Facts and Figures about Hydropower Development in Nepal

Dr. Hari Man Shrestha

Abstract: The author in this paper makes efforts to present facts and figures about hydropower development in Nepal. The paper also highlights that interest groups play differently at different times, but the decision makers must be fair and be bold enough to decide correctly in a way favorable to the need of the country. The paper also states that the country's hydropower requirement should be the priority focus for its development by way of attracting its nationals in capacity building through self-study, self-finance, self-construction and self-consumption. It is, however, disgusting to note that even the most attractive simple type of moderate size projects needed to be kept for such purpose have been handed over to the outsiders for use outside the country, e.g. the Upper Karnali and Arun-3 projects. Such approach is leading to a situation that Nepal in the future will have to buy her own resources at higher prices from the outsiders.

Keywords: VIJULI ADDA, Growth Trend, Entanglement, Back-Tracking.

Institutional Background

Historically, the Electricity sector in Nepal had been looked after by an Electricity Office known as "Shree Chandra Jyoti Prakash Vijuli Adda" since the Bikram Sambat 1968, Jestha 9 (1911 AD), when the generation and distribution of electricity by way of a hydropower plant at Pharping was inaugurated. This office continued to exist for a long time even after demolition of Rana Regime in 2007 BS, but with the name of "Shree Tin Juddha Chandra Prakash Jyoti" after installation of a second hydropower plant in 1991 BS at Sundarijal.

In between 1991 BS and 2007 BS in Nepal, industry and trade began to increase, as a result in 1997 BS, the Morang Hydroelectric Supply Company appeared. It, by way of establishment of a hydropower plant on Chisang Khola (a tributary of Letang Khola) along with a diesel/ thermal power plant, started to distribute electricity to the general public. Similarly, in 2005 BS, electricity distribution by Birgunj Electricity Supply Company from a diesel power plant began in Birgunj. Thereafter a number of private companies such as Shree Bageswori Electric Work (P) Ltd in Nepalgunj and Dharan Electric Supply Company in Dharan were established to render supply of electricity in the said localities by diesel power plants.

Even after, 2007 BS, there was no substantial development in electricity sector. Up to 2008 BS, under a single director general with separate chief engineers for telephone, ropeways and electricity, the office used to function. In 2012 BS, Electricity sector was organized into a separate entity. It is only towards fiscal year 2014/015 BS, the office carried the name "Electricity Department", which functioned under Ministry of Irrigation and Power with a position of Chief Electrical Inspector at the Ministry for regulatory purpose including licensing. In 2013 BS, for the coronation of the late king Mahendra, a diesel plant with a capacity of 1728kW was established. Only then, the supply of electricity in the Kathmandu valley to the public became more open.

In 2017 BS, for the first time, engineering services were created under overall government service and in 2018 BS, all kinds of services under the government were reorganized. During that time the Electricity Department was reorganized into four sections - Construction, Transmission & Panauti, Survey & Investigation and Trishuli Sections. From Bhadra 1, 2019 B.S, Nepal Electricity Corporation (NEC) came into being following the promulgation of Nepal Electricity Corporation Act. In 2031 BS, through purchase of non-governmental shares of Morang Hydroelectric Co. and Dharan Electric Supply Co. by the then His Majesty's Government (HMG) of Nepal, Eastern Electricity Corporation was created. This corporation was amalgamated with the Nepal Electricity Corporation in 2039 BS.

The then Electricity Department (ED) continued to exist until the amalgamation of the Nepal Electricity Corporation with the Electricity Department in Bhadra 2042 BS (1985 AD) to form Nepal Electricity Authority (NEA). Until that period, although the then ED had a mandate for construction works, the construction of hydropower plants were done under separate project development Boards with project manager and engineers deputed from the then ED and the newly appointed assisting engineers responsible to the respective Boards.

After creation of NEA, the then HMG faced a problem of adjustment of government staff (particularly the engineers) who did not show willingness to convert their positions from government to corporate staff. For some time, they were placed under Ministry. It is only on July 16, 1993 AD (Shrawan 2050 B.S), Electricity Development Centre (EDC) was formed under the then Ministry of Water Resources (MoWR), where these government staffs/engineers were adjusted. The EDC was created following the promulgation of Hydropower Policy in 1992 AD and the subsequent introduction of Electricity Act, 2049 and Electricity Regulation, 2050 which necessitated an organization to develop and promote hydropower sector and to improve financial

effectiveness of this sector at the national level by attracting private sector investment.

The present Department of Electricity Development (DoED) is the renamed organization of EDC since February 7, 2000 AD (Magh 24, 2056 BS). The department is responsible for assisting the Ministry in implementation of overall government policies to the power/electricity sector. The major functions of the department as of now are (i) to ensure transparency of regulatory framework, (ii) to accommodate, promote and facilitate private sector's participation in power sector by providing "One Window" service, and (iii) to license to power projects. The overall works of DoED have been divided into (a) Project Study Division, (b) Licensing Division, (c) Inspection and Monitoring Division, and (d) Planning Division.

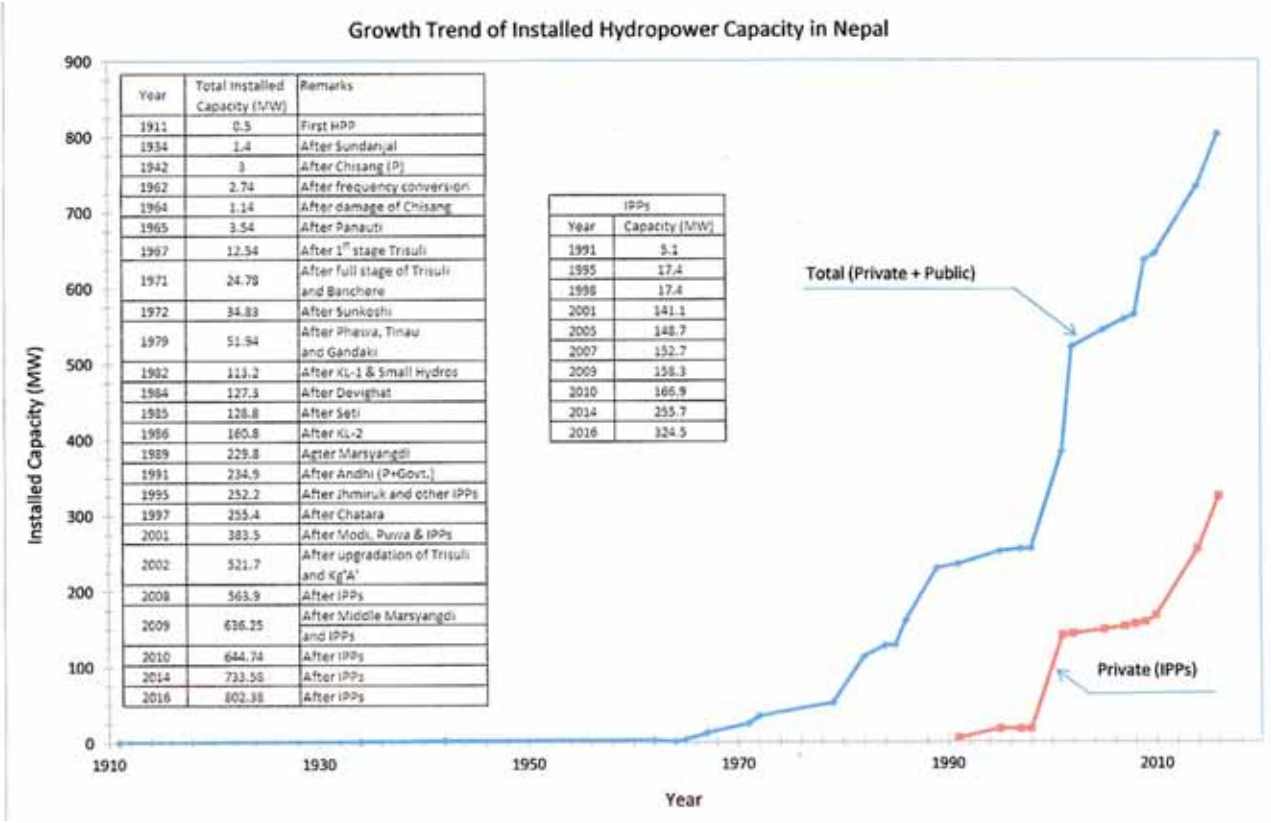
The Role of Hydropower in Overall Electricity Sector

It is wondering to note that the first electricity production in Nepal was done by way of tapping the ground/spring water source. The start of tapping of river water source began only after 23 years from the date of production from the first hydropower plant, from a tiny source lying at most upstream course of Bagmati River with catchment area of mere 16.8 km^2. Until the third hydropower plant appeared along with diesel/thermal power plant for an industrial use in the eastern Nepal, i.e., for about 31 years the electricity production in Nepal was fully dependent on hydropower. However, after 1951 AD (2007 BS), when the feudal Rana rule collapsed, the demand for electricity grew substantially. In order to cope with this situation diesel plants were established in different locations. At the time of creation of Nepal Electricity Corporation (NEC) in Fiscal Year 2019/020 BS, the role of diesel plants in the Kathmandu valley went up to 67.2 % in terms of total energy production and the role of hydropower reduced to 28.3% in terms of installed capacity. Within less than a decade hydropower production rose substantially step by step with start of production from Panauti and Trishuli hydropower plants reducing the need of generation from diesel plants. Consequently, some of diesel plants established in the valley were sent for use in the locations outside the valley. The NEC was, thus, able to reduce the energy production by costly imported diesel source to about 0.14% of total production by the fiscal year 2028/029 BS. Since then, the role of hydropower in the Nepalese Power System is towards increase. By now, the system owner possesses although as much as 53.41 MW of diesel/multifuel plants, these plants are not operated even under load-shedding condition due to extremely high cost. As per the data of 2015 AD, out of the total available energy of 5005 GWh, only 1.25 GWh or about 0.025% is from the diesel/thermal source. It is, however, to be noted here that there are numerous private hotels, commercial entities including hospitals, educational institutions, banks and business communities with high profit earning capacities, they do not feel costly to use diesel generators of their own.

Growth Trend of Installed Hydropower Capacity

The electricity production in Nepal, although has a long history of 105 years, the beginning was exclusively aimed for lighting of Durbars (Palaces) of the then feudal rulers. For appearance of a second hydropower plant it took 23 years. During this period the installed hydropower capacity rose from 0.5 MW to 1.4 MW. It remained, again, constant until a private company appeared for installation of a third hydropower plant with a capacity of 1.6 MW along with a diesel/thermal power plant to fuel industries in the east Nepal. The frequency conversion of the 2nd hydropower plant at Sundarijal in 1962 AD, reduced the installed capacity to 2.74 MW from a total of 3.0 MW, and, again, after the damage of the 3rd hydropower plant at Chisang Khola due to landslide occurred during 1964 AD, the hydropower capacity reduced to a bare minimum of 1.14 MW.

Only from the year 1965 A.D, after the implementation of 2.4 MW Rosi Khola hydropower plant at Panauti, the visible growth in hydropower installed capacity of the country could be noted. However, two periods particularly from 1989 to 1998 and from 2003 to 2008 AD, which are distinct in the growth trend graph (Fig 1), seem responsible for creation of long lasting load-shedding situation in the supply area covered by Integrated Nepal Power System (INPS). The first period belongs to divergence from a plan of implementation of 225 MW Saptagandaki Project (for which feasibility study was completed in January, 1983, updated in March, 1987, easily accessible from the existing highway and was already at the threshold of implementation with financial support from Japanese government) to Arun-3 (which was just identified during 1983-85 basin master plan study and required construction of a long access road in the high mountain terrain). The second period (from 2003 to 2008 AD) was also due to lack of seriousness in implementation of hydropower project(s) in the public sector. In any way, the promulgation of policy for hydropower development in 1993 AD for opening private sector to participate in hydropower development and emergence of related Act and Regulations encouraged the Independent Power Producers (IPPs) to invest on hydropower projects. The effect of IPPs, however, became visible only after the end of nineties. Figure-1 gives the plot that shows growth trend of hydropower installed capacity in Nepal. It is hoped that in future the installation of hydropower plants will grow in a way to meet almost all the electricity requirement of the country by indigenously available water sources.



Year	Total Installed Capacity (MW)	Remarks
1911	0.5	First HPP
1934	1.4	After Sundarijal
1942	3	After Chisang (P)
1962	2.74	After frequency conversion
1964	1.14	After damage of Chisang
1965	3.54	After Panauti
1967	12.54	After 1st stage Trisuli
1971	24.78	After full stage of Trisuli and Banchere
1972	34.83	After Sunkoshi
1979	51.94	After Phewa, Tinau and Gandaki
1982	113.2	After KL-1 & Small Hydros
1984	127.3	After Devighat
1985	128.8	After Seti
1986	160.8	After KL-2
1989	229.8	After Marsyangdi
1991	234.9	After Andhi (P+Govt.)
1995	252.2	After Jhimruk and other IPPs
1997	255.4	After Chatara
2001	383.5	After Modi, Puwa & IPPs
2002	521.7	After upgradation of Trisuli and Kg'A'
2008	563.9	After IPPs
2009	636.25	After Middle Marsyangdi and IPPs
2010	644.74	After IPPs
2014	733.58	After IPPs
2016	802.38	After IPPs

IPPs	
Year	Capacity (MW)
1991	5.1
1995	17.4
1998	17.4
2001	141.1
2005	148.7
2007	152.7
2009	158.3
2010	166.9
2014	255.7
2016	324.5

Figure 1: Decade of Nineteen Sixties was A Turning Period for Hydropower Development in Nepal

Decade of Nineteen Sixties was A Turning Period for Hydropower Development in Nepal

The decade of nineteen sixties was an important landmark for hydropower in Nepal. During that period,

- The growth in installation of hydropower capacities started to take place in a visible manner reducing the generation of electrical energy from diesel power plants based on costly imported diesel fuel from 67.2% to almost 0.14% of total production;
- Country-wide assessment of hydropower potential was carried out covering all 32 major river courses (with catchment areas 1000 km² and more) and 83 smaller river courses (with catchment areas lying between 300 km² and less than 1000 km²) with cadastral charts showing potential concentration per unit length of all the major rivers making the selection of river stretches for furthering the study for priority development easier;
- Karnali Basin Hydroelectric Development study was completed using UN Special Fund, which, besides identifying ten potential development sites, fulfilled the feasibility studies of one large storage project and two moderate run-of-river projects at its lowest reaches.
- Kankai river basin plan with identification of four potential development sites was also formulated leading first to preparation of engineering report on Kankai Dam and Power Project and then to Feasibility Study of Kankai Multipurpose Project.

These studies paved ground for conduct of similar basin plan studies for Gandak and Koshi rivers in the decades of seventies and eighties leading to feasibility studies of a number of priority projects selected by the basin plan studies.

Some Factors That Affected the Development

Different interest groups played differently at different times. Following are some examples:

- *Abandonment of 22 MW Kaligandaki Diversion Project:* It was in the month of Ashad, 2006 BS, during the first meeting with the newly appointed Indian Ambassador, the then Maharaja of Nepal, with a view to impress him that Nepal is engaged in small and big development works, mentioned about 22 MW Kaligandaki Diversion Project with energy price of 6 paisa per unit through a diversion tunnel to Nawalparasi for also to irrigate the land in Nawalparasi area. The project was ready, a fund of Rs. 3.33 crores (more than sufficient to cover the project cost estimated at 1.8 crores at that time) was at hand which had been received from Britain for services rendered by the Gurkhas during the Second World War. The Ambassador was quick to advise that India would make soon available to each and every household of Nepal, Bihar and Bengal far cheaper electricity at 2 paisa per unit from the Koshi project at Barahkshetra and suggested to invest the available resources in other beneficial sector(s). This led to abandonment of the ready-made project. The Maharaja even scolded the project initiators. The implementation of the project equal to Chilime size, sixty seven years ago, could have been what the

Chilime has now been to Nepal in terms of use of local resources and skills.

- *60 MW Kulekhani-I versus Devighat:* There were two efforts for killing the 60 MW Kulekhani Storage Project. The first effort was the complaint filed stating that the Kulekhani water source is required for drinking water supply to Kathmandu valley and the second effort was that the concerned engineers of the department, the chief engineer including the minister of the time got together favouring Devighat. In both the occasions, the author had to stand singly for preparing papers that favour implementation of Kulekhani-I for power generation. Fortunately, the cabinet meeting held in presence of the then King "Birendra" decided in favour of both the projects- to move ahead firstly with the implementation of Kulekhani-I, and then only with Devighat, if grant assistance from India would be available for the later.
- *Entanglement with Arun-3 Hydroelectric Project:* Three well-prepared projects quite suitable for Nepalese need of the time namely, Saptagandaki and Kaligandaki 'A' hydroelectric projects and Kankai Multipurpose project were at hand, when the Arun-3 hydroelectric project was just conceptualized under Koshi basin water resources development master plan study carried out during 1983-85. The study indicated that the project is attractive for priority development. Since then, noises for Arun-3 became high, feasibility study was carried out. Consequently, the World Bank (WB) got involved in the project as lead agency for project financing, the conditions including the question of affordability of investing in more than one hydropower project "Arun-3" in public sector was raised and restriction for investment in public sector for the hydropower project(s) of more than 5 MW was imposed by the WB. Almost a decade became entangled sticking with the Arun-3, ultimately the WB withdrew its hand from the project. In between, even there was a correspondence between Asian Development Bank (ADB) and The World Bank of following nature extracted from ADB's letter dated 29 April, 1993:

  We are surprised to find that you had written to the Minister of Water Resources, HMGN insisting that they demonstrate their commitment to Arun-3 by excluding all expenditure relating to Kaligandaki in their budget of 1993/96, a project being funded by the ADB, UNDP and the Government of Finland.....Even after Arun-3 is shown to be a fundable and practical option, we believe that there is a need to review the load forecast and that such a review might warrant an investment plan including Kaligandaki 'A', Khimti and Arun-3. Our preliminary analysis indicates Nepal could afford both Arun and Kaligandaki in public sector".

Effect of this entanglement period is clearly visible in the Growth Trend Figure (Refer Fig.1)

Approach of Self Finance, Self Construction and Self Consumption Ignored

All of the hydropower projects identified so far in the country are attractive, if the cost of production will be compared with electricity that could be produced in Nepal based on any of the imported fuels. The only requirements are (i) the selection of the projects for implementation that match the production with the demand (ii) their implementations through mobilization of internally available technical manpower, capital and other resources such as construction materials and (iii) proper scheduling with respect to type and size of the available projects for timely completion. In other words, the approach needed is prioritization of appropriate project(s) for implementation, self finance, self construction and self consumption. On the contrary, the wrong concept of becoming rich by exporting electricity had been the priority attention of the ruling planners, politicians and decision makers of the time when the studies indicated that Nepal has abundant hydropower resources. This concept led to priority focus in project preparation works of large scale projects requiring utilization of external resources in terms of technical expertise and large capital resources, which not only deprived the steadily fulfilling of the country's growing demand by way of self study, self finance, self construction of moderate size simpler projects suitable to country's market situation, but also lost the opportunities of learning by doing process through implementation of projects of smaller sizes at the first instance and step-by-step to medium and then to larger ones. It is quite disgusting to note that in the recent past the suicidal decisions like handing over to outsiders, the simplest and most attractive projects such as Upper Karnali and Arun-3 hydroelectric projects prepared for internal consumption, were taken for uses of their production outside the country. These projects could have been implemented easily for self consumption by mobilization of internally available resources in a scale palatable to the Nepalese market.

The Lack of Strong Willpower

The lack of strong determination power for the sake of the country is, again, evidenced in priority selection of a storage project, acutely needed for supply in the dry season. There is sufficient basis to assume that if there would not have been any external interest/pressure behind the scene, Budhigandaki storage project could not have appeared as a project of national pride. If it would have been planned for implementation after Saptagandaki and Bhomlichok hydroelectric projects, it could have some sense, because at least the downstream additional benefits in these projects accruable inside the country could have been realized from flow regulation. In the present circumstances, the West Seti storage project with similar amount of energy production with lesser dam height and lesser submergence effect is far superior to the Budhigandaki. The present larger noises for the

Budhigandaki may, again, retard the development of West Seti project. It is for sure that the Budhigandaki as finalized by Tractebel Engineering of France is not pragmatic for implementation from technical, socio-economic and environmental consideration. Over and above, there has not yet been any effort so far made to create basis for realization of the potential benefits accruable due to flow regulation at downstream reaches inside the country and outside in India in the existing Gandak irrigation facilities, in order to make the project financially viable.

It is, again, wondering to note why a daring will-power for implementation of Kankai Multipurpose project at Mainachuli is not forthcoming! This project is a moderate scale project which will not only produce peak power/energy, but also provide water for irrigation of as much as 67,500 ha of land located in eastern Terai of Nepal on year-round basis. Its feasibility study was completed in July, 1978 by SALZGITTER Consult of Germany and further feasibility with a suggestion of re-regulating reservoir and upgrading of the installed hydropower capacity in July, 1985 by EDF International of France. Similarly, the Sunkoshi-Kamala diversion multipurpose project, which is a life-line priority project for irrigating on a year-round basis the area in Terai enclosed between Saptakoshi and Bagmati rivers with two power plants en route, had been made entangled with the Saptakoshi High Dam project study to please India through obtaining some grant assistance from her in the name of preparation of detailed project report (DPR). It is already many years, the study report has not yet been submitted. The objective is very clear-to block the project for independent enhancement by the government of Nepal (GoN). Now, in order to pave ground for back-tracking from this project, a less attractive Sunkoshi-Marin diversion has been conceptualized. Why such escapism? To whom to please?

Concluding Remarks

Interest groups work on their own way to maximize their benefits, the Nepalese decision makers/ politicians in the same manner, disregarding the national interests, join hand with them to show "Yes Sir" attitude. In the case of Upper Karnali and Arun-3, the Nepalese best resources are going to be used by India as Indian resources just by providing little lollipops like the royalty and some free energy to Nepal. If the Nepalese do not become careful, when there is still time, the only indigenous country's resources "The Water", on which the bright future of Nepal could be relied, will fall in the hands of outsiders, particularly India. As a consequence, Nepal will have to buy her own resources from India or from other outsiders at much higher prices.

- -

Dr. Hari Man Shrestha *holds M.Sc. (hydro-power Engineering, September 1957- July 1963) and Ph. D. (Technical Science, September 1963-March 1966) from Moscow Power Institute, the then USSR. He is the first Nepali Ph.D. in Technical Science (Engineering). Dr. Shrestha, while conducting an academic research for his Cadastre of Hydropower Resources Ph. D. thesis at the Moscow Power Institute (then USSR), in 1966 AD, came up with an exciting finding, which showed Nepal's theoretical hydropower potential at an 83,000 MW. He has a wealth of experiences spanning over 40 years in the fields of hydropower and water resources, having worked in different capacities including the Executive Secretary (Chief) of Water and Energy Commission Secretariat (WECS) and also an advisor to Water and Energy Commission (WEC) during his tenure of services in the Government.*

Corresponding E-mail: ssudhii@gmail.com

References:

Nepal Electricity Corporation - Achievements of Ten Year (Fiscal years 2019/20 to 2028/29 BS).

Audyogic Jagat, A Bi-monthly Journal of Nepal Industrial Development Corporation, the 1st issue, Marga-Paush 2023 BS - Importance of Kankai River Basin for the Development of Mechi zone (A master plan) by Dr. Hari Man Shrestha.

A case study of landslide at Chisang Khola Hydroelectric Plant by Dr. C.K.Sharma, 2023 BS.

Karnali Project - Key to Nepal's Industry by Dr. Hari Man Shrestha, September 1967 AD, Industrial Digest.

VIDYUT, Half-yearly Journal of Nepal Electricity Authority, Bhadra Issues of Years 2051 BS and 2063 BS.

NEA Year Books.

Hydro-Nepal, Issues #s 16, 17, 18 and 19 .

Feasibility Study of Kankai Multipurpose Project by SALZGITTER Consult, July 1978 AD and Further Feasibility Study by ELECTRICITE DE FRANCE (EDF International), July 1985 AD.

Detailed Review Report of Sunkoshi-Kamala Multipurpose Project by Prof. Dr. Eng. Karl Erich Gall (WAKUTI), April 1990.

Matters in Relation to chronological Events of Arun-3 and Participation of WECS on them by Dr. Hari Man Shrestha.

Master Plan Study on The Koshi River Water Resources Development by Japan International Cooperation Agency (JICA), March 1985.

The Nepal-India Water Resources Relationship: challenges edited by Dwarika Dhungel and Santa Bahadur Pun published in 2009 by Springer.

Khulla Bazar, Bhadra Issue of 2056 BS.