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Nepal's hydropower development: Predicament and dilemma in policy-making

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Abstract

Nepal, the world's second most water-rich country, nevertheless struggles to provide sufficient domestic electricity. Despite Nepal's potential to become the hydropower source for South Asia, it still relies heavily on importing electricity from India. This paper investigates why Nepal's hydropower capacity is inadequately utilized from both domestic and international perspectives and finds that domestic factors such as geo-climate features, weak infrastructure, political instability, and institutional deficiencies significantly hinder Nepal's hydropower development. From an international perspective, Nepal's geopolitical bonds and energy dependency with India and the regional power-sharing configuration have significantly influenced its hydropower policy-making. Furthermore, this paper proposes how Nepal could sustainably develop its hydropower for self-sufficiency by establishing better policy instruments, attracting foreign investments, and upgrading its electricity infrastructure.

KEYWORDS
diplomacy, energy dependency, hydropower, NEA, Nepal, Nepal–India hydropower diplomacy

1 | INTRODUCTION

Nepal, officially the Federal Democratic Republic of Nepal, is a landlocked country in South Asia. A developing country with a population of 28.1 million, Nepal is the world's second most water-rich nation (Pokharel, 2019). Even with 83,000 MW of hydroelectric power capacity, only 42,000 MW is financially feasible at present, of which Nepal's annual hydroelectric power production is a mere 730.47 MW (Acharya & Marhold, 2019; Thanju, 2013). The country can wisely use its natural resources to enhance its economy, and hydropower can play a significant role in

development. However, Nepal struggles to provide sufficient electricity internally, despite having the potential to become South Asia's hydropower hub.

Nepal's electricity supply ranges between 750 and 1,140 MW and increases by 7.56% annually (Ridel, 2017). The country does not currently export electricity to any other country. Of the electricity supplied, 482.2 MW originates from hydroelectric sources (public and private), and 221.1 MW is imported from India. A small percentage (53.4 MW) of electricity comes from thermal and solar sources (Surendra et al., 2011). Nepal's hydroelectric potential to generate approximately 727,000 GWh of electricity is one of the world's largest. If used efficiently, this vast resource will not only make Nepal a self-sufficient energy economy but also make it one of South Asia's few large-scale energy exporters.

Then, obvious questions manifest: Why does Nepal reply on Indian electricity instead of producing its own given its vast amount of hydropower potential for electricity production? And what are Nepal's predicaments regarding its hydropower generation and utilization from both internal and externalperspectives?

This article refers to Robert Putnam's famous "Two-Level Game" theory, which argues that domestic politics and international relations are entangled inextricably, and one country's political ratifications often times reflect the simultaneous imperatives of the country's domestic game and international game, as a framework for analysis (Putnam, 1988). This analytical framework consists of two levels of variables, namely, domestic level factors and international level factors that lead to Nepal's hydropower predicaments and dilemma. Furthermore, this article discusses the potential strategies for Nepal to seek energy independency as policy recommendations.

2 | DOMESTIC FACTORS THAT HINDER NEPAL'S HYDROPOWER DEVELOPMENT

Compared with other economies in South Asia, Nepal's economy is remarkably poor as 25.2% of the population survives under the subsistence level. In 2018, the income per capita was only US$ 812.20, with 57% of the population surviving on US$ 1.30 or fewer per day. In 2019, Nepal's GDP per capita continued to decrease below the world average, which is the lowest in the region (Alam et al., 2017).

In contrast, Nepal's hydropower potential is tremendous, yet profoundly underdeveloped. Its estimated hydroelectricity potential is 83, 000 MW, which could essentially boost industrial sectors and the local economy, but the actual supply ranges only from 750 MW to 1,140 MW with annual growth rate of 7.56% (Surendra et al., 2011). Therefore, Nepal does not export electricity to its neighboring countries but rather imports about 200 MW of electricity from India.

The main obstacles could be derived from four aspects, namely, climate-geographical features, energy infrastructure, political instabilities, and institutional deficiencies.

2.1 | Climate and geographic challenges for Nepal's hydropower development

There are many challenges that Nepal faces in terms of its climate and geographic conditions. Nepal has a subtropical climate with many seasonal variations, creating a problem for the large number of rivers. Because of the low water level, the production of electricity is hampered. Thus, dry periods and water availability are potentially harmful disadvantages of Nepal's hydroelectric potential.

Nepal has significant variances in annual climate and rainfall, causing distinct problems for energy production. Nepal has a rainy period and a dry period. These periods are exaggerated by five climatic altitude regions and three longitudinal regions from west to east (Bhatt, 2017). Throughout the rainy periods, vast volumes of water are carried in the air from the ocean in the southeast and are released in Nepal as they ascend and cool down the mountains. The rainy period is a bit colder than the summer period, causing widespread flooding and landslides. Seasonal

differences in water accessibility generate problems in matching the energy supply because the rainy period begets an excess and the dry period begets a shortage (Bajracharya et al., 2011). Bright, stormy, and sandy days typify this period, yet local rain and hail occur at the end of April and May.

Since 2016, the public has been able to enjoy the advantages of electricity in Nepal's urban areas, but according to the World Bank, approximately one-third of the rural people still do not have access to electricity. They depend on fuel stoves and diesel generators. Nepal's challenging topography, the pattern of dispersed settlement, and the financial state of the Nepalese government have hindered increasing much-needed transmission networks. In 2014, the Energy Expansion Project was contracted to intensify primary access to electrical currents to reduce load shedding, build additional transmission lines to India, and inspire the growth of off–grid structures. In 2018, 83% of the 32 million residents lived in rural areas, of which around 71% had access to outflow electricity, due to the complications and high prices involved in construction on rough topography.

2.2 | Poor infrastructures for hydropower generation and distribution

For decades, Nepal has been suffering from a severe energy crisis. It has seriously affected its economic, social, and political development. Although Nepal's water resources are estimated at 225 billion m^3/km^2/year, which is four times the world average, Nepal currently only uses 1% to 2% of this resource (Nepal et al., 2011). One of the key factors causing the energy crisis is the lack of infrastructure: power generation and distribution infrastructure is aging, and maintenance costs are too high.

Currently, there are 88 hydropower plants in operation in Nepal, with a total power generation capacity of 967.85 MW; 60 of them are independent power producers, contributing 441 MW, and there are more than 100 hydropower plants under construction. However, most of the existing hydropower stations are river type, so in the rainless months, once the river water flow decreases, hydroelectric power generation will be affected. The 30 largest hydropower projects have a total generating capacity of 127.66 MW, accounting for only 15% of the country's total hydropower potential (Poudyala et al., 2019).

In addition, large-scale hydropower projects often have significant environmental, social, cultural, technological, financial, and economic impacts. If the basic energy facilities do not have sufficient capacity, these effects will spread, and hydropower projects face high returns and high risks. The World Commission on Dams has developed a set of guidelines. Unfortunately, large-scale hydropower projects have very slow power production, old energy infrastructure, and huge economic and time costs, which would only be feasible through significant investments of oversea companies or financial institutions. However, the political instability and labour actions have negatively affected the development of hydropower projects.

Another “side effect” associated with weak infrastructure is arrangement loss, which is recognized as transmission and distribution (T&D) loss. There are two dissimilar kinds of T&D losses: mechanical and non-mechanical. Mechanical losses are mostly due to the misspending of power in electrical machinery, whereas non-mechanical losses are diverse in forms. Beginning in 2010, increases in arrangement loss in Nepal continued for several reasons, one of which being the absence of measurement and care in T&D instruments. Due to the lack of precious information, it is not possible to ascertain whether the losses are mechanical or non-mechanical. So, non-mechanical losses could play a more important part than expected. As a result, the Nepal Electricity Authority (NEA) applies load shedding to provide energy equitably in Nepal given the inadequate supply structure, causing the Nepalese people to face problems of load shedding for 6–8 h/day, some even up to 12–14 h/day. Despite the existing facilities for electricity generation, which are vulnerable to natural disasters such as earthquakes, hurricanes, storms, and floods, there is an estimated 6.6 million people who have no or poor access to electricity. Only 58% of Nepal's households are connected to the national grid and merely 9% of them have access to off-grid renewable energy supplies. As a result, Nepal ranks the 145th out of 188 countries worldwide, according the Human Development Index (HDI) (Poudyala et al., 2019).

2.3 | Political instability and institutional deficiencies of the Nepalese government

The political parties and government have changed 10 times in the last 10 years, which is very strange and disturbing. There has been hardly any period when the country is politically steady. The fascination of the political parties with grabbing control by any means, good or bad, is extremely unpleasant. Political instability explains why the country has continued to weaken, even six decades after the initiation of planned development. Therefore, the greed for power of political parties should be jettisoned, and they should dedicate their time and energies to the relief of the people and Nepal's development. Because of political instability, many investors face a dilemma about investing in large hydropower plants. Regular change in rules and regulations has made many investors withdraw from hydropower projects. Overseas investors and venture capitalists want a smooth and efficient working environment, which is currently lacking in Nepal due to unstable governance.

A number of institutional instruments are developed into "Policies," such as the Water Resources Law, 1992; the Electricity Law, 1992; the Water Resources Regulation, 1993; and the Electricity Regulation, 1993, for hydroelectric development, that have not defined margin principles in relation to ecological sensitivity. The 5 MW margin principles of the 1993 EIA parameter continually addressed the Environmental Protection Law and Rules of 1997 for the ecological assessment process. However, the principles had certain drawbacks during authorizing procedure when it comes to the ecological evaluation of hydroelectric power production. The Water Resources Development Policy (WRDP) 2001 endorses the integration of ecological aspects during the expansion of water resources (Mandal, 2016).

The WRDP policy aims to ensure a minimum of 10% power release rate as suggested by EIA in the operation process of hydroelectric plants and inspires private investors to attain the essential land for the mission themselves. These policies are not appropriate for all projects because of the size, site, and sensitivity of hydropower plants. Due to this policy, the electricity supply is restricted to 43.7% and only 8% for urban and rural areas, respectively. Thus, Nepal has partial access and less electricity usage among other emerging countries. Nepal's policy level paper has uncertain high dam effects and mitigation actions. All procedures are conservative and require to be reformulated in the current situation.

3 | EXTERNAL FACTORS THAT UNDERMINE NEPAL'S HYDROPOWER INDEPENDENCY AND GROWTH PROSPECTS

3.1 | Geopolitical "bonds" between Nepal and India

In Asia, some borders were constructed by foreign influence to fulfill political objectives. The history of the Nepal–India borders testifies such facts. The boundary was redefined by the British after 1857, which is also essential in Indian history. This was when the Indian armed forces, enrolled by the East India Company, rose in rebellion, endangering the dreams of the British in India. Jung Bahadur Rana, the ruler of Nepal, presented his Nepalese troops to the Indian Government, and the British respected the help of Nepal to the East India Company (Whelpton, 2005). In World War I, Nepal also dispatched its army to battle for Britain.

Geographically speaking, the Nepal–India boundary is smooth and penetrable, indicating the strong mutual bonds between the two nations. After the 2015 border blockade, which was triggered by Nepal's changes to the Constitution and incremental cooperation with China, the situation of Nepal and India suddenly deteriorated. The blockage was ended in a few days, and although the official boundary remained as before, perceptions for the two nations have changed. Also, the lacking safety matter concerning the Nepal–India border is no longer effective. Now the South Asian border politics that are considered a security dilemma are also relevant to the Nepal–India border.

As neighboring nations, Nepal and India share special bonds of alliance and coordination categorized by an open boundary and rooted relations of morals and values. There is a long custom of unrestricted cross-border people

movement. Nepal has a boundary of >1,840 km touching five Indian states: Bihar, Sikkim, West Bengal, Uttar Pradesh, and Uttarakhand. The 1950 Nepal–India Agreement of Friendship and Peace contours the base of the special connection between Nepal and India (Hrabovszky & Miyan, 1987). Almost 6 million Nepalese people are living and working in India.

From a socio-economic perspective, about 1.5 million Indian citizens live and work in Nepal. Businesspeople and others live in Nepal for an extended period, such as professional doctors, engineers, IT employees, and construction laborers. On September 14, 1990, the Indian Citizens' Association (ICA) of Nepal was established. The ICA is an organization of Indian inhabitants in Nepal with divisions at Bhairahawa, Pokhara, and Dhamak, which offers a stage for genuine interest of Indian inhabitants in Nepal and guarding such comforts.

After the devastating 7.8-magnitude earthquake in Nepal on April 25, 2015, the Government of India (GoI) quickly shipped National Disaster Response Force squads and superior aircraft with saving and relief elements to Nepal (Joshi & Joshi, 2018). India facilitated re-establishing three power substations in Kathmandu. Indian relief aid to Nepal totaled more than US$ 67 million. The GoI declared a post-earthquake rebuilding package of US$ 1 billion, which covers US$ 250 million funding and a US$ 750 million concessional line of credit.

In Nepal, Indian companies are among their major investors, accounting for around 30% of foreign direct investment (FDI). Indian projects lead foreign investment with FDI commitments of US$ 800 million (INR 59.42 billion) as of September 15, 2018. One hundred and fifty Indian projects are functioning in Nepal in industrial services (education, finance, telecommunications, assurance, and dry port), power and tourism. The major Indian lenders include ITC, Dabur India, Hindustan Unilever, Asian Paints, Punjab National Bank, State Bank of India, Life Insurance Corporation of India, Manipal Group, CONCOR, MIT Group Holdings, Transworld Group, Nupur International Patel Engineering, Bhushan Group, Bhilwara Energy Feedback Ventures, RJ Corp, KSK Energy, Berger Paints, and Tata Power. Altogether, the close geopolitical ties and bonds between the two countries are illustrated. As a regional small state in terms of economic and military power, Nepal is particularly vulnerable and influenced by India from both domestic and international politics.

3.2 | Nepal's energy trades and dependency with India and China

Nepal has an extreme deficiency of energy and significantly depends on the importation of energy from India, which consists of the imports of materials such as electric power, diesel and petroleum equipment, and investors.

In 1920, mutual power cooperation between India and Nepal began: First, the Kataiya power plant and the Phewa, Trishuli, and Devighat hydroelectric plants were implemented in Nepal with monetary and mechanical support from the GoI; In 1968 with help from India, the 1 MW hydropower project in Pokhara was established, which initiated foundations for broader energy cooperation between Nepal and India (Pandey, 1998), followed by a 22 MW plant in Trisuli, a 15 MW plant in Gandak, and a 14.2 MW plant in Devi Ghat in 1969, 1979, and 1983, respectively. India and Nepal established a Power Purchase Agreement with an inadequate and lower capacity trade at many places, including the border. Border interchange programs and power services in Nepal and India provide access to electricity to places that are offered from across the border with several 11 and 33 kV interconnections.

In July 2001, the Indian government selected the Power Trading Corporation (PTC) as an apex body to manage issues related to energy exchange with Nepal. PTC is the only agency of India to finalize commercial and practical activities with the NEA and coordinate with related Indian corporations. In October 2014, an energy trade agreement was contracted between Nepal and India to expand the two-sided power trade (Singh et al., 2015).

The accomplishment of two dual-circuit transmission passages between Dhalkebar to Muzaffarpur (90 km) and Hetauda to Duhabi (300 km), partly sponsored by the World Bank, together with the production of a collective potential of 20,000 MW of hydroelectric plants as well as research in western Nepal, is projected to increase power supply between Nepal and India. The addition of production capacity in Nepal explains the increasing demand for electricity, which makes Nepal a net importer of power from India. Power import now represents almost 20% of the

entire import of the country. Given the mismatch between Nepal's supply and demand, it can continue to import power from India through the next short-term interconnections (Khan et al., 2019). However, it can be converted into a net exporter of power by developing its hydropower capability.

In 2016, for better electric current circulation, the first high-capacity Dhalkebar in Nepal and Muzaffarpur in India cross-border power transmission lines were built with the help of India funding of US$ 13.2 million. In 2017, two new 133 kV cross-border transmission connections between Kusaha (Nepal) and Kataiya (India), Parwanipur (Napal) and Raxaul (India) were built with GoI funding assistance. There have been more than 20 transmission connections of 132, 33, and 11 kV, constructed for power exchange and trade in bordering zones of the two countries. The electricity delivered from India to Nepal is about 450 MW (Kumar, 2016).

Besides electricity, Nepal continuously imports oil from India that reinforced its energy dependence (Dhakal & Raut, 2010). Between 2005–2006, the total import of oil products was US$35 million. Though about 50% of oil imports are for conveyance and, therefore, would not be counterbalanced by the development of hydroelectric properties, another 50% for housing, profit, and civic facilities would be balanced by replacing oil with hydroelectric power. So, the long-term result of continuing fossil fuel dependence helps as an additional basis for increasing hydroelectric capacity.

China is another major player for joint hydro-power projects with Nepal. Under the Belt and Road Initiative (BRI), China has courted Nepal with ambitious investment proposals for developing hydropower in Nepal. In 2015, China obtained official approval from Nepal's Investment Board to proceed with 1.6-billion-dollar dam construction project on the West Seti River in north-western Nepal. According to the Investment Board Nepal (IBN), China plans to construct a 756 MW hydroelectricity joint project in eastern Nepal. This project will cover the electricity supply for three Nepalese districts, namely, Taplejung, Terhathum, and Panchthar Province. So far, China has become the largest foreign investor in the past 4 years according to Nepal's Department of Industry (China Daily, 2020).

Many political commentators regard this series of acts from China as a hedging behaviour to gain geo-political influence over Nepal to curb India's influence. It is no secret that China and India, as the two largest neighboring superpowers in Asia, have long regarded each other as the most important strategic competitors in the region. Military fractions, and even limited wars since 1960, have occurred due to "disputed" bordering areas. China's diplomatic maneuvers over transboundary water resources such as the Ganges-Brahmaputra-Meghn (GBM) river basin have been perceived as geopolitical strategies disguised under the pursuit for economic interests (Xie et al., 2018).

Nepal, as a small country stuck between two "giant" neighbors, seems to have less choices when it comes to the triangle power play between India and China. On the other hand, Nepal could make full use of the Sino-Indian negotiations for access to its hydro resources, which are valuable negotiating assets for both economic and geopolitical benefits.

3.3 | Regional development and power-sharing configuration in South Asia

An increase in regional power-sharing is realized as important for trade and integration for regional development. Attention in regional development and teamwork has existed for some time in the South Asia Region (SAR), before the establishment of the South Asia Association for Regional Cooperation (SAARC) in 1985 (Hassan, 2001). In 2004, an agreement for a South Asian Free Trade Area (SAFTA) provided a shared marketplace.

Shortly after the foundation of SAFTA, an interest in regional power-sharing and cooperation was established. In 2006, the South Asia Regional Energy Coalition was founded to encourage promotional actions by leading policy-oriented associations in South Asia. The SAARC Energy Centre, recognized in 2006, has also focused on its objectives of regional cooperation in the power sector. At the end of 2014, the SAARC members settled on a "framework agreement" for regional electricity cooperation. The agreement covers unlimited supplies for the foundation of regional development in the electricity market, with non-biased access to transmission, electricity prices created on the trade market, and the creation of an agency to coordinate the integration and trade of regional power

(Shahidehpour et al., 2003). It is difficult to say how quickly or extensively these plans and services will be implemented.

At present, bilateral agreements for energy transmission and trade predominate. Specifically, bilateral production and transmission agreements between Nepal and India, India and Bhutan, and, more recently, India and Bangladesh govern regional power cooperation in South Asia (Dwivedi, 2009). These bilateral relations are mainly based on government-to-government relations, with the private sector playing a minimum role. Nepal has continuously been upgrading its hydroelectricity capabilities. Some of the proposed hydropower plants are listed in Table 1.

3.4 | Difficulties for foreign investors to obtain a project development agreement (PDA)

Nepal began market liberalization in the early 1990s and put forward the Foreign Investment and Technology Transfer Act (FITTA) with a limited negative list in 1992 to boost investment in hydropower, tourism, and information technology sectors. Moreover, Nepal also signed the Bilateral Investment Protection and Promotion Agreements (BIPPA) with France, Germany, the United Kingdom, Mauritius, Finland, and India in succession. The most recent active partnering country is China. Foreign investors want to join the hydroelectricity business in Nepal to harness its renewable energy potential (Shrestha, 2007). Unfortunately, the Nepalese government has many obstacles for foreign investors including:

3.4.1 | Obtaining concessions for hydropower developments

Along with a series of other permits and approvals required for hydroelectric power projects, perhaps one of the most important for hydropower developers is the survey license, issued by the Department of Electricity Development (DOED). This allows for possibility studies and conservational studies and is valid for 5 years. Assuming the results are positive, companies can obtain a Generation License (GL), also from the DOED (Lilien et al., 2002). The terms of the GL characteristically stipulate that a Power Purchase Agreement (PPA) must be attained from the NEA within 1 to 2 years to remain valid. Also, Rule 21 of the Electricity Regulation requires creators to begin physical construction within 1 year of the date of issuance of the GL.

TABLE 1 Major proposed hydropower projects and capacity

S/N	Name	Installed capacity (MW)	River
1	Dudh Koshi Storage	640	Koshi
2	Tamor Storage	530	Tamor
3	Upper Arun	335	Arun
4	Uttar Ganga Storage	300	Uttar Ganga
5	Chainpur Set	140	Seti
6	Tamakoshi V	87	Tamakoshi
7	Upper Bheri	85	Bheri
8	Upper Modi A	42	Modi
9	Upper Modi	18.2	Modi
Total		**2,177.2**	

Note: Compiled by the authors with the data from Nepal Electricity Authority.

The awareness of readily available finance is also well-founded, given the number of hydropower projects that have continued with the assistance of local lenders, who typically rely on the GL and PPA as security. However, the profits that a PDA can potentially offer a project in terms of risk allocation should not be ruled out. Project risks that are generally addressed in a PDA include political or community resistance, policy continuity, a fair return on investment, expropriation of assets, a predictable time frame in administrative and regulatory processes, and competitive rights on the site for using water.

3.4.2 | Current issues with PDA application procedures

When a developer chooses to take advantage of the various protections and access to international finance offered by a PDA, the complex negotiation process of the PDA may seem formidable. The PDA Procedures Guidelines accepted by the MOE in 2013 not only offer some guidance but also pose several challenges for developers seeking to obtain a PDA (Caballé et al., 2010). First, PDA procedural guidelines require that a PPA be finalized before requesting a PDA, meaning that the PPA and the PDA cannot be negotiated in parallel. This is problematic, because in order to be financeable with potential lenders, the PPA must guarantee that the revenue stream is sufficient to recover all project costs. However, these costs are difficult to control until the terms of the associated concession are finalized (according to the PDA) (Yescombe, 2002). These terms include taxes and royalties, tax exemptions, government guarantees, risk allocation, and performance obligations, among others. In summary, the PPA and the PDA are inextricably linked and are challenging to negotiate consecutively.

Although the Ministry of Education has published a PDA model, the Government of Nepal (GoN) has since negotiated two PDAs (for the 900 MW Upper Karnali and 900 MW Arun III hydroelectric plants) that deviate from the published model. In addition, the recently signed PDA for the Trishuli Superior project offers some guidance (Mandal, 2016). Finally, unlike energy project developers in Nepal who choose to proceed with only one GL, the initial PDA processing fee of US$ 1,500 per MW is another considerable disincentive for developers looking for a PDA, especially when the project is in its early stages.

3.4.3 | Assessing project development authority PDA viability

The current PDA application process can undoubtedly cause undue delays for hydropower projects in Nepal and, therefore, is not feasible for many developers, some of whom will continue to rely solely on the GL (Van Houweling, 2013). However, developers should be able to overcome the problems described by obtaining a PDA (and the related benefits for both parties), particularly if the application starts at an early stage to maximize the time frame available for negotiation.

Undoubtedly, the PDA process should be resolved to facilitate international developers and more substantial projects in Nepal, where the vast funding available according to project financing models requires a sufficiently complete concession agreement.

4 | PROMOTING NEPAL'S HYDROPOWER GENERATION AND ENERGY INDEPENDENCE

To better promote its hydropower generation and realize its energy independence, Nepal has put forward strenuous efforts in seeking external institutional aids, enhancing domestic policies for climate mitigation and adaptation, and taking bold actions for change and growth.

4.1 | External institutional aids: The Millennium Challenge Corporation (MCC)

The Millennium Challenge Corporation (MCC) is an American foreign aid corporation focused on the battle against poverty (Nowels, 2004). Established by the United States Congress in January 2004, the MCC provides American foreign assistance with a focus on good policies, national ownership, and consequences of development (Tarnoff, 2013). In December 2014, the MCC nominated Nepal as qualified to develop a compact program and to continue developing a pact in December 2015. Throughout this process, Nepal must continue to perform well on the policy indicators used in the competitive MCC selection process.

The cross-border transmission line is an essential element of the electricity transmission project. In developing the Pact and determining the preconditions, the MCC actively collaborated with the governments of India and Nepal to identify areas of mutual interest and synergies (Shah, 2006). The consultations in 2015 and 2016 highlighted the concentration of the two countries on cross-border electricity trade and the importance of several cross-border transmission lines, particularly, the Butwal–Gorakhpur line. The MCC and Nepal agreed to ensure that the line would be connected to the Indian grid, so that Nepal could export excess electricity in the future, or import as needed, when signing the Compact.

Besides MCC, other foreign institutions also play active roles in facilitating Nepal's hydropower development such as the World Bank, Asian Development Banks (ADB), and the Asian Infrastructure Investment Banks (AIIB), in a range of Nepal's renewable energy and capacity building projects. For example, the ADB funded the South Asia Sub-regional Economic Cooperation (SASEC) project to enhance the tariff mechanism for the remote mini-grid of wind energy; the World Bank offered Nepal a credit of 130 million USD for Grid Solar Energy and the Energy Efficiency Project (GSEEP) and other capacity building projects (Poudyala et al., 2019); AIIB approved a 90 million USD load for the Upper Trishuli-1 Hydropower Project, among other investments.[1]

4.2 | Mitigation and adaptation policy

Nepal plans to generate 4,000 MW of hydropower by 2020 and expand it to 12,000 MW by 2030, together with 2,100 MW of solar power, and 220 MW of bio-power (Bhatt, 2017). The government plans to preserve 40% of the country's jungle area by endorsing biodiversity preservation, flexibility substructure, and reforestation on government and civil lands (Hunter Jr & Yonzon, 1993). To preserve Nepal's ecosystems, its geographical regions must be managed by approving sustainable forest management, improving the adaptive capacity and resilience of local communities, expanding carbon stock by maintainable forest supervision, and reducing carbon discharges.

Methods to regulate the capacity of the dam and reservoirs in the arrangement and planning phases will be enhanced by analysing the seismic strategy in the International Commission on Large Dams (ICOLD) Bulletin 148 (2010). Likewise, the dangers of glacial lake outburst floods (GLOF) are tough to guess, but a correct knowledge of glacial hazards in the upstream watersheds, examined and regularly observed, if possible, every 5 years, can support with the preparation and suitable tactics to mitigate the possible danger.

To assess likely dangers or failures and downhill dangers, all movements such as the initial notice system, alternative response preparation, dam failure risk analysis, flood mapping, analysis of dam failure floods, and the practices of dam failure mechanisms for emergency response planning must be stipulated. A series of efforts, including afforestation, circumventing, or reducing deforestation, and obtaining forest-related carbon credits are crucial for the upcoming global climate treaty. Likewise, ecologically, financially, and socially adapted ecosystem-based methods can be resilient for hydroelectric organizations and reservoirs to survive climate and weather change (Camacho, 2009).

The advantages of hydroelectricity can be analysed by a case study: the annual electricity production of the Upper Bhote Koshi power station (45 MW) with a capacity factor of 70% would be 275,950 MWh/year (Bhatt, 2017). By regulating the projected GHG emissions from the hydroelectric project, annual carbon dioxide

discharges will equal zero. The yearly reduction in benchmark emissions for UBHEP alone will be 160,095 tons of carbon dioxide per year. From 2001–2016, Bhote Koshi HEP has decreased approximately 2.49.1390 tons of carbon dioxide.

4.3 | Action for change and growth

When operating on vulnerable and difficult problems, feedback to arguments and general agreements should be emphasized, and dedication must be given to accelerate orders and look for rapid gains. Together, stakeholders should focus on solving Nepal's hydroelectric potential, such as (1) improving the power legislation; (2) revolutionizing the NEA; (3) formulating bilateral procedure between Nepal's related ministries with its neighbors; (4) confirming terms and conditions of power procurement and project advancement agreement; and (5) drawing reasonable risk-sharing agreements between public and private groups.

The GoN is focusing on concluding a sizeable discount contract, the Nepal PDA (Bhattacharyya, 2007). The IFC and the World Bank are taking this opportunity to work with the government, private organizations, venture capitalists, and their stakeholders to build cooperation, businesses, and launch revolutionary ideas. A transmission line of >3,000 MW of hydroelectric volume has been recognized with private organizations desiring to enhance Nepal's electricity network.

4.4 | Improvement and policy recommendation for Nepal's hydropower development

There are three major aspects that should be further improved, as analysed in Sections 2 and 3, to create more political stability, appropriate social acceptance, and stronger financial institutions, both domestically and internationally.

Political stability should be a prioritized task to pursue. An unrestrained political situation in Nepal proves to be problematic for the development of hydroelectric power plans. So, the kinds of projects effectively completed earlier will be measured more politically possible than those without a model. Missions with less government oversight or fewer steps to approve purchases are more politically possible.

One previous difficulty in the application of hydroelectric projects has been public opposition and protests connected to the dams. The foundation for developing micro-hydroelectric plants with dynamic community participation is to enable plan achievement while growing the volume and extra reimbursements of the development (Regmi, 2004). Applications for large-scale hydropower plans have frequently sparked communal protests in Nepal, mainly in the rural communities (Carmel & Tjia, 2005). Thus, it is important to consider communal perceptions of different hydro options when assessing the possibility of diverse policies. Offers involving collaboration between India and Nepal for the construction of Pancheswar dam in Mahakali region of Nepal have been met with strong protest.

Despite tightening competition for Himalayan river resources, there are numerous sources of finance for the growth of Nepal's hydroelectricity (Crow & Singh, 2009). Projects of different sizes will entice diverse donors, with development banks, public spending and foreign aid being the most probable sources of finance for micro–hydro and FDI. As such, the availability of capital sources for each project is measured with extra carefulness.

In addition, the following measures are suggested and recommended to facilitate Nepal's hydroelectric development.

Adopt permanent “law and order” for protection of investors

Prospective investors and other international partners view the lack of permanent hydroelectricity laws in Nepal as a sign of continued instability and as a deterrent to pursuing hydroelectric projects in Nepal. The appointment of the

Nepalese Prime Minister as head of government marks an important step in the transition to a new constitution, but until the drafting process is completed, it will remain a major obstacle to the development of Nepal (Adhikari et al., 2010). In addition, having institutional instruments with certainty in forms or law and order, policies, and mandates would reinforce the impression of political stability and institutional integrity, ensuring a safe market environment for prospective investors.

In addition, active involvement in a multilateral platform, such as joining the International Centre for Settlement of Investment Disputes (ICSID) Convention, and sound enforcement of bilateral investment treaties of Nepal and foreign entities would demonstrate its strong will and willingness to create a leveled playfield, equal market access, and sound dispute settlement mechanism for foreign investors and the state, which would eventually contribute to the sustainable growth of Nepal's energy sector.

Create a community mapping and resettlement plan

The construction of dams disproportionately affects vulnerable rural and/or indigenous groups. The GoN should establish benchmarks to promote effective resettlement of communities whose homes or livelihoods are affected by the development of hydroelectricity. As an important part of the compensation for the dislocated population, this would mitigate the negative impacts for the affected project areas and reduce potential resettlement disputes between the government and the people.

Strengthen the capacities of national and cross-border networks infrastructure

Although building a full national network is both technically and financially unachievable at the moment, the GoN should recognize the need to build mini–networks in inaccessible localities while expanding the national network to areas whenever possible.

Facilitate foreign investment

The Global Renewable Infrastructure Development is trying to disrupt the blockade for foreign investors by working with local partners in Nepal (Yadoo & Cruickshank, 2012). CEO Nenad Kostic of Terra Power Solutions is affiliated with a local partner to enter the market in Nepal and is currently in final negotiations to develop three mid-range projects. Significant development has been made with the application of measures such as enabling investors to recover the benefits of development projects and more favourable PPA tariffs.

5 | CONCLUSIONS

The hydroelectric capability of Nepal is enormous, and the workable expansion of hydroelectricity is key to enable the economic and sustainable development of Nepal while reducing scarcity. Analysis of the obstacles to the expansion of hydroelectricity and the affiliated commercial breaks emphasizes the debate contours in Nepal. These limitations should be dealt with from policy-making levels, addressing both domestic and external factors in order to ensure the further growth of hydroelectricity. Nepal' power dependency on India could be progressively improved with sensible political involvements such as (1) better plans and policies for the advancement of hydropower; (2) political stability to attract foreign investment; and (3) procedures and design for the steady utilization of electrifying the country.

For Nepal, the first sensible step must be controlling and removing load shedding while achieving the present national need for electricity, satisfying customers who are presently not electrified. It is, therefore, required to upgrade the capacity of transport interconnections quickly and immediately. Second, the supply of national electricity must be given priority over importing from India. Whenever possible, electricity should only be imported if a national requirement is not fixed by internal production. Electricity usage and plans should be wisely distributed and arranged; however, some of the power produced by private investors should be purchased by the Nepal government in extra cost for decreasing the economic burden in the private sector. Third, Nepal needs to establish a systematic policy to implement village electrical connectivity to improve access to electricity to local people while articulating concerns about the possible low supply that could result from exporting power.

Energy improvements in Nepal are unable to be effectuated from external efforts and should be settled internally first. The internal pressure is expected to increase the costs of hydroelectric projects and make plans more difficult. In terms of overall results, Nepal's advancement has been susceptible to domestic requirements. So, it is necessary for Nepal to plot and design hydroelectric plans and their objectives, particularly solving challenges arising from inadequate resources and communal disputes.

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ENDNOTE

[1] AIIB website: http://aiib.org/en/news-events/news/2019/AIIB-Approves-First-Investment-in-Nepal.html.

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