropower. In this context, there are a few hydro-projects like Upper Karnali 900 MW, Arun III 900 MW, and Upper Trisuli-I 216 MW that has already gone for construction under FDI. The West Seti 750 MW is under process. India, China, Bangladesh and South Korea are keenly interested to invest to Nepal's hydropower projects. Policies, programs, priorities, and investment policies should be formulated with confidential commitment to implement them for their development. Positive attitude, consensus, and forethought are necessary from all the stakeholders for the development of hydropower.

VI. CONCLUSIONS

The theoretical hydropower potential of the country is nearly 83,000 MW on which at least

42,000 MW is technically and economically feasible. However, the country has harnessed only about 2% of its economic potential. On the other hand, over 25% populations do not have access to grid connected power in Nepal. Moreover, the annual growth of power demand (grid connected) is over 10%. During the lean season, the power shortage becomes so acute that NEA used to ration the power up to 12 hours each day previously. However, this problem has been solved shifting the load shedding to the industry sector during the peak demand hours and importing electricity (up to 496 MW) from India. It is anticipated that this problem will be reduced in near future, as 1000 MW projects are under construction and will be completed within two years, meeting the target of 2,000 MW by FY2020. Furthermore, the country has attractive projects for future developments. Priority should be given to storage type projects for further development rather than run off projects for the regular power supply. The run of river projects generally produces less than half of the full capacity of the plants due to less discharge in the dry seasons.

Financing the hydropower projects is the main problem to harness the hydro resources, hence; there is a dire need for private investments and foreign investments. The Government program, Electricity for all Households, Share for All People could be the effective initiative to finance the hydropower projects.

NEA has a plan to eliminate load shedding from industrial sector also by the year 2018. Elimination of load-shedding in the industrial sector is expected to boost the industrial output. Capacity utilization of Nepali industries picked up in the last fiscal year as electricity supply to industrial units improved. We should have the policy to utilize the harnessed energy in the country itself in domestic and industrial sectors. We should develop industries which create employments and increase in production of goods and services as we will have plenty of energy i.e. the green energy in the country. However, the country can export the excess energy to India, Bangladesh, and China as a green power exporter in the region.

The government plan “2016–2026 National Energy Crisis Reduction and Electricity Development Decade is being implemented and end the current power shortages within two years and also generate surplus power in wet seasons. This will change the energy utilization scenario of the country shifting from fossil fuel to electricity. This will reduce the imports of petrol, diesel, and LPG in huge quantities saving the hard earned foreign currency as well reducing the trade deficit significantly.

The economy of Nepal will boom as the private sector will become optimistic as regards making investments in the economy because of the adequate and reliable supply of electricity. The increased volume of investment in different sectors of the economy from the national and international investors can be expected as the supply of electricity meets the demand for it. This increases the attraction for investment in the economy. Higher volume of investment uplifts the creation of additional job opportunities increasing the rate of employment.

The certainty of energy supply encourages the investors. It will increase the willingness to invest and the ability to invest. Investors go for a higher level of investment for the mass production of goods or services with no worry of energy. Produced goods and services on a mass scale can compete in both the domestic and international market. It is because of a lower cost of production. The lower cost of production makes goods and services cheap on the one hand and is likely to be of the best quality of the products on the other. This ultimately creates a competitive situation for domestically produced goods and services in the market. The implication is that it increases the income or revenue of the firm. This will boost the ability to further invest in the economy. This will help in achieving national prosperity goal set by the government of Nepal by development and utilization of its hydro energy.

In spite of facing several challenges in the energy sector, Nepal has made a remarkable progress in clean energy development and has a great prospect for the development of hydro energy fulfilling the energy deficit of the country in few years and will export the surplus energy to the neighboring countries.

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