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Urja Khabar

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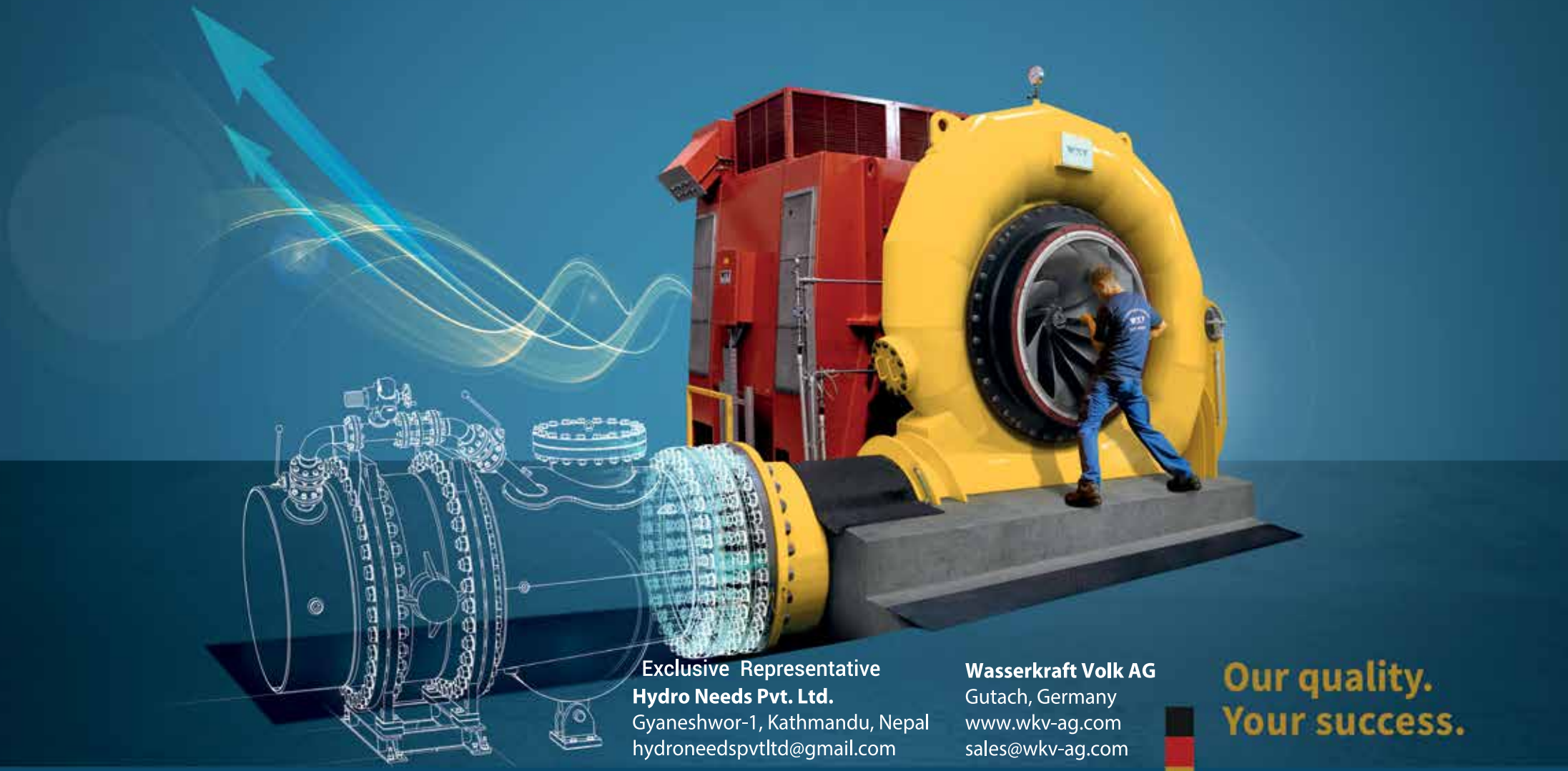

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ADVISORY COMMITTEE

Reader's View

Focus more on
other renewable energy as well

Apeksha Shah

I just wanted to share my appreciation for Urja Khabar. Everyone at Gham Power read issues of your write up on regular basis and we were thoroughly impressed with the quality of the magazine. The articles are well-written and provide valuable information about the various types of renewable energy sources in the energy sector. Your efforts in promoting these sources are truly commendable and we applaud your hard work.

There's just one tiny thing that's gutting. We noticed the magazine has hydropower content more than other renewable energy and we believe a little more focus on renewable energy other than hydropower could make Urja Khabar even more diverse and insightful.

Here are some other specific suggestions for how you could improve the coverage in your magazine:

- Write more articles about the latest renewable energy research and technology. There is a lot of exciting research happening in the fields of solar, wind, geothermal, etc. and even in Gham Power, we're innovating to make Nepal's energy more self-reliant and secure.
- Feature more companies and entrepreneurs related to clean energy. There are many successful companies and entrepreneurs working on clean energy and I think your readers would be inspired by their success stories.
- Highlight the environmental benefits of clean energy and its efforts towards climate change mitigation.

I hope this is helpful to make your magazine even more informative and engaging.

EDITORIAL

Urgent Call for Government Action for inviting 'Green Fund'

The 18th-century industrial revolution stands as a turning point in the economic development of Europe and North America. It propelled agrarian economies into a new era, thereby transitioning to an industry-based manufacturing system. In parallel, global temperatures have consistently increased since 1800, primarily driven by the emission of greenhouse gasses such as methane and carbon dioxide, marking the onset of the era of human-induced climate change. The transition from burning fossil fuels to utilizing petroleum oil and wind witnessed an ongoing release of CO_2, thereby contributing to the sustained increase in global temperatures.

Over time, the world witnessed numerous adverse impacts brought about by climate change. The rise in atmospheric pollution contaminates the coastal and marine water bodies, as approximately 30% of carbon dioxide emitted into the atmosphere gets absorbed by the sea.

Furthermore, swampy lands are drying up, and snow-covered mountains are melting, turning into mere dark boulders, contributing to the rise in sea levels. News coverage consistently highlights the hardships locals experience as a result of these changes.

There is an intense competition among major global economies to secure the top position. Consequently, in 2023, there was a surge in carbon emissions due to the extensive use of coal as the primary energy source. Due to unregulated economic activities, there has been a significant impact on both the atmosphere and the planet as a whole. The far-reaching consequences of climate change have posed threats to the lives of animals, plants, and humans alike.

Most of the effects of climate change in recent years have been felt in the Hindu Kush Himalayan region, which spans from Afghanistan to Tajikistan and lies between Pakistan and Myanmar. The assessment conducted by the International Center for Integrated Mountain Development (ICIMOD) in 2023 revealed that glaciers are rapidly melting, the frequency of snowfall is decreasing, and the permanent snow (permafrost) is melting. This is generating an unparalleled impact on countries, societies, and biodiversity both within and outside South Asia. Sea level rise is submerging islands and low-lying areas in coastal nations like the Maldives. The frequency of natural disasters, including unseasonal rainfall, floods, droughts, incessant rains, and partial rains, has increased in the region. Notably, Nepal observed blooming of rhododendron flowers during off seasons and the imminent extinction of vegetation like Paiyun (Prunus cerasoides).

With indiscriminate industrialization and an imbalanced ecological cycle, concerns about the crisis of our own existence are growing. Globally, efforts are being made to mitigate climate change. The recent conference in Dubai aimed at addressing the effects of climate change brought together 198 member states. A collective commitment to gradually reduce fossil fuel use was endorsed at the gathering.

According to the International Energy Agency, the USA produces the most carbon emissions from coal-fired electricity, followed by China and India. Nepal's global contribution to carbon emissions is almost negligible, standing at 0.027%. However, as Nepal shares its borders with China and India, the carbon emissions originating from these two nations have a direct and substantial impact on Nepal's environment. Mountain ranges and the environment of Nepal have suffered irreparable damage. Yet Nepal has failed to persuade the global forum about the responsibility that the countreis need to assume for their notable carbon emissions while compensating low contributors.

Intergovernmental Panel on Climate Change (IPCC) set a goal in 2018 to limit the global temperature increase to 1.5 degrees Celsius, aligning with the Paris Agreement. This goal implies attaining net zero carbon dioxide (CO_2) emissions globally by the year 2050. Nepal has committed to reaching the goal by 2045. China and India, ranked second and third, respectively, have committed to reaching this goal only by 2060 and 2070.

The key point to remember here is that Nepal will still bear the burden of carbon emissions from China and India for an additional 25 years, even if it meets the target within the specified time frame. Thus, Nepal should seek compensation from these countries, holding them accountable for any damages they may have caused during this time period. Additionally, Nepal needs to make every effort to position hydropower within renewable energy boundaries, thereby attracting green funds to meet its goals.

Adequate initiatives have not been undertaken to secure the necessary "green funds," including green bonds, climate finance, and green incentives, aimed at mitigating and adapting to the impacts of climate change. The Nepalese government has, in this context, been slow to take effective diplomatic steps, which is its primary responsibility. Additionally, various agencies, private sectors, and NGOs in Nepal committed to environmental and climate mitigation must take appropriate steps in order to attract financial support.

The promotion of citizen awareness is also crucial for preventing climate change, minimizing its effects, adapting plant and animal lives accordingly, and safeguarding the Earth. An effective way to accomplish this is to develop and implement a comprehensive curriculum integrating climate change across all levels of education.

A substantial initiative was taken by the Curriculum Development Center in December 2020 by designing and releasing a climate education curriculum aligned with Nepal's academic objectives. There are still a limited amount of effective instructional materials on climate change in the market, despite the need to raise awareness about climate change impacts, reduce disaster risks, and enhance the ability to deal with such challenges. University-level textbooks contain some content, but it has been difficult for this knowledge to be effectively translated into a public campaign. Besides, community awareness programs have also been implemented.

Moreover, a significant concern is the absence of a designated government body addressing climate change issues in Nepal. Currently, the Ministry of Forests and Environment's Climate Change Management Division is responsible for this duty, but its effectiveness is questionable. The difficulty primarily stems from the challenges in coordinating at the inter-ministerial level, especially regarding energy-related matters associated with climate change. Considering this is a multilateral challenge, it has been suggested to establish an entity or mechanism to represent all ministries. Climate change experts advocate for a standalone ministry that focuses exclusively on the issue. Nevertheless, concerns about its effectiveness and possible impact as a 'white elephant' draining the country's resources must not be overlooked.

As an example, in 2020 the government created the Climate Change Policy and set up a Climate Council under the Prime Minister's leadership. To date, the council has not convened a single meeting. There are also "inter-ministerial coordination committees" under the coordination of the Ministry of Forests and Environment, but none have been activated. This implies that, even if the Ministry of Climate Change is established, it might face similar challenges to other government departments.

Considering examples from India and Bangladesh, where a single ministry effectively manages issues related to forest, environment, and climate change, it suggests a successful model. Thus, it may be a good idea for us to appoint necessary experts and develop a climate change mechanism under the Ministry of Forests and Environment. It is incumbent on Nepal to effectively raise the issue of climate change both domestically and internationally, ensuring that the existing system is capable, competent, and resource-rich.

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समृद्धिका लागि ऊर्जा
Urja Khabar
Energy for Prosperity

INSIDE

Hydropower Export amidst a Plethora of Bends and Curves: Would There Be a Boom or a Crawl Indeed ?

Towards a Resilient Electricity Generation System in Nepal

Nepal should consider attracting foreign investment to promote green energy

Alleviating the 'Boiling Earth' through Hydropower Development

Odd Hoftun: a Nepali Hero

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1. Upper Chameliya (40MW)
2. Naugarh Gad (8.5 MW)
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The Essence of Kosi Treaty and Kosi High Dam

Ajay Dixit

After winding through the hilly region of Nepal, the Kosi reaches Chatara at the head of the Tarai plains. Upon traversing Nepal Tarai, it crosses into Bihar and eventually joins the Ganga. In the plains, the Kosi River underwent significant changes in its planform. Over a span of 220 years, from around 1730 to 1950, the river shifted approximately a maximum of 115 kilometers westward in Bihar. In this process, an estimated area of 1,280 square kilometers in Nepal and 15,360 square kilometers in Bihar was affected by frequent flooding and the shifting of the river's various courses. The recurring floods, causing extensive damage, led British Colonial Engineers to dub the Kosi River as "the Sorrow of Bihar."

British engineers initiated efforts to control the changing course and flooding of the Kosi River in the early decades of the 19th century. They contemplated two options: one proposal involved the construction of embankments on both sides of the river, and the other suggested building a high dam in the Barahachhetra gorge in Nepal to store water. However, due to strained relations between the East India Company and the Nepali government at the time, neither of these proposals moved forward.

After the signing of the Sugauli Treaty by the two governments, relations between the two countries began to improve, and the East India Company government initiated correspondence with Nepal on this matter. In 1827, the East India Company government, through the Bengal Irrigation Department, formed a four-member committee to study the nature of floods in the Kosi River and propose measures for its control.

In 1891, the British government sought approval from Nepal to construct embankments with an estimated cost of Rs 15,000 to control the shifting course of the Kosi River. A letter was sent to the Prime Minister of Nepal, seeking approval for the construction of the embankment. The then Nepali Prime Minister, Bir Shamsher, agreed, expressing confidence that the embankments would also provide protection against floods within Nepal. However, in May of the same year, the Kosi area (Nepal-India) witnessed a major flood, underscoring the need to implement control measures. The proposal did not move forward again.

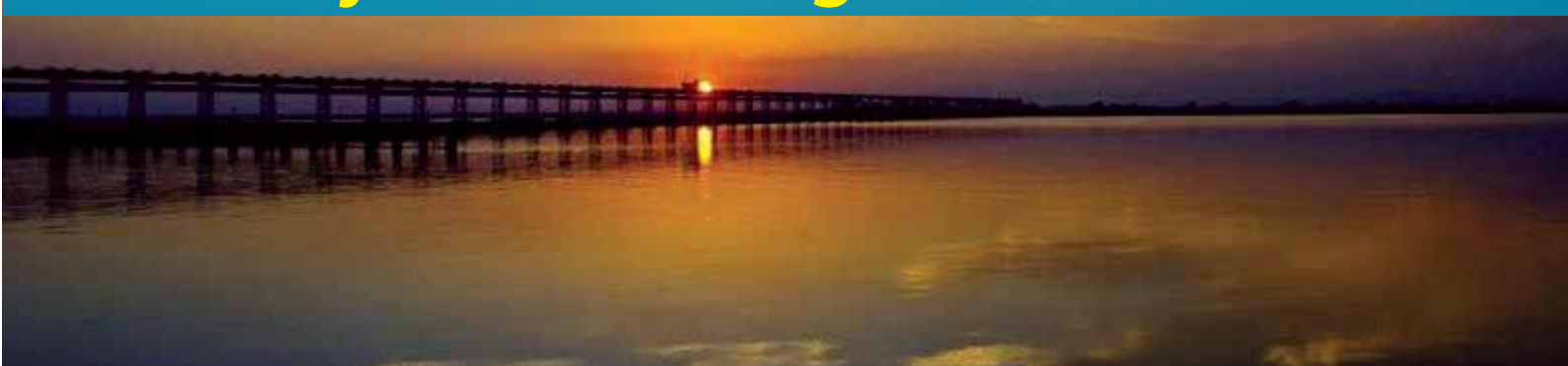
In the Bengal Delta and parts of the Ganga plains, local zamindars (landowners) were already building smaller embankments to meet limited flood control and irrigation needs. They would also break these structures when necessary. Unfortunately, the colonial engineers failed to appreciate the value of local knowledge and practices. British officials prohibited the breaking of these embankments.

In the meantime, the structural approach to flood control by building embankments was already being pursued in the United States. In the 1850s, the United States Congress had approved the construction of embankments along both banks of the Mississippi River for flood control. Subsequently, organizations like the U.S. Army Corps of Engineers and agencies like

In 1891, the British government sought approval from Nepal to construct embankments with an estimated cost of Rs 15,000 to control the shifting course of the Kosi River.

High costs, a strained economic system, and a lack of technical knowledge for constructing a massive concrete dam were identified as limiting factors.

Opposition parties criticized the agreement, alleging that Nepal had lost its rights over the waters of the Kosi River.



the Bureau of Reclamation began building embankments along rivers in the United States to control floods.

In the case of rivers in Eastern India, British engineers, however, did not reach an agreement on the specific method of controlling floods. One view leaned towards constructing embankments, while the other favored building a high dam. In flood control-related meetings and conferences, participants discussed the benefits and drawbacks of different methods but did not arrive at a consensus on solutions.

During the Kolkata Flood Conference held on March 24, 1897, the issues of the Kosi River's floods were also discussed. Senior officials of the British government in India participated in the conference, but a definitive resolution on flood control measures for the Kosi could not be reached. Deliberations and debates continued.

Forty years after the Kolkata Conference, in November 1937, another flood conference was held in Patna. During this conference, J.F. Hall, the former chief engineer of Bihar, raised questions about the effectiveness of embankments in controlling flooding. He argued, "Embankments shift the problem from one place to another. They do not effectively control floods." Similar views had also been expressed in the flood conference held in Odisha, East India, in the 1930s.

In the 1937 Patna Conference, a proposal for constructing a high dam at Barahachhetra was also discussed. Jimut Bahan Sen, the then Secretary of Public Works and Irrigation for Bihar, presented the proposal. Prior to this, a government team, including Sen, had visited the Kosi area.

Four years after the Patna Conference, in 1941, Sir Claud Inglis, the director of the Central Irrigation and Hydrodynamic Research Center of India, visited the Kosi area. He emphasized the need for the study and research on various aspects of the Kosi River. However, his proposal did not gain traction due to the ongoing dynamics of the Second World War.

In 1945, Viceroy Lord Wavell of British India visited the Kosi area. A year later, Ayodhya Nath Khosla, Chairman of the Central Water and Power Commission of India, was assigned the responsibility of preparing the initial design for the dam at Barahachhetra. Specialists such as Dr. J.S. Schavel, Walter Young, and Dr. F.H. Nickells, who were involved in the construction of the Boulder Dam and Grand Coulee Dam in the United States, also provided input to the design.

In addition to the government's efforts, local people also demanded that Kosi floods be controlled. In a conference held on November 16-17, 1946, in Nirmali, North Bihar, a slogan emerged: "Control the flow, build a dam on the Kosi, and provide electricity to every household."

Following this conference, another meeting was organized in Nirmali in April 1947, in which 60,000 flood victims from the Kosi area participated. In the same year, in August, India gained independence from Britain.

In the April conference, C.H. Bhabha, the Central Energy Minister of India, proposed the construction of a 229-meter-high concrete dam in Barahachhetra. With an installed capacity of 1200 MW, the proposed project would also provide irrigation services to 1.2 million hectares of land in Bihar. Notable political figures from India, such as Dr. Rajendra Prasad, Dr. Shrikrishna Singh, Rajendra Mishra, Harinath Mishra, and Anugrah Prasad Singh, participated in the Nirmali conference.

After India's independence, discussions and debates continued regarding the proposed measures for controlling the Kosi River. In June 1951, under the chairmanship of an engineer from the West Bengal government, a committee was formed to study the proposed high dam on the Kosi River and its alternatives. However, for various reasons, this proposal did not proceed.

High costs, a strained economic system, and a lack of technical knowledge for constructing a massive concrete dam were identified as limiting factors. Political considerations also played a role, particularly the competition between Punjab and Bihar over whether to build the Kosi High Dam or the Bhakra Dam in Himachal Pradesh. Eventually, the Kosi High Dam was not chosen, and the decision was made to proceed with the Bhakra Dam.

In the discussions related to the control of the Kosi by building embankments or a high dam, there was no participation from Nepal, although some historical documents do mention that Nepal needs to be consulted since Barahachhetra was located in the country. The high dam in Nepali territory, by controlling the Kosi River, would benefit the lower region, mainly Bihar.

In 1953, a massive flood disaster affected North Bihar, prompting the Bihar government to form a committee of experts to study flood control measures. On October 31 and November 1 of the same year, Indian Prime Minister Pandit Jawaharlal Nehru conducted an aerial survey of the flood-affected areas. Witnessing the hardships faced by the flood victims, he suggested that immediate measures be taken to alleviate the hardship. The 1953 flood disaster was caused by a high stage of other rivers, not the Kosi. Still, the construction of embankments along the Kosi River was chosen as the solution, although debates about their long-term effects had not been resolved.

In December 1953, India's Lok Sabha formally approved the Kosi Barrage and Embankment Project. Earlier, the Indian government minister, Mr. Gulzarilal Nanda, had made two statements in the Lok Sabha advocating the project.

On April 24, 1954, after the Lok Sabha's approval of the proposal, Minister Nanda arrived in Kathmandu to negotiate an agreement with Nepal. Matrika Prasad Koirala, Prime Minister of Nepal, led the Nepali delegation, and Minister Nanda led the Indian team.

The Indian team had hoped to return on the same day with the agreement signed with the Nepali government, but discussions continued for two days. Forty-two years later, in 1996, government officials of Nepal and India discussed for two days before signing the Integrated Treaty on the Mahakali River.

The 1954 agreement aimed to prevent floods in the lower Kosi River basin. The elements of the treaty included constructing a barrage, protective structures (referred to as embankments) on the two banks of the river, appurtenant works such as afflux and flood banks, and canals. The broad points agreed were as follows:

(a) The barrage will be situated about 3 miles above Hanuman Nagar.

(b) Detailed description of the plan; barrage, general layout, areas within the afflux bund, flood control embankments, and communication lines are provided in the Appendix-1 of the Agreement.

(c) Nepal has the right to use water from the Kosi River for irrigation or any other purpose from time to time as per the need (Nepal), without causing harm to the right of India to manage water in the Kosi River at the barrage site and to produce electricity according to the objectives of the project.

(d) Nepal, through consultations, shall be able to utilize up to 10% of the electricity produced from the powerhouse at the barrage site by making payment to India for the royalty on the tariff fixed for the sale of electricity.

On April 30, 1959, King Mahendra of Nepal laid the foundation stone of the Kosi Barrage. The then Prime Minister of India, Pandit Jawaharlal Nehru, was present at the ceremony. About four years later, the construction of the barrage was completed. On March 31, 1963, the steel doors of the barrage were closed, and two years later, on April 24, 1965, King Mahendra inaugurated the barrage. The then Prime Minister of India, Mr. Lal Bahadur Shastri, was also present at the ceremony. The Kosi project area has been leased to the Government of India by the Government of Nepal for 199 years for operation and management.

The Kosi Agreement led to political controversies in Nepal. Opposition parties criticized the agreement, alleging that Nepal had lost its rights over the waters of the Kosi River. Accusations were also made that the government had sold the river. Mr. B.P. Koirala, the leader of the Nepali Congress, also expressed dissatisfaction with the agreement.

On December 19, 1966, the agreement was amended, and some provisions of the revised agreement are as follows:

- Nepal will have the right to use water from the Kosi or Sun Kosi River basin from time to time for irrigation or other purposes according to the needs. India will have the right to manage water remaining in the river from time to time and to generate electricity in the Eastern Canal, according to the objectives of the project.

In the Kosi Agreement of 1954, there was no mention of irrigation facilities for Nepal. Ten years later, in 1964, India agreed to construct the irrigation project at Chatara to irrigate land in Sunsari and Morang districts. There was no provision to provide irrigation water to Nepal from the Western Kosi Canal, though it was being built through Nepali territory and that the country had been demanding provision to irrigate land in Nepal.

In 1965, Indian Irrigation Minister Dr. K.L. Rao visited Nepal to discuss the Kosi and Gandak projects. During the visit, Minister Rao requested Nepali Irrigation Minister Dr. Nageshwar Prasad Singh to provide land in Saptari District for the construction of the Kosi Western Canal. However, Dr. Singh put forth two conditions. First, the construction of a blacktop road from Kunali to Fattehpur (Saptari) should be ensured. Second, electricity should be supplied to Rajbiraj in Saptari from the Kataya Powerhouse. Dr. Rao accepted these proposals.

On July 7, 1978, representatives of India and Nepal signed the agreement in New Delhi to build the canal from Western Kosi branch canals and the Kosi Pump Canal. Thus the branch canals on the Kosi Western Canal to irrigate 10,000 hectares of land in Nepal's Saptari District and the Kosi Pump Canal systems were constructed.

After the 1954 agreement regarding the Kosi, Nepal and India continued discussions for about 25 years on various aspects related to the barrage and river usage. The initial Kosi agreement had not included some of these elements.

Postscript

After their completion, the embankments have breached eight times in major ways, causing widespread disasters. The 2008 breach at Kusaha was the most devastating. In the meantime, the Kosi High Dam continues to be touted as the panacea for total flood control in Bihar. In earlier debates, officials within state agencies would express concerns about the high cost of the dam and other associated risks. Today, issues such as the high sedimentation of the proposed reservoir jeopardizing the project's economic viability, the accompanying high social, environmental, and cultural displacements, the risk to the dam in a seismically active region, the larger challenges of flood risk reduction and social vulnerability, rainfall in areas downstream of proposed dam contributing to flooding, including risks due to climate change-induced uncertainties, are primarily highlighted by those outside the state agencies.

This article is an adapted version of the section on Kosi from the book "Dui Chhimekiko Jalayatra" written by Dixit. It is printed with his permission and a postscript.

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	Projects under Construction: ➢ Nyadi Hydropower Project, 30 MW ➢ Kabeli – A Hydropower Project, 37.60 MW
Investments:	**Plant under Operation:** ➢ Khimti – 1 Hydropower Plant, 60 MW
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Hydropower Export amidst a Plethora of Bends and Curves: Would There Be a Boom or a Crawl Indeed ?

Background

If you are sure that you have adequate statesmanship, there is no need to be worried whether your voice could be contentious. However, debates continue to oscillate between 'should' and 'shouldn't' when hydropower export from Nepal pops up and a splash of wrath may sluice you if you advocate that we should.

Electricity is like a raw material and its use in the country should always be a priority. However, it's a 'finished' product, too, to be exported to neighboring countries and earn the revenue when there is surplus generation in the country. The Government of Nepal is setting ambitions target of hydropower generation up to 28,500 MW by the year 2035, out of which 13,000 MW will be used for domestic consumption, whereas 10,000 MW and 5,000 MW of hydropower will be exported to India and Bangladesh respectively after fulfilling the domestic demand of electricity.

Likewise, the issue of climate change is becoming increasingly prominent in these years and the world leaders have expressed their national commitments to achieve net zero emission in the spirit of the Paris Agreement, 2015, which is a legally binding international treaty on climate change. Accordingly, Nepal has committed to achieve net zero by 2045, whereas India's goal for the same has been expressed as 2070. This context has opened avenues for strategic collaboration in energy sector with our neighboring countries, especially India and Bangladesh where energy sources are predominantly fossil fuel-based and clean energy transition needs to be implemented without compromising energy security.

Nepal and India have already made understanding during the India visit of the Right Honorable Prime Minister of Nepal during May 31 - June 3, 2023 that hydropower export from Nepal to India will be increased to 10,000 MW within ten years. A Long-Term Power Export Agreement in this regard is has been signed recently on 4th January 2024, between the two countries in Kathmandu as the Agreement had already been initialed by the Power and Energy Secretaries of the two countries in New Delhi during the same high-level visit. It will be an Inter-government initiative for the implementation of Agreement on Electric Power Trade, Cross Border Transmission Interconnection, and Grid Connectivity signed on 21st October, 2014. This will trigger conducive environment for the further investment in hydropower projects in Nepal and the cross-border transmission infrastructures between the two countries in different timeframes.

Prabal Adhikari

Nepal has committed to achieve net zero by 2045, whereas India's goal for the same has been expressed as 2070.

Cross border power trading between Nepal and India will be helpful in avoiding diurnal and seasonal mismatch between demand and supply of electricity.

The figure of 10,000 MW mentioned in the Agreement matches with the Supplementary Report on Integrated Master Plan for Evacuation of Power from Hydro Projects in Nepal, worked out by the 11th JTT meeting between Nepal and India held in February 2022. The Report has arrived at the total capacity of 13,531 MW from 483 Hydropower projects identified for 6 pooling points: Attaria, Kohalpur, Dododhara, New Butwal, Dhalkebar and Inaruwa; 75 percent of it stands at around 10,000 MW which may be exported to India on long- and medium-term basis.

1. Hydropower Generation in Nepal

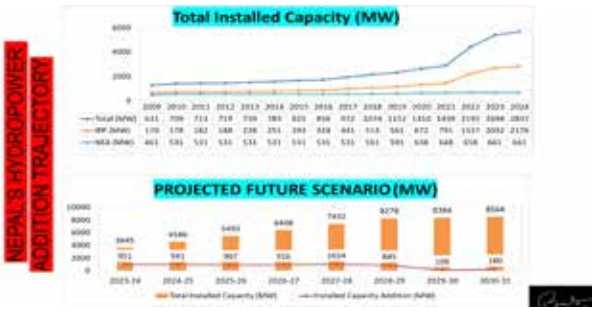
Nepal has enormous potential for hydroelectricity, a clean form of energy and a huge part of it is still unharnessed. There are many large-scale hydropower projects suitable to be developed in various river corridors of Nepal. This requires multilateral collaboration coupled with investment support from the external agencies as domestic funding will not be enough. Electricity generation in Nepal is predominantly hydropower-based. Total estimated hydropower potential of Nepal, as per conventional estimation, stands at around 83,000 MW which can be far higher with the optimization in design criteria of the projects and comprises Run-off-River (ROR), Peaking Run-off-River (PROR) and Storage/ Pumped Storage types. Currently, installed capacity of Nepal has reached 2847 MW, whereas around 950 MW of hydropower projects are under expected commissioning in this fiscal year 2023/24 alone. NEA has signed long term power purchase agreements with IPPs for the projects with the combined installed capacity of 9080 MW with around 99% hydro, out of which around 3,300 MW of projects have already achieved the financial closure and are under construction.

Nepal's hydropower potential is far higher than that required for the domestic consumption. Nepal and India have already agreed a transmission Master Plan for the transmission interconnections between the two countries. Eleven high voltage transmission interconnections between Nepal and India are identified and planned for future depending on the development of hydropower projects in Nepal in various timeframes.

Government of Nepal has decided to adopt Generation Mix as follows so as to generate 15,000 MW of electricity by the fiscal year 2027/28:

- ROR: Maximum 45% => 6750 MW
- PROR: Maximum 30% => Max. 4500 MW
- Storage & Pumped: Maximum 25% => 3750 MW
- Alternative Sources: Maximum 10%. => 1500 MW

However, Nepal has targeted to generate 28,000 MW of hydropower by 2035 as per the latest Government report, which is yet to be approved by the cabinet.



2. Hydropower Export to Neighboring Countries

By the predominance of Run-off-River (RoR) type of hydropower projects, Nepal is currently in the state of power surplus during the monsoon season and power shortage during the dry season. After few years, Nepal is expected to be entirely a power exporting country round the year as more hydropower projects are on the verge of commissioning.

Having signed a landmark agreement with India on cross border power trading and transmission connectivity in 2014, Nepal-India bilateral power trading is gaining momentum of power transactions with success stories one after the other. Cross border power trading between Nepal and India will be helpful in avoiding diurnal and seasonal mismatch between demand and supply of electricity.

As per the provisions of India's CBTE Guidelines, 2018 and Designated Authority (DA)'s Procedure, 2021, NEA started to import power up to 350 MW from the Day Ahead Market (DAM) of Indian Energy Exchange (IEX) since May 1, 2021 and export power up to 39 MW since November 3, 2021.

As of 31st December, 2023, Nepal has obtained India's approval for the power export to India from Nepal's various hydropower projects of 656 MW in total, out of which 110 MW of hydropower projects have been approved for mid-term power export for 5 years from June to October through NVVN on bilateral basis, whereas the same power of 110 MW has also been approved by the DA for the sale in the Day-Ahead/Real Time Markets of Indian power exchanges during the remaining months of the year from November to May. NEA signed a medium-term (2023-2027) power purchase and sale agreement for 200 MW of hydropower with NTPC Vidyut Vyapar Nigam (NVVN), an Indian power trading licensee, on 23rd May, 2023 for the period from June to October. Out of this 200 MW of contracted power, hydropower projects are yet to be approved by the Designated Authority of India to export the remaining quantum of 90 MW. NVVN has signed a back-to-back agreement with Haryana Power Purchase Centre (HPPC) to sell power purchased from Nepal on similar term and conditions. The hydropower projects (200 MW in total after deduction of 3% losses from the respective installed capacities) proposed for the power sale on the mid-term basis to Haryana subject to the DA's approval are as follows:

- Solu Khola (DudhKosi) 83.42 MW [Approved by DA]
- Dordi Khola 26.19 MW [Approved by DA]
- Upper Balephi 'A' 34.92 MW
- Super Madi 42.68 MW
- Upper Chaku 'A' 12.79 MW

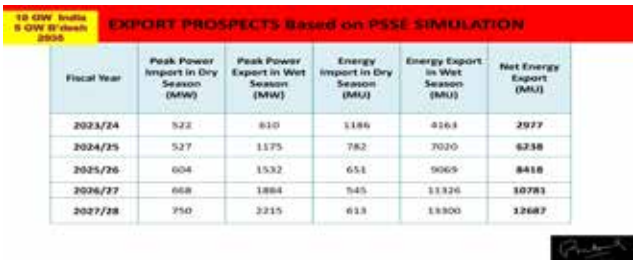
In this regard, Nepal has also signed Cross Border Settlement Nodal Agency (SNA) Agreement with NVVN on 5th October, 2020 for the settlement of grid operation-related charges including operating charges, charges for deviation, etc. related to power trading as per the requirement of the Indian Government policies on CBTE. The Ministry of Power, Government of India, has designated NVVN (besides being the nodal agency for cross border transactions) as Settlement Nodal Agency for settlement of grid operation-related charges with neighbouring countries, namely, Bangladesh, Bhutan, Nepal and Myanmar on 26th November, 2020.

Ministry of Power, Government of India, vide letter dated 26th July 2023, conveyed to Central Electricity Authority that participation of entities of neighboring countries in Real Time Market (RTM) segment of Indian power exchanges may be permitted on case-to-case basis after two years and five months ago since when the DA's Procedure was issued on 26th February 2021. Accordingly, the Procedure for Approval and Facilitating Import/ Export (Cross Border) of Electricity by the Designated Authority has been amended through its Amendment-I to facilitate transfer of power through Real Time Market (RTM) of Indian power exchanges under Clause 5.3 of the Guidelines. Prior to this, only Day Ahead Market (DAM) segment was allowed to the neighboring countries for participation in the Indian power exchanges though there are various market product, available in it.

Clause 6.5 (iv) of DA's Procedure comprises the following provision:

"Any Indian power trader, on behalf of any Entity of neighbouring country, may trade in Indian Power Exchanges (DAM/RTM/Both DAM and RTM segment), after obtaining approval from the Designated Authority, up to specified quantum (MW) and duration, provided, however that the entity on behalf of where Indian power trade is trading belongs to the neighboring country which has an agreement on cooperation in the power sector with India, and the generating asset is also owned/controlled by the said country having agreement on Power cooperation with India."

It has been agreed between the two countries, as of now, that Dhalkebar-Mujaffarpur (D-M) 400 kV Transmission Line will be transferring up to 800 MW of power in either direction until some transmission constraints downstream of Dhalkebar Substation are cleared on Nepal side. Currently, hydropower projects up to the total capacity of 586 MW are exporting their power through this line and 70 MW through 132 kV Tanakpur-Mahendranagar line. More hydropower projects are awaiting approval for power export to India through the 400 kV D-M line and the 132 kV lines linking Nepal and the Indian States of Bihar and Uttar Pradesh in future.



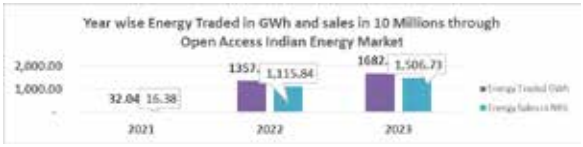
Fiscal Year	Peak Power Import in Dry Season (MW)	Peak Power Export in Wet Season (MW)	Energy Import in Dry Season (MU)	Energy Export in Wet Season (MU)	Net Energy Export (MU)
2023/24	522	810	1186	4163	2977
2024/25	527	1175	782	7020	6238
2025/26	604	1532	651	9069	8418
2026/27	668	1884	545	11326	10781
2027/28	750	2215	613	13300	12687

S.N.	Organization/ Company	Projects	Installed Capacity (MW)	Approved Capacity (MW)	Approved Period	Injection Point/ Line	Type of Transaction
1	Nepal Electricity Authority	Trishuli	24.00	23.28	30th April, 2023 to 30th Apr 2024	Mujaffarpur/ DM Line	DAM (IEX)
2	Nepal Electricity Authority	Devighat	15.00	14.55	30th April, 2023 to 30th Apr 2024	Mujaffarpur/ DM Line	DAM (IEX)
3	Nepal Electricity Authority	Marsyangdi	69.00	67.00	31st May 2023 to 31st May 2024	Mujaffarpur/ DM Line	DAM (IEX)
4	Nepal Electricity Authority	Kaligandaki A	144.00	140.00	31st May 2023 to 31st May 2024	Mujaffarpur/ DM Line	DAM (IEX)
5	Nepal Electricity Authority	Middle Marsyangdi	70.00	68.00	31st May 2023 to 31st May 2024	Mujaffarpur/ DM Line	DAM (IEX)
6	Green Ventures Pvt. Ltd.	Likhu-IV	52.40	51.00	31st May 2023 to 31st May 2024	Mujaffarpur/ DM Line	DAM (IEX)
7	Chilime Hydro Power Company Ltd.	Chilime	22.10	21.4400	30th April 2023 to 30th Apr 2024	Mujaffarpur/ DM Line	DAM (IEX)
8	Upper Solu Hydroelectric Co. Pvt. Ltd	Solu Khola	23.50	22.8000	30th April, 2023 to 30th Apr 2024	Mujaffarpur/ DM Line	DAM (IEX)

9	Arun Kabeli Power Ltd.	Kabeli B-1	25.00	24.25	1st Oct 2023 to 30th Sep 2024	Mujaffarpur/ DM Line	DAM and RTM (IEX)
10	Manang Trade Link Pvt. Ltd.	Lower Modi	20.00	19.40	1st Oct 2023 to 30th Sep 2024	Mujaffarpur/ DM Line	DAM and RTM (IEX)
11	Himalayan Power Partner Pvt. Ltd.	Dordi Khola	27.00	26.19	June-October, 2023-2027	Mujaffarpur/ DM Line	Bilateral, Started 5.9.2023
12	Sahas Urja Ltd.	Solu Khola (DudhKosi)	86.00	83.42	June-October, 2023-2027	Mujaffarpur/ DM Line	Bilateral, Started 5.9.2023
13	Sanigad Hydro Pvt. Ltd.	Upper Kalangagad	38.46	32.70	28th Jul 2023 to 31st May, 2024	Tanakpur/TM Line	DAM (IEX)
14	Api Power Company Ltd.	Upper Chameliya	40.00	37.30	31st July, 2023 to 30th June, 2024	Tanakpur/TM Line	DAM (IEX)
15	Liberty Hydropower Pvt. Ltd.	Upper Dordi A	25.00	24.25	1st Oct, 2023 up to 31st Aug, 2024	Mujaffarpur/ DM Line	Both DAM and RTM (IEX)
15 (A)	Himalayan Power Partner Pvt. Ltd.	Dordi Khola	27.00	26.19	November 2023-May, 2024	Mujaffarpur/ DM Line	Both DAM and RTM (IEX)
15 (B)	Sahas Urja Ltd.	Solu Khola (DudhKosi)	86.00	83.42	November 2023-May, 2024	Mujaffarpur/ DM Line	Both DAM and RTM (IEX)
		Total	681.46	655.58			

NEA has exported electricity to India through power exchange and bilateral modes in the years 2021, 2022 and 2023 as follows:

Year	Energy Traded GWh	Energy Charge (Crores NRs)
2023	1682.47	1506.73
2022	1357.39	1115.84
2021	32.04	16.38



The month wise export of electricity in the year 2023 remained as follows:

Months	Energy Traded (GWh)	Energy Charge (Crores INR)
May	0.60	0.14
June	118.36	60.04
July	251.12	112.17
August	269.61	188.08
September	317.40	191.39
October	443.75	276.88
November	273.20	109.41
December	8.43	3.60
Total	1682.47	941.70

A landmark agreement on the long-term power trade between Nepal and India was initialed during the visit of the Nepalese Prime Minister to India during 31st May – 3rd June, 2023. The Agreement has been to be signed by two countries on 4th January 2024 in Kathmandu, Nepal. As per this Agreement, Nepal will be increasing power export to India up to 10 GW within ten years on medium -term and long-term basis. The detailed action plan to implement the same shall have to be worked out jointly as hydro projects of more than 13,000 MW to be pooled in 6 different locations of Nepal have already been identified by India- Nepal 11th Joint Technical Team (JTT) meeting.

There are bilateral institutional mechanisms like Joint Joint Working Group (JWG) co-chaired by the respective Joint Power/Energy Secretaries and Joint Steering Committee (JSC) co-chaired by respective Joint-Secretaries between Nepal and the neighbouring countries- India and Bangladesh. They are operational and making several important decisions to bolster power trading and cross-border transmission infrastructures. India and Nepal have also set up Joint Hydro Development Committee (JHDC)

for the development of suitable hydropower projects in Nepal.

A tripartite agreement among the government-designated entities of India, Nepal and Bangladesh for the quantum of 40 MW of hydropower export from Nepal to Bangladesh is expected to be signed shortly and the power trading is about to begin from the wet season months of the year 2024 accordingly by using the Indian transmission lines between the two Countries. There are plans to enhance the cross-border power transfer capacity between Nepal and Bangladesh on mid-term and long-term basis by agreeing a transmission infrastructure development modality among the three countries in near future.

3. Cyber Security Threats

The smart grid which deploys information and communication (ICT) technologies with the role to improve operational efficiencies also introduces vulnerabilities to cyber security threats. The New York Times article dated 28th February, 2021 indicated vulnerability of Indian power system to cyber-attacks, quoting the report published by a US-based intelligence firm, Recorded Future. As per the analysis of the Recorded Future, ten distinct Indian power sector organizations, including four of the five Regional Load Dispatch Centres (RLDC) responsible for operation of the power grid through balancing electricity supply and demand were identified as targets in a concerted campaign against India's critical infrastructure.

Coincidently, India's eligibility criteria for import of power as stipulated in the Designated Authority's Procedure came at around the same time, that is, on 26th February, 2021. It seems that India was concerned about the cyber security concerns on its energy infrastructures and their operations when the generating assets located outside India would be connected to the Indian grid through the cross-border interconnections.

Cyber-attacks on power systems are intended for data spying, damage to critical infrastructure, malfunction of its hardware and software, loss of control over devices, blackouts, etc. That is why national cybersecurity standards and regulations need to be formulated and enforced during planning, design and operations by each country. The power industries need to have in-built features of intelligence-gathering capabilities as well.

4. Climate Change and Its Looming Impacts

Hindu-Kush Himalayan region which comprises 8 countries – 4 BBIN countries, China, Pakistan, Afghanistan and Myanmar – are largely vulnerable to climate change. As for Nepal, it contributes only 0.027% of the global Green House Gas (GHG) emissions, but it ranks at number ten from the perspective of most climate change-affected countries of the world as per a German organization's report. Its impacts are observed in many sectors including water resources and hydropower. Some of the potential impacts of climate change on the hydropower projects of Nepal may be listed as follows:

- Changes in precipitation patterns
- Glacier retreat
- Shift in the course of rivers
- Extreme events like flash floods and drought
- Increased sedimentation
- Temperature rise
- Water availability

5. Challenges Ahead

Cross border power trading in South Asia has been running at a sluggish pace. Hence it is also observed as one of the least integrated regions of the world. For the same reason, despite diverse resource endowment in the region, South Asia is largely fossil fuel-dominated, energy security issue prevails, power prices are high, per capacity electricity consumption is low and economic indicators are not encouraging.

In this context, major challenges in the cross-border power trading can be summed up with the following ten items:

1) Lack of sufficient grid connectivity
2) Delay in power sector reform
3) Inadequate domestic market
4) Impact of climate change on hydropower projects
5) Lack of cybersecurity standards in power system
6) Geopolitical issues
7) Lack of common grid and common minimum grid code
8) Inadequate funds
9) Poor stakeholders' consultation in policy formulation
10) Insufficient legislation in land acquisition, Right-of-Way and forest clearance in building energy infrastructures

6. Ten Tips for Success

Amidst a myriad of hurdles, here are ten items that Nepal needs to carry out for achieving success in power export to neighboring countries:

(1) Construction of transmission infrastructures of adequate capacity in domestic and cross- border system

(2) Political and diplomatic initiatives for India's policy flexibility for cross border power trading

(3) Synchronization of Nepal grid with the Indian grid along with Special Protection System deployment supported by reliable data and voice communication

(4) Power Sector Reform through new Electricity Act and deregulation

(5) Ensuring non-discriminatory open access to all grid users

(6) Introducing Deviation Settlement Mechanism (DSM) for avoiding demand-supply imbalance in the grid

(7) Operationalization of Nepal Power Trading Company at the first stage and other private sector power trading companies subsequently

(8) Infrastructural and commercial arrangements for trilateral power trading among Nepal, India and Bangladesh

(9) Building resilient generation infrastructures against climate change-induced disasters like glacier retreat, cloudburst and drought

(10) Government's prioritization for the development of hydropower projects through adequate stakeholders' consultation the creation of conducive environment

7. Advantages of Cross Border Power Trading

Cross border power trading has numerous advantages for the socio-economic transformation of the country. Having realized this and due to the strong nexus between energy, environment and economy, Nepal and India have emphasized collaboration in power sector by issuing a Joint Vision Statement on Power Sector Cooperation which envisages renewable energy production, hydropower in particular, a corner stone of energy partnership, based on respective national policies and respective climate-change commitments.

Key advantages of cross border power trading may be illustrated by the following ten points which are relevant to the South Asian context:

(1) Optimum allocation of energy resources

(2) Energy security by bridging between energy surplus and energy deficit countries

(3) Boost for clean energy transition

(4) Less spinning reserve/reserve margin required

(5) More integration of renewable energy possible into the grid due to improved energy mix with hydropower

(6) Enhancement of grid security and stability

(7) Price stability of electricity

(8) Strong energy partnership and multilateral collaboration

(9) Poverty alleviation and economic prosperity

(10) Technology transfer and knowledge sharing

8. Conclusion

Notwithstanding the rich endowment of clean energy resources, the BBIN sub-region still predominantly relies on fossil fuel for fulfilling the energy needs including electricity. As such, the sub-region also faces substantial climate change concerns, towards which governments have made some national commitments for emphasizing clean energy transition. India's goal of generating 500 GW of renewable power by 2030 and Bangladesh's initiative to increase renewable energy capacity target to 40 percent by the year 2041 can be well supported by immense hydropower supply to these countries from Nepal and Bhutan which also have seasonal complementarities of demand and supply with India and Bangladesh having high demand of electricity during summer months. Further, increasing intermittencies caused by the aggressive integration of variable renewable energy sources like solar and wind in the Indian power system can be mitigated by the cross-border transfer of hydro electricity from Nepal and India, thereby enhancing grid stability. As bilateral power trading has already started to certain extent between India and other countries of the BBIN sub-region, the countries need to harmonize their policy and regulatory frameworks, technical and institutional procedures for the multilateral power trading to begin. It can be accelerated by developing strong cross border transmission infrastructures, non-discriminatory open access and a competitive electricity market with minimal Government intervention in the spirit of regional and bilateral understanding reached in the past.

South Asia, especially BBIN countries are required to work together for the energy security of the entire region by optimum utilization of our diverse energy resource endowments. Clean energy transition goals set differently, with net zero emission targets like 2070 by India and 2045 by Nepal, can be met more conveniently through a common action plan and coherent implementation strategies coupled with cross-border high-capacity transmission interconnections and multilateral power trading emphasizing open access, suitable imbalance settlement mechanism and other pre-requisites for a competitive market.

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Indo-Nepal Co-operation on Water Resources and Hydro Power Development

Water Resources in Nepal

Water resource is the most important natural resource of Nepal. The combined annual discharge of the rivers and streams is 225 billion cu. M. and 12 billion cu. M is recharged annually in underground reservoirs. Besides thousands of lakes and wetlands contribute to the flow of water. The Nepali rivers flow into the Ganges and contribute to 71% of its flow in the dry season. Multipurpose development of water resources could provide flood control and irrigation facilities in both Nepal and India, (India would become the major beneficiary), hydro electricity generation, drinking water, river navigation and even tourism attraction facilities.

Global climate change causing the increase of atmospheric temperature has led to droughts and the melting of glacial lakes and snowy slopes, have resulted in flooding the causing devastation globally. It is imperative for both India and Nepal to co-operate bilaterally and regionally to reduce carbon emission and global warming and conserve water through storage and water conservation measures.

Projects Undertaken Jointly

The first joint project undertaken by the two countries is the construction of the Sarada Barrage at Banbasa in the Mahakali River through a treaty with the British in 1920. This barrage would provide water to the sarada canal to irrigate 396,000 ha of land in Uttar Pradesh in India. In this arrangement Nepal would receive the water to irrigate 3000 ha of its land. Subsequently GON took loan from the World Bank to improve the old canal system and build more system to irrigate land and now 11,600 ha of land are being irrigated.

The second was the Kosi Project Agreement. It was signed in 1954. It comprises a barrage, headworks and other appurtenant works about 3 miles upstream from Hanuman Nagar a Nepali town on the Kosi River built for the purpose of flood control, irrigation and generation of hydroelectric power. In the design, there were two canal off takes one on the eastern side and another one is on the western. The eastern part was totally within the Indian Territory. This canal is designed to irrigate 612,500 ha of land in India.

Making use of the canal drop, a powerhouse with the capacity of 20,000 kW has been constructed at a distance of 11 km from the barrage in the Indian Territory. The western canal passes through 35 km of Nepali territory and a meagre 11,300 ha of Nepalese land is to the irrigated whereas the land to be irrigated in India is 356,310 ha The project was constructed with Indian financial outlay in Nepalese land which was leased for 199 years. It also provides for the government of Nepal to

Ajit Narayan S Thapa

The Govt. of India's practice on cross-border electricity trade between two neighbors (Nepal and Bangladesh) using the Indian transmission system is against all norms of co-operation as envisaged in the objective of the BBIN.

use 50 per cent of the hydroelectric power produced within the radius of 10 miles from the barrage in the Indian territory on payment of tariff mutually agreed between the two countries. The Indian leaders would have been satisfied with 99 years lease but were overjoyed when king Mahendra readily granted them 199 years lease for their asking without any consultation with other Nepalese leaders.

Implementation:

Implementation of the Kosi treaty by India has been shoddy. Due to poor maintenance and neglect, the Kosi River breached its embankments and shifted its course on 18th August 2008. In Nepal, this caused the displacement of some 107725 people, damaged about 5500 hectares of farmland and about 14 km of East West highway. About 300 million rupee worth of crop was destroyed. Cost of rehalitiatation of damaged infrastructure and compensation of crop was estimated to be about 501.46 million rupees. Nepal could claim this loss from India but it has not pursued this issue vigorously. Surprisingly, even the land acquired during the construction is yet to be fully compensated and the nominal lease rent has not been collected by GON for years.

The Eastern canal of the project built in Indian Territory is designed to irrigate 612500 ha of agricultural land in Bihar. The Western Canal passes through 35 km in the Nepalese Territory before reaching India. The canal provides irrigation water for 11,300 ha of Nepalese agricultural land and 356,610 ha in India. There were large protest in Nepal over this unfair distribution of benefits. As a Compensation, India constructed the Chatara Canal to irrigate 53000 ha of land. However the canal stopped to function fully due to heavy silt deposition and had to be rehabilitated by a massive loan of 155 million US$ from the World Bank under the Sunsari-Morang irrigation project. The Kosi pump irrigation project in the Western canal is almost non-functional due to heavy electricity cost for its operation. The 10 MW power supply to India from Kataiya is not regular and is of poor quality.

The third project is the Gandak Project. Under this project, a barrage has been constructed at the Gandaki River near Bhaisalotan in Nepal to regulate the flow of water for irrigation and power purposes. The main Eastern canal lies in the Indian Territory but one of its branches called the Don Branch Canal reaches the Indo Nepal Border and bifurcates into 2 canals of which the eastern canal passes through Parsa, Bara and Rautahat districts in Nepal. The main eastern canal provides irrigation water to 920,520 ha of land in India and the Don Branch canal to 37,200 ha in Nepal. The main Western Canal passes through a few KM in Nepal and provides irrigation to 47000 ha of land in Nepal and 930000 ha in India. Another canal called Nepal Western canal irrigates 16000 ha of land in Nepal. On the main Western canal at Surajpura, in the Nepalese Territory, lies a powerhouse to generate 15000 kW of power and this has been handed to Nepal.

For the construction of the project, the Government of Nepal was to provide by acquiring or requisitioning, as the case may be, all such land for the project as required for the construction, operation and maintenance of the project. The government of India was to pay compensation for all such land made available to it. The ownership of all such land was to be vested to the government of India as proprietor. The government of India was to pay land revenue at the rate that was to be levied on agricultural lands in the neighborhood. Since the agreement did not fix any time period, the ownership of the land by India is in perpetuity.

Immediately after the conclusion of the Agreement, the political parties and general people started to oppose the agreement vehemently, alleging that the treaty was a complete sell-out of Nepalese interest and that it has undermined the sovereignty of the country. The debate reached its height when a 'Sankalpa Prastab' (Sanction Motion) was tabled in the Mahasabha (Upper house of the Parliament) by a member from the Communist party of the Nepal. While replying to the question raised by the parliamentarians, Prime Minister B. P. Koirala did except that the provisions in the Agreement relating to the allocation of water to India was at fault. However, he argued that if such conditions were not accepted, how could India be willing to invest some such huge amount as rupees 50 corer on the project? The 'Sankalpa Prastab' was defeated by 15 to 12 votes on the flower of the house.

Implementation

The farmers whose lands had been taken over by the government for the construction of the western canal have not yet received about Rs 1.2 million of the compensation to be given to them. No compensation is paid for the destruction of the crops destroyed by the flooding of the land as a result of the barrage operation annually. Again, the land compensation paid out was not sufficient to by substitute land and so many farmers have been made landless.

Furthermore, there are recurring problems in the operation and maintenance of the project.

a. Drainage problem: Every year, due mainly to the non-repairing of the drainage system, thousands of Ha of land are facing water logging in Nepal. This has been such a serious problem that be locals of the area whose lands are submerged revolt and cut the structure to release the water. The Indian side has not made a planned and sustained effort to reserve this problem.

b. Water supply from the Don Canal: The Nepal Eastern Canal originates at the Nepal-India border on the western as of the project area and extents 62 kilometers to the

Arya River. This canal is supposed to receive 850 cusecs of water from the Don Canal to irrigate 37,000 Ha of land. The latest joint record by the two sides is that so far, the maximum delivery has been only 633 cusecs.

c. Water delivery to the Western Canal: The designed pond level of the barrage is not maintained at 362 fit during the monsoon period and as such the Head Regulator cannot release sufficient amount of water required to irrigate the land as agreed between the two countries. The Indian side attributes this to the operational rules of the Barrage that the gates are to be opened for flushing the silt when the water discharge in the river reaches 3 lakhs cusecs. Whatever the case, the sore point remains that even the small benefits promise to Nepal are not being delivered.

In brief, the Gandak Agreement was conceived, designed and implemented for mainly fulfilling the requirements of India and Nepal's sacrifice in the building and operation of the project far outweighs the meagre benefits it derives.

The fourth project, which has been signed as a joint venture between the two countries is the Mahakali Integrated Development Project which includes the Sarada Barrage, Tanakpur Barrage and Pancheswor High Dam Projects. The salient features of the project which was signed between the Prime Ministers of India and Nepal in Delhi on 12th Feb 1996 are:

1. Nepal shall have the right to a supply of 28.35 m3/s (1000 cusecs) of water from the Sarada Barrage in the wet season (i.e. from 15th May to 15th Oct) and 4.25 m3/sec (150 cusecs) in the dry season (16th Oct to 14th May).
2. India shall maintain a flow of not less than 10m3/s (350 cusecs) downstream of the Sarada barrage in the Mahakali River to maintain and preserve the river eco-system. In case the Sarada Barrage becomes non-functional.
3. Nepal shall have the right to a supply of water as mentioned in paragraph 1.1 to this article, from the Tanakpur Barrage. Such a supply of water shall be in addition to two the water to be supplied to Nepal from the Tanakpur Barrage for using the Nepalese land to construct the eastern afflux bond.
4. In lieu of the Eastern afflux bund constructed in the Nepalese territory of about 2.9 hectares, Nepal shall have the right to a supply of 23.35 m3/s (1000 cusecs) of water in the wet season and 300 cusecs in the dry season from the date of entry into force of the treaty.
5. Nepal shall also receive a supply of 70 million kwhr (units) of electricity on a continuous basis from the Tanakpur Power station.
6. Nepal shall have additional energy equal to half of the incremental energy generated from the Tanakpur power station from the date of augmentation of the flow of the Mahakali river and shall bear half of the additional operation cost and if required, half of the additional capital cost for the generation of such incremental energy.
7. Pancheshwor Multipurpose Project (hence project) is to be constructed on a stretch of the Mahakali where it forms the boundary between two countries and hence both of the parties agree that they have equal entitlement in the utilization of the water resources of the Mahakali river without prejudice to their current respective consumptive uses of the water. The project will be constructed in accordance to the detailed project report (DPR) being jointly prepared by the joint team. The project will be designed and implemented on the basis of the following principles:
   a. It will be designed to produce the maximum total net benefit.
   b. Benefits accruing from the project in the form of power, irrigation, flood control etc. shall be assessed.
   c. There will be two power stations on both sides of the river of equal capacity and will be operated in an integrated manner and the total energy generated will be shared equally between the parties.
   d. The cost of the project will be borne by two parties in proportion to the benefits, accruing to each party.
   e. A portion of Nepal's is share of energy shall be sold to India and its price will be settled on mutually agreed terms.
   f. India will supply 10m3/s (350 cusecs) of water for irrigation of Dodhara-Chandani area of Nepal territory.
   g. Water requirement of Nepal will be given prime consideration.
   h. Both the sides will be entitled to draw their share of water from the Tanakpur Barrage and/or other mutually agreed points as provided in this treaty.
   i. The Pancheshowr is a multipurpose project to control flood, generate electricity and provide irrigation to 1.6 million Ha of land in India and some 93,000 Ha in Nepal. The power output would be determined in the DPR and is expected to be in the range of 4000-6000 MW.

Implementation status of the Mahakali Treaty

1. As stated in the treaty, Dodhara-Chadani area of Nepal has not yet received the 350 cusecs of water and no time bound delivery schedule has been fixed.
2. The head regulator with sill level fixed at EL 244.25 meters has been approved by both the sides.

The Indian side is drawing the water for the Sarada canal at a sill level 241.10 meters. Initially the Nepalese side was apprehensive that a high sill level like 244.75 (As proposed by Indian side) would not assure the continuous supply of water. The Nepalese leaders like K.P. Oli when he was coordinator of the Mahakali Study Task Force and Pashupati Shamsher JB Rana as Water Resources Minister had insisted that Nepal too should draw the water at a sill level 241 miters as the Indians are doing but India did not agreed.

3. The most important aspect of the treaty is the preparation of the DPR which was to be made jointly. However this task has been handed over to an Indian Public Sector Consultancy company called (Water and Power Consulting Services-WPCS). When the Prime Minister of India Narendra Modi visited Nepal in 2011, he had exhibited great enthusiasm for the implementation of the Mahakali treaty and had proclaimed that the DPR would be prepared within six months and then construction of the Pancheswore project would begin right away.

   However, 13 years have lapsed since then and there are no signs of the DPR being finalized. On the other hand, the DPR prepared by WPCS estimates a much higher quantity of water as the existing consumption of India from the Mahakali River than the current supply arrangement allows. This has led to a disagreement between the two sides and this can be only settled by diplomatic and political intervention at the high level.

4. India has finally completed the construction of the main Eastern canal from the Tanakpur Barrage to the East-West highway in Nepal and the service road for the canal up to Brahmadev Mandi. There was a test run for the water supply in the canal last year during the wet season. On Nepal side, the distribution canal has not yet been constructed fully and it is expected that this will be completed within 2 years. So, it looks like when Nepal is ready to receive the irrigation water fully, India would begin to supply the required and agreed quantities on a regular basis. After the visit of P.M. Puspa kamal Dahal and his team to india in june 2023, the Integrated Mahakali Project has received a new booster doze of energy and the Pancheshwore Project Board comprising of officials of both countries have met to discuss the final preparation of the DPR on a time bound basis.

5. 70 million kWh (units) of electricity per year from the Tanakpur hydroelectric plant has been made available to Nepal on a continuous basis.

6. The irrigation water from th Sarada Barrage for the Mahakali irrigation project phase-1 is being under available.

7. Nepal's will most probably begin to receive the irrigation water for Mahakali irrigation project phase-II in 2 year time when Nepal is distribution canals are ready.

8. India has not released the 350 cusecs of water below the Sarada barrage in Mahakali River to maintain its ecosystem.

9. India has not yet supplied the 350 cusecs of water for irrigation of Dodhara-Chandani area of Nepal.

As the DPR has not yet been finalized and more complications are introduced by the Indian side by assessing the present consumptive use by India on a far greater scale than available from Sarada Canal built in Nepal by including other water resources from India. This has been contested by Nepal. If both sides are serious about implementing the project, it should be taken up at the highest political and diplomatic level to smooth out all remaining disputes and differences and clear the way for the finalization of the DPR. On Pancheshwor, Ranjit Rae, former Indian ambassador to Nepal in his excellent book 'Kathmandu Dilemma: Resetting India Nepal Tie', adds: it should be our highest priority to assure that all pending issues preventing finalization of the Joint DPR for the Pancheshwor Project be resolved politically so that financial closer can be achieved soon. This project has the potential of dramatically improving the quality of the India-Nepal relationship.

Co-operation on Hydropower Development:

The first project gifted by India was the 21MW Trishuli Hydropower Project and associated transmission system (Trishuli-Balaju) 66 kV transmission line as well as Balaju 66/11 kV substation in 1967. As a part of Gandak River agreement, India completed the 15 MW Gandak Hydropower plant and handed over to Nepal in 1979. India further gave two small project as gifts via 1.08 MW Fewa Hydropower in 1967 and 14.1 MW Devighat Hydropower Project and associated transmission system (Devighat-Chabahil) 66 kV transmission line as well as new Chabahil 66 kV substation in 1984. Nepal also receives 10 MW power from the Kosi project.

10,800 MW Karnali-Chisapani Multipurpose Project

This project was initiated by king Mahendra in the 60s and India got involved. In December 1962, UNDP from a grant received from U.S.A at the request of king Mahendra awarded the consultancy contract to ascertain the hydropower potential of the Karnali River and the most desirable site for a hydropower project to Nippon Koei of Japan. Nippon Koei submitted four reports in 1966 and also identified the 1800 MW Karnali-Chisapani Hydroelectric project with an arched 207 meters high dam.

The Deupty P.M. of India, Morarji Desai during his visit to Nepal in 1967, agreed to co-operate in the development of the Karnali Project. During the visit of the Indian president Dr. Zakir Hussain in 1968 and on the request of King Mahendra, the Indian President expressed India's willingness to develop the project in a mutually beneficial manner. UNDP then funded the review of the project by Snowy Mountain Hydroelectric Authority in 1968. Snowy Mountain recommended a gravel fill embankment dam downstream of that proposed by Nippon Koie. In 1969, as Nepal asked India to withdraw its wireless operator's station at 17 posts in the Nepal-Tibet border, India-Nepal relations soured and India retaliated by refusing to renew the trade and transit treaty that expired in 1970 and imposed restrictions in the import of construction materials and industrial goods to Nepal from India.

In May 1973, India's planning Minister D.P Dhar, visited Nepal and agreed to purchase Karnali power if India was fully associated with the development of the project. In August 1973, meetings were held between the technical teams of Nepal and India and detailed discussion were held on reports prepared by Nippon Koie and snowy Mountains. But the project got stalled after the coronation of late king Birendra. At the farewell reception hosted by King Birendra at the conclusion of his coronation in 1975, he proposed that Nepal be declared a Zone of Peace. Most of the nations of the international community endorsed Nepal's Zone of Peace proposal except India. India felt that this was not necessary between India and Nepal, as India perceived that Nepal was under the Indian security umbrella as from the 1950 India-Nepal Peace and Friendship Treaty. This again pushed back the progress of the Karnali Project.

During the Indian P.M. Morariji Desai's Visit to Nepal in 1977, it was agreed to put up a committee to review the Karnali project and outline future course of action. It was also agreed to put up a joint committee to investigate the feasibility of the construction of Pancheshwor Hydroelectric Project to be located on the border of Nepal and India on river Mahakali (Sarada). During this visit, it was also agreed that India would buy the surplus power from Nepal generated by Karnali and Pancheshwor Hydroelectric Projects. As with Pancheshwor, a committee was formed to review the Karnali-Chisapani Hydroelectric Project and to determine its implementation modality. Following this, UNDP contracted Nor-consult/Electrowatt to conduct the second feasibility study of the Karnali-Chisapani Project.

This study recommended a 210 meters high embankment dam at the same site identified by Snowy Mountain in 1968 but increased the capacity to 3600 MW for generating an average annual energy of 15072 GWhr. Consequent to the visit of the Indian P.M, the secretary level committee was constructed between the two countries. On 4th April 1978, the first meeting of the Committee on Karnali was held in Kathmandu. The Committee led by K.D Adhikary, Secretary of Water and Power from Nepal and by Y.K Murthy, Chairman, central water commission from India agreed on the need for evolving a concrete time bound action program and noted that some more studies and pre-construction investigations would have to be completed in firming up the costs, technical and other features of the project to finalize the project document. The committee also considered the need for providing to Nepal by Government of India about 50 scholarships every year for the study of engineering in Indian Educational Institutes for a period of five years to supplement Nepal's human resources for the Karnali Project.

In the secretary level meeting between the two countries held from 21st to 24th February in 1984 at Kathmandu, India emphasized the need to make progress on the three major projects Karnali, Pancheshwor and West Rapti simultaneously. Many believe that after the 1954, Kosi and 1959 Gandak projects, India was zeroing on West Rapti but for the 1962 Sino-Indian border conflict. Nepal also informed India that negotiations with the World Bank had already taken place and it had agreed to provide more than 10 million $ to conduct phase-I study of the Karnali-Chisapani Multipurpose Project. This study should progress as fast as possible and all necessary steps to expedite should be taken. India stated that no major hurdles were expected but reemphasized that Pancheshwor project should also make a headway simultaneously. Thus by insisting on parallel action be taken on both Karnali as well as Pancheshwor projects, India clearly indicated its preference for Pancheshwor to be built on the common river.

At the 4th committee on Karnali meeting, held during the same period, India questioned the very validity of the Karnali-Chisapani project without the successful conclusion of agreement of tariff and bulk purchase of power by India as well as the arrangement for the implementation of construction and operation of the massive Karnali-Chisapani Multipurpose project. It should be noted that Karnali-Chisapani Project was well inside Nepal, about 40 km upstream from the Indo-Nepal border. After negotiations with the World Bank, where Nepal insisted that as the project was within Nepal, the Nepalese would be responsible for its construction management and operation. And, so it was agreed that the study would not include them.

On the basis of competitive bidding Himalayan Power Consultants comprising of one American and three Canadian firms was awarded the Detail Feasibility Study (DFS) preparation contract on May 1988 and they started their work. In December 1989, the Himalayan Power Consultants submitted their DFS of Karnali in accordance with the terms of reference jointly

prepared and agreed upon by India and Nepal. The consultants noted that there are very few sites in the world at which a river of this size can be so readily dammed and raised. The DFS recommended a 270 meter high gravel fill embankment dam at the same site recommended by Nippon Koie in 1996 and having a live storage of 16.20 billion cubic meter with the reservoir extending 100 km upstream.

The 10,800 MW powerhouse located in the left bank would have 18 units each of 600 MW size generating an annual average energy of 20,842 GWh at roughly half that of alternative generation source in India displacing about 10 million tons of local consumption annually. The re-regulating dam 8 km downstream would generate 84 MW- six units of 14 m each. Five 765 kV transmission lines would connect to the Indian grid. The DFS envisaged a five year pre construction period from 1990 with the large scale construction beginning from Jan 1995 and the first two 600 MW units coming on line in November 2003. The remaining 16 units were planned to come on line one every three months and terminating in November 2007.

The 1989 capital cost of the project was estimated at 4890 million US $ While the irrigation potential in Nepal was estimated to 191000 hectares, India would have a gross irrigation potential of 3200000 ha. Karnali-Chisapani reservoir will increase dependable dry season's flows about for four resulting in annual crop production increase in excess of 18 million tons per year. The DFS further noted that Karnali-Chisapani Projects generated substantial social and environmental impacts with the need to resettle 60,000 people.

The full set of the detailed feasibility report costing more than NC Rs. 50 crore (about US $18 million) comprising of 24 volume were sent to India for final approval. India, has continued to express her reservation on all the project parameters recommended by the consultants:

(i) Probable maximum flood value to be reviewed as it was on much higher side.

(ii) The Sedimentation rate adopted in the study also high with almost 3 times the value adopted by India.

(iii) On seismicity, India questioned the tectonic model used in the study.

(iv) Dam height/reservoir capacity should be fixed to meet the existing and committed power and irrigation demand in India as well as taking to consideration the probable upstream storage reservoir sites in Karnali.

(v) Initial optimal installed capacity to be in the range 5400 MW to 7200 MW with provision of ultimate installed capacity of 10,800 MW and

(vi) Studies of also 500 MW generator capacity units size.

The DFS has assessed the benefits as:

Power 80.96%, irrigation 18.88% and others 0.16%. India contested that irrigation and flood control benefit was negligible and only power benefits was considerable. At the 8th meeting of the Karnali Committee in March 1991, B.K Pradhan, secretary, water resources GON requested his Indian counterpart S. Raj Gopal, Secretary Power to agree that the completed feasibility study report is acceptable to both sides. But secretary Raj Gopal stressed on the need to resolve the above mentioned outstanding issues, thus effectively putting the Karnali Multipurpose Project in abeyance and blocking further progress. As a result of the preparation for the construction of the Karnali Project, 410 Nepalese students returned after receiving their degrees in Engineering from Indian Rorkee University, acknowledged for civil engineering.

On their return, the students found themselves jobless and even had to resort to strike to bring the attention of the Nepalese government about their plight. While some were absorbed by the Nepalese government, many had to leave Nepal and go abroad in search of jobs. After more than two decades of exercise on the development of Karnali Project from both sides and Nepal incurring a debt a more than Rupees 50 core for the investigation study, India's desire of taking complete control of the project (even though, it was well within Nepalese territory) and it's weariness that Nepal might use the size of the project as a bargaining tool resulted in India's withdrawal.

The Saga of 300/900 MW Upper Karnali HEP

Upper Karnali, with a design flow of 236 cubic meters per second, a mere 2.3 km length headrace tunnel to obtain a head of 141 meters had a potential energy output of 1,757 GWh. The double circuit 220 kV transmission line from the powerhouse to the Indo-Nepal border was 115 km only away. With such short tunnel to gain such a good head with such flows, and the so-called 'ever hungry client just across the border, the Canadian consultant's aptly, named Upper Karnali 'the jewel in the crown' of the projects studied.

- 2006-Global Tender for the 300 MW Upper Karnali

With 7 hours of load shedding daily, Water Resources Minister Gyanendra Bahadur Karki, decided to put the two run-of-the river projects, 300 MW Upper Karnali and 402 MW Arun-II, along with the 600 MW storage Budhi Gandaki for global competitive bidding in 2006. These two run-of-the river projects, Upper Karnali and Arun III, were identified as Nepal's most feasible and attractive projects. While the 300 MW Upper Karnali 'jewel' had the largest number of 14 bidders (11 from India, 2 from china and 1 from Netherlands), the 402 top priority Arun III also had 9 bidders (7 from

India and 2 from China) But the 600 MW Budhi Gandaki had just 2 bidders (1 Indian and I Chinese, the same bidders for Upper Karnali and Arun III).

A seven member committee was constituted under the co-ordination of ex-finance secretary, Bhanu Prasad Acharya. This committee awarded both the 300 MW Upper Karnali and 402 MW Arun III to GMR Energy. Prudently, the Parliament Subcommittee on Natural Resources and Means directed that only one project be awarded to one bidder. GMR energy, naturally chose the Upper Karnali and Satlaj Jalvidhyut Nigam (SJVN), a government of India undertaking was awarded the 402 Arun III project. Regarding the storage 600 MW Budhi Gandaki, the Bhanu Acharya committee evaluated both the bidders. Maytas from India and Sino-Hydro from China as unqualified.

As the subcommittee on Natural Resources and Means prioritized free energy over free equity, the Anup Kumar Upadhyay committee negotiated with GMR to increase the free energy component from 7.5% to 12% by reducing 6% on the 33% free equity offered by GMR to bring it to 27%. To ensure genuineness of the bidders, the Upadhyay committee negotiated with GMR energy the payment of, at the time of issuing survey license, a non-refundable fee of 1 lakh per MW. GMR Energy also agreed to pay Rs 8 crore for the costs incurred during the project studies and deposit, at the time of issuing the generation license, a bank guarantee of Rs 5 lakhs per MW.

In January 2008, GMR and Anup Kumar Upadhyay joint secretary, Ministry of Water Resources, signed the agreement to commission the 300 MW Upper Karnali within 84 months, 30 months for survey and 54 months for construction to bring it to commercial operation by January 2015. The generation license under the build, own, operate and transfer (BOOT) was for a 30 year period- that is, GMR would hand-over 300 MW Upper Karnali project to GON by January 2045.

The coalition government of CPN-UML, Nepali Congress and Sadbhavana party under Madhav Kumar Nepal as P.M. truncated the 29 year old Ministry of Water Resources into that of Energy and Irrigation Ministries on 25th May 2009. Just seven months after truncating the Water Resources Ministry, Energy Minister Dr. Prakash Sharan Mahat on 18th December 2009, approved the upgrading of 300 MW to 900 MW under the pressure of GMR but cited 'optimization of the resources of the site'. The Investment Board of Nepal (IBN) under the chairmanship of the Prime Minister was established in 2011 to facilitate the implementation of all domestic and foreign large projects and all hydropower projects above 500 MW.

With this, the upgraded Upper Karnali from 300 MW to 900 MW and Arun III from 402 to 900 MW, also came under the IBN. Both GMR and SJVN successfully convinced the IBN to have their 2008 agreements with MOWR annulled and enter into a new agreement under the framework of the newly coined concept of Project Development Agreement (PDA) with the IBN on September 2014.

It was reported that the review committee led by Dr. Govina Raj Pokhrel, Vice-chairman of NPC studied the PDA with the GMR on the issues like GMR balance sheet, exemption of taxes for export project, ensuring fair rate of return on Nepal's 27% equity, mitigation of impact on irrigation downstream etc. to create the so-called win-win situation. However, it is not known whether this review committee examined the impact of the upgrading to 900 MW on the upstream 4,180MW storage project KR1B. In the national interest, Nepal should not be sacrificing the 4180 MW upstream storage project for the scaling up of GMR's Upper Karnali from 300 to 900 MW.

In the PDA signed between GMR and IBN, GMR was given 2 years to achieve financial closure i.e by 19th sept 2016. At an interaction program organized by IBN to get a feedback on the PDA, the representative from the Irrigation Ministry informed that 900 MW 4 hour peaking operation of Upper Karnali without the re-regulating dam will have adverse impact downstream to Nepal's existing irrigation system particularly to 11,000 ha of Rani-Jamara-Kulariya project. Though this information initially bought about some stirrings it failed to have a substantial impact to either IBN or GMR. In fact, the IBN has not bothered to inform the relevant authorities or the public how it has addressed this important downstream adverse impact.

When the two year financial closer timeline expired in September 2016, GMR was granted extension till September 2017. When this extension also expired, another one year extension was given in 2017 which again expired in 2018. P.M. KP Oli decided to keep this project at bay by neither cancelling this license nor giving it any extension for three years. When S.B. Deuba became P.M in July 2021 he formed a review committee under National Planning Commission (NPC) Vice- chairman Dr. Bishwo Nath Poudel who after fulfilling the usual rituals dutifully recommended a two year extension. The Deuba cabinet decided to give a two year extension with the placid condition that GMR achieves the financial closure within 24 months.

This unwarranted and questionable decision to give another 2 year for financial closure was challenged by Ratan Bhandari at the Supreme Court and the single bench of Justice Ishwar Prasad Khatiwda issued an interim stay order not to implement the decision until the final verdict. Jurist Khatiwada observed that since the deadline of the last extension of many extensions failed on 4th November 1918, no decision was taken to either renew or maintain the agreement for three years. Thus, there cannot be any justification for the additional two years extension till July 2024. Of late,

the Supreme Court has approved the government decision on the two year extension but instructed that there will be no more extensions after 2024.

Alas, this jewel in the crown project with a mere 2.4 km headrace tunnel and adjacent to the 'Birendranagar (Surkhet)-Manma (Kalikot)' highway is languishing quietly mainly owing to the Nepalese Authorities inability to act decisiviely in the national interest. The MOWR would do well to think about alternatives when the two year extension will most probably expire in 2024 without financial closure. If this happens, the Govt must make future decision with a view to help the people of Karnali Province in a manner that will not only optimize their benefits and welfare but also serve the best national interest.

The Arun III 402 MW and Other Projects Awarded To India's Public Sector Undertakings

The Upper Karnali 300-900 MW project was awarded to Indian private sector GMR and the Arun III 402-900 MW HEP was awarded to Government of India undertaking Satlaj Jal Vidyut Nigan (SJVN) at the same time in 2008 on the basis of international competitive bidding. In the case of Arun III, the PDA was negotiated for 21.9% free energy and no free equity was acquired by GON. The PDA was signed in 2014 and the project was upgraded to 900 MW from the initial 402 MW.

The implementation of this project seems to the satisfactory in the hydro electricity generation front but lagging in the construction of the long transmission line from Sankhuwasabha District in Nepal to the Nepal-made border down south. Irrespective of the spirit of Constitution and established practice and policies of the GON to award hydroelectric projects based on international competitive bidding, of late, the government under various P.M.s has been awarding attractive hydro projects to the Indian public sector companies like SJVN and NHPC based solely negotiations. This is certainly a compromise in the best national interest committed by our political leaders.

Projects Awarded to the Indian Public sector (PSU) undertaking and the Indian Private Sector.

S.N.	Projects	Capacity (MW)	Free Energy to GON	Equity
1.	Arun III	900	21.9 %	100% SJVN (PSU)
2.	Arun IV	490	21.9%	49% NEA, 51% SJVN
3.	Lower Arun	669	21.9%	75% SJVN, 25% Nepal Public
4.	West Seti	750	21.9%	100% NHPC (PSU)
5.	SR-6	450	21.9%	100% NHPC
6.	Fukot Karnali	480	21.9%	51%NHPC, 49% Public sector
7.	Upper Karnali	900	12% free energy	27% free equity to GoN, 73% GMR (Private)

As India has put condition in the export of Nepalese Hydropower to India by insisting that only power generated by companies with Nepalese and Indian investment, machinery and construction materials and labor will be allowed in the Indian market. To ride over this obstacle, the Nepalese leaders have begun to award most of the technically and financially viable projects to Indian PSU without international competitive bidding. Thus, this makes the development of Nepalese hydropower sector highly dependent on the goodwill and capacity of the Indian public sector (Govt of India). The Government of Nepal will do well to stop awarding additional power projects to Indian Public and Private Sector Companies solely based on negotiations. It has already taken the SJVN more than 15 years for the construction of the Arun III HEP and its completion will take a few more years. In all likelihood, the projects being built by the Indian Public sector undertaking like SJVN and NHPC will take a minimum of 10 to 15 years for their completion. So Nepal will not be able to export 10,000 MW of power to India in the next 10 years unless India relaxes its conditions on imports of power from Nepal.

The Indian Market for Nepali Electricity

Nepal began to explore market for its electricity in India since Feb, 2010 by sending the draft of the Indo-Nepal Power Trade Agreement, in Dec, 2011. Nepal was assured that India had an open electricity market, which is functioning effectively for over last five years and Nepal may take advantage of the competitive prices for buying and selling for bulk power between Indian and Nepalese relevant entities. Having stated this, India did not respond to the proposed Nepalese draft in due time and only after 4 years sent a draft of the Indo-Nepal Power Agreement which tried to tie the entire Nepalese Hydropower sector to India's interest.

This obviously put the Nepalese Authority in a state of quandary. Fortunately, this was resolved when Bharatiya Janata Party (BJP) formed the central government in 2014 and Narendra Modi became the P.M. Following up with the spirit of P.M. Modi's vision "neighborhood first" policy, India and Nepal signed the Indo-Nepal Electricity Trade, Cross-border Transmission and Grid Connectivity" Agreement on Oct 21st, 2014 and India also signed the SAARC Framework Agreement for Energy Co-operation (Electricity). (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka) in Kathmandu on 27th Nov 2014.

The salient features of the 2014, Indo-Nepal Electricity Power Trade Agreement are:

a. The parties shall allow non-discriminatory access to the cross border inter connections for authorized/licensed participants in the common electricity market.

b. The parties shall allow the authorized/licensed electricity producers/buyers/traders of their countries to engage in cross-border electricity trading, including

that through power exchanges and to seek cross border transmission access as to the laws of the respective country.

However, this somewhat open policy was constricted by the 2016 guideline issued by GOI. Citing electricity trade involved "Issues of strategic national and economic importance," the new guidelines provided that.

Participating entities complying with following conditions shall be eligible to participate in cross border trade of electricity after obtaining one time approval from the designated authority.

(i) Imports of electricity by Indian entities from Generation projects located outside India and owned or funded by Government of India or by Indian public sector units or by private companies with 51% or more Indian entity (entities) ownership.

(ii) Any other participating entity shall be eligible to participate in cross border trade of electricity after obtaining approval of the designated authority on case to case basis.

This new guideline restricts the import of hydropower from Nepal to India only from those generated by Indian owned public sector entities like SJVN (900 MW Arun III) or by the private sector GMR which owns more than 51% of the 900 MW Upper Karnali hydro project. All other entities not having the above type of ownership would be or required to get approval on a case by case basis. In fact, this is what is happening to NEA while exporting power to India. It has to get approval for each generating entity involved with power export to India. NEA has yet to get approval for the export of power from the 456 MW Upper TamaKosi Hydro Project which was built using the services of a Chinese contractor for the civil works, while the entire Hydro-mechanical and electrical equipment is from India and other non-Chinese sources.

If one carefully studies India's 2018 guidelines the basic element of 2016 guideline are intact, however, the contents have been stated differently. The significant aspects of the guidelines:

a. The import/export of electricity will be consistent with the provisions of the prevailing laws in the respective countries. However in the case of tripartite agreement, the cross border trade of electricity across India shall be allowed under the overall framework of bilateral framework signed between the Government of India and the respective country.

Despite the November 2014, SAARC Framework Agreement for Energy Co-operation (Electricity) one clearly perceives the Indian intension of sticking to bilateralism in this new guideline.

b. Respective countries will appoint a Designated Authority for facilitating the process of approval and laying down the procedure for import/export of electricity.

c. Any entity proposing to import or export electricity may do so only after taking the approval of the Designated Authority.

d. Considering the fact that import/export of electricity from and to India involves issues of international relations, the Designated Authority will grant approval only after concurrence of Govt. of India.

e. The Designated Authority shall grant approval for export/import of electricity only after taking into account the generation capacity available and the demand. Imports may normally be permitted only when the demand exceeds generation. However, Govt. of India reserve the right to import/export electricity from/to neighboring countries for reasons of larger policy interests.

f. The Designated Authority shall consider the application for approval of participating (entity agencies) only after the receipt of the equity pattern of ownership of the said entity. This is basically a continuation of the 2016 guidelines which stipulated that foreign generating entities that had 51% or more ownership by Indian public sector units or private companies would be eligible for exporting power to the Indian market.

g. The tariff for import of electricity by the Indian entity (ies) shall be determined through a process of competitive bidding as per tariff policy of India or through mutual agreement. In the case of hydro projects, the tariff may be determined by CERC as per its regulation.

From the last clause regarding the involvement of CERC, it is clear that there are more bureaucratic hurdles to export hydropower to India. Thus, Nepal's dream of reaching prosperity through the export of electricity using its vast hydro resources developed to export to its neighbor, for all practical purposes, may remain on unfulfilled.

Export of Power from Nepal to India

Nepal has been exporting unto 452 MW of power on the day ahead bidding basis through the IEX and PEX during the surplus season and importing up to 800 MW power during the dry season when generation is low and demand is high.

During the Nepalese P.M. P K Dahal's visit to India from May 31 to June 3rd, he asked the Indian P.M. Narendra Modi to open up the Indian electricity market and an understanding was reached between the leaders. The summary of the agreement is included in the statement issued by India's Ministry of External Affairs which is as follow:

1. Recalling the joint vision statement on power sector co-operation of April 2022, the two prime ministers expresses satisfaction at the progress made in power sector co-operation that covers the development of generation projects, power transmission infrastructure and power trade. Both Prime Ministers appreciated the growth in export up to 452 MW power from Nepal to India and the progress made in the construction of the 900 MW Arun III hydroelectric project in Nepal.
2. Both sides finalized an agreement for long term power trade. It was agreed to strive to increase the power import from Nepal to India to 10,000 MW within a time framework of ten years and towards this end take all necessary measures to encourage mutually beneficial investments in Nepal's hydropower generation and transmission infrastructure.
3. Both leaders also jointly carried out the ground breaking of the 400 kV Butwal-Gorakhpur transmission line. The signing of the MOU for the development of 480 MW Phukot Karnali Project by NHPC and VUCL Nepal and the Project Development Agreement for the development of the 669 MW lower Arun between SJVN and the Investment Board of Nepal (IBN) was welcomed by both sides.
4. The Nepali side welcomed the decision of government of India to facilitate the trilateral power transaction from Nepal to Bangladesh through Indian grid with an export of up to 40 MW of power. Both sides expressed the commitment towards greater sub-regional co-operation, including in the energy sector, which would lead to increase inter linkages between the economies for mutual benefit of all stakeholders.

The Nepalese Authority and IPPAN seem to be really ecstatic about the agreement reached between the two Prime Ministers on export of up to 10000 MW of power from Nepal to India. The reality is somewhat different. In the first place, India says that it will strive to import up to 10000 MW. Secondly, as discussed above, India put fourth conditionality on the import of power. It will only buy power from generating stations that have 50% or more ownership of India's PSU's or private sector. India has so far only approved the export of 452 MW and the approval for the 1000 MW of power from various projects including the 456 Upper TamaKosi Project for power export is still pending.

Further, of the seven projects on which agreement for implementation has been entered between the Indian relevant institutions and the Nepalese entities only Arun III has been completed up to 50% and it will take a few years more for its completion and generation. The rest of the projects are only at the initial stage and they will take more time than stipulated in the PDA to be completed. Even the Indian private sector GMR's Upper Karnali has taken more than 16 years only for the financial closure. It is not certain whether financial closure will be completed even by the end of 2024.

If the seven projects were completed then it would be sure that India would be importing an additional 4639 MW. But with restrictions on the source of import, the 10000 MW seems to be a far cry. This is further buttressed by India issuing a stringent procedure in the 2018 guidelines that effectively prohibited export of the electricity from Nepal to India by third party. The procedure lays down that the generating entities owned by the citizens of a third country with whom India shares land border and the third country does not have a bilateral agreement on power sector cooperation with India shall be considered only after the receipt of the equity pattern of ownership of the said entities. This, in effect, blocks the export of power from generating units produced by entities having full or partial ownership of Chinese citizens/entities.

At an election rally 2022, S.B. Deuba former P.M. and President of Nepali Congress declared since India is reluctant to purchase energy produced by Chinese company in Nepal, we will talk with Modi for the engagement of Indian developers. Instead of exploring alternatives, it seems that our political leadership has resigned itself and left the development of our hydropower to India. This may seem pragmatic in the short run but may prove to be harmful in the long run.

The prospects of Power export to Bangladesh

Nepal and Bangladesh are separated by a mere 18 km stretch of Indian Territory that has been called the chicken neck. Bangladesh has an installed capacity of 29000 MW with 16000 MW oil fired and 11000 MW gas fired generations. Hence, Bangladesh is keen to import hydropower from Nepal and Bhutan. The BBIN (Bangladesh, Bhutan, India, and Nepal) Association was formed at India's initiative for regional cooperation but has failed to live up to its expectations. In spite of the repeated request by Bangladesh's P.M. Saikh Hasina Begam to P.M. Narendra Modi of India (first made in 2017) for the facilitation of cross border power sector co-operation with Nepal, India finally responded in 2022 by telling Bangladesh that the guidelines for the same are already in place meaning the 2018 guidelines and 2021 procedures for import/export of electricity from/to neighboring countries. In the recent meeting in June, 2023 between the two Prime Ministers of Nepal and India, India agreed to facilitate the export of power from Nepal to Bangladesh using the Indian transmission system to the tune of 40 MW. Let us hope that this will be materialized soon.

The Govt. of India's practice on cross-border electricity trade between two neighbors (Nepal

and Bangladesh) using the Indian transmission system is against all norms of co-operation as envisaged in the objective of the BBIN. The study of cross-border electricity trade between the neighbors in the ASEAN region is illuminating and exhibits the lack of co-operation by India in cross border electricity trade between neighbors.

Cross-Border Electricity Trading in the ASEAN Region

(i) Laos-Thailand cross-border Electricity Trading

Like Nepal, Laos is also landlocked and hydropower rich with a hydropower potential of 26,500 MW. As early as 1993, Thailand signed an MOU with Laos agreeing to import 1500 MW from Laos. Laos presently has an installed capacity of 7213 MW with a further 7598 MW of hydropower project under construction. In 2016, Thailand agreed to upgrade the 1993, 1500 MW import to 9000 MW and Thailand imported 5720 MW from Laos in 2021. In 2022, Thailand agreed to top the 9000 MW with an additional 1200 MW.

In 2021, Thailand had an installed capacity of 52,200 MW and yet agreed to import 10,200 MW from Laos-that is an import of a fifth of Thailand's installed capacity. In contrast to India's attitude of treating electricity trade as an issue of strategic, national and economic importance, Thailand treats it as an economic good necessary to accelerate development and improve the living standard of its people. India has an installed capacity of 417000 MW and yet it is hesitant to import clean energy from Nepal and has only agreed to import 452 MW so far. Under these circumstances, the hope that India will import 10000 MW in 10 years seems to be a herculean task given the conditions led by India for import of power from Nepal.

(ii) Laos-Malaysia/ Singapore Electricity Trading

Besides Vietnam and Cambodia, Laos also trades electricity with Malaysia and Singapore through Thailand. On September 23, 2016 Laos, Thailand and Malaysia concluded an agreement wherein Malaysia was to buy 100 MW of power from Laos using the Thai grid by paying wheeling changes. Singapore too begun to import 100 MW from Laos paying the wheeling changes to both Thailand and Malaysia. Unlike India, Thailand does not bother with the equity pattern of the developer exporting electricity to it.

In addition to the electricity trade between Nepal and India on a day ahead basis through the IEX and PEX, India has also agreed to purchase 200 MW of power for a five year period.

Bhim subba, a Bhutanese refugee of Nepalese origin who once, headed the Bhutan Government's power department observed as far back as in 2002 that:

- Nepali is trying to sell electricity while it is water that India needs and
- India is pinning its hope on overcoming, by Nepal's default, the impending water crisis in the Ganges basin, through power projects developed in Nepal.

It is estimated that Nepal's installed capacity will rise to 6700 MW by 2027. This will far exceed our domestic demand. India is only striving to import 10000 MW in 10 years and within the framework of its 2018 electricity guidelines in electricity trade followed by its 2021 procedure (with additional strictures). It is difficult to estimate what will be the fate of Nepal's Hydro sector if it does not develop other alternatives to power export destination.

Summary and Evaluation of Indo-Nepal Co-operation in Water and Power

The first project undertaken by the two countries is the construction of the Sarada Barrage at Banabasa in the Mahakali River with the British East India Company in 1920. Nepal was to receive upto 1000 cusec of water in the wet season (15th May to 15 October) and 150 cusec in dry seasons (16th oct to 14th May). However, Nepal started to receive the water only after the establishment of the Mahakali irrigation project in 1970. Currently, 11,600 ha are being irrigated in Nepal.

The second project in irrigation and flood control was Kosi Agreement and it was signed in 1954 by the M.P. Koirala led government. Implementation of the Kosi Treaty has been disappointing. Due to poor maintenance and neglect the Kosi River breached its embankment and shifted its course on 18th August 2008. In Nepal, this caused the displacement of 107725 people, damaged about 5500 ha of farmland and 14 km of East-West highway and an estimated Rs 300 million worth of crop was destroyed. Cost of rehabilitation of damage infrastructure and compensation for crop was estimated to be about 501.4 million. Nepal could claim this from India but is has not pursued this vigorously.

The third was the Gandak Project. This project provides substantial benefit to India but insignificant benefit to Nepal. Thus in both Kosi and Gandak Projects, India has been an enormous beneficiary in terms of flood control and regulated water for irrigation. Nepal benefits little but suffers from flooding caused by breaches in embankment and other structures.

The fourth project is the Mahakali integrated Development Treaty signed by two Prime Pinisters of India and Nepal on 12th February 1996. Although this was hailed as a historic and landmark decision on Water Resources Development Co-operation between the two sides, even the Detailed Project Report (DPR) is yet to be finalized after 27 years. Let us hope that the Pancheshwor Board which met in Pokhara after the visit of Nepal's P.M. PK Dahal to Delhi in June 2023 and decided to complete

DPR within 6 months will finally fructify.

Indo-Nepal co-operation in Water Resource Development has been mostly a one sided affair, with substantial benefits to India and little benefits to Nepal which bears the brunt of flooding and displacement of people and their habitats. In spite of the often touted age old ties of friendship cemented by 'Roti-Beti' relationship, India has not co-operated with Nepal in the development of the following projects which could benefit Nepal immensely.

1. 60 MW Kankai Multipurpose Project (85 meter Dam, irrigation of 6745 ha of land of Jhapa)
2. SunKosi/Kurule-Kamala Diversion (tunnel 16.6 km, power 61.4 MW, Kamala dam 51 m, power 32 MW and irrigation of 175000 ha of land in Dhanusa and Siraha districts).
3. 140 MW Bagmati Multipurpose Project (117 m dam, irrigation to parts of Bara, Rautahat, Sarlahi, Mahottari and Dhanusa for 120000 ha of land).
4. Western Rapti, Multipurpose Project (90m dam at Bhalubang, power 62 MW, 9.03 km tunnel to surai Naka power 45 MW and irrigation to 80,350 ha of land in Kapilvastu, Deukhuri and Banke).

Note: Of these projects the SunKosi-Marin-Bagmati Diversion Project is being implemented by GON through the MOEWRI

Forty seven percent of India's 1.2 billion people depend on the (Ganges water for their livelihood). In the most critical dry season, the Nepalese rivers provide 72% of the Ganges waters. India would like to benefit from Nepal's water resources by Nepal's own default rather than by entering into a comprehensive development deal that would benefit both sides. India is also interested in the construction of the Multipurpose Project at Barahachhetra with a 268 meter high dam in the Kosi. This will not only submerge Nepal's limited fertile land up to the tip of Tumlingtar Airport, but also displace 75000 people (estimates of BS 2062) Nepal does not need this project but India does. As in the past will India be able to take our political leaders for a ride and create a sorrow for Nepal's while eliminating the sorrow of Bihar?

Nepal has not benefited in proportion to the sacrifices it has made from the major bilateral projects such as the Kosi and Gandak. The much hyped multipurpose Mahakali Integrated Project which was proclaimed to be a game changer in Nepal's development has yet to see the light of the day even after 28 years of the Treaty being signed by the two countries; Prime Ministers. The irony is that even the DPR has yet to be finalized. India wants to benefit from Nepal's water resources without making a fair contribution for the benefits derived. This is why the Majakali Project has dragged on for years as India does not agree on the benefits it acquires in the form of irrigation and flood control and so the price sharing proportion cannot be determined.

Nepal went on a building spree of ROR hydro projects using the private sector with the understanding that India (which actually needs to have more clean energy in its system) would be a willing buyer. Nepal's hopes has been dampened as India is insisting that it can buy power only from projects that have more than 50% Indian investment. It has also not agreed to buy power from projects that were built by using machinery and contractors from countries that have borders with India which have not signed Electricity Trade Agreements (China). India is currently buying power in a limited way only from some of the projects sent for its approval. Although there is a huge potential to export power to Bangladesh via the Indian grid, India has only granted permission for 40 MW for export via its territory.

Future Course of Action

Nepal's water resources is its most important natural asset after its human resources and it should be more strategic in its utilization so that the nation and people reap maximum benefits while ensuring sustainable development. Towards this end, the following measures need to be adopted.

a. Revise the draft Electricity Bill that the GON has tabled in the parliament for deliberation and passage. It seems that the draft Bill has not given due importance to the private sector in hydropower development as multipurpose project and large attractive projects are reserved to the public sector and their associate companies. As of 2080 Ashadh 25th, total power connected to the national grid is 2794 MW of which private sector provides 1655 MW, NEA and its subsidiary provide 1139 MW. Thus the private sector provides 59.25% of the power in the national grid.

   Given Nepal's current economic situation where government resources do not meet current expenditure (and it is borrowing to pay for salaries and other administrative expenses), there is a need to attract more private sector investment (both domestic and foreign) in Nepal's hydropower and other infrastructure development.

b. Formulating a clear cut policy on bilateral co-operations: the Water and Energy Commission Secretariat (WECS) has conducted many valuable studies on Nepal's water resources potential and formulated strategies needed to achieve to maximum benefits on a sustained basis. A Water Recourses Strategy was formulated in 2002 and it is time to update this document. The new strategy should also

outline the role of public sector institution (NEA, DOED, DOI and others), the private sector, international donors and bilateral co-operation in water resources development. In the past, our governments (which change frequently) have adopted adhoc polices in awarding water related projects to either individual players or projects undertaken as bilateral co-operation.

There should be a uniform predictable policy for bilateral co-operation and agreements should be made accordingly. The draft bill must also be revised to account for the augmented flow as the result of the construction of multipurpose project with high dam and power generation. Lower riparian nations pay for the benefits accruing from such augmented flows. The Budhi Gandaki reservoir project was initially conceived as a 600 MW projects and now it has been upgraded to a 1200 MW with higher dam and more reservoir capacity. During the dry season, the flow in the Narayani River will be augmented and as Nepal does not have the necessary irrigation facilities to utilize this augmented flow in the Chitwan area, this will benefit lower riparian country India by default.

c. Future bilateral co-operation: India is keen to develop the Kosi high dam in Barahachhetra as the present Kosi Barrage downstream will outlive its utility in the near future and is doggedly pursuing to seal an agreement with Nepal by showing that this project will have plenty of benefits for Nepal. This is not clearly in Nepal's interest as the high dam would not only cause immense environmental damage and uproot thousands of people from their habitat and submerge thousands of ropanis of fertile agriculture land but also pose a major survival threat to the people of downstream area should the dam breach owing to high floods or earthquakes. Like India which takes electricity trading as a strategic, economic and social commodity instead of as an economic good, Nepal should also take water resources as a strategic commodity. Should Nepal be obliged to construct the Barahchhetra Projects on some compulsion, it should do so only after India agrees to settle the border disputes, flooding caused by the construction of dams and others structures near the border and other irritants that beset our relationship.

d. Develop Electricity Market: It would not be prudent to rely only on India for the market for the surplus electricity (not consumed domestically) generated in Nepal. Primarily Nepal needs to expand its own market by:

- Promoting more manufacturing and service industries that consume power
- Increase electricity use for irrigation and farm production.
- Increase domestic consumption by promoting the use of electricity for cooking and heating.
- Promote the use of electric vehicle (EV) by lowering Tax on imports, encouraging manufacturing of EV's domestically and constructing large network of charging stations throughout the country.
- Diversify export market to Bangladesh and China. A beginning has already been made as India has allowed the use of its transmission network to export 40 MW of power. Nepal must work in unison with Bangladesh to vastly increase this quantity in tune within BBIN co-operation framework.
- Nepal must have transmission line to Tibet across several points along the border.
- The private sector must also be allowed to export surplus electricity.

e. Strengthening Institutional Capacity: The Water and Energy Commission Secretariat (WECS) which was established and founded with the assistance of the government of Canada has made valuable studies on Nepal's hydropower potential and its optimum utilization. However over the years and with the gradual withdrawal of Canadian assistance, its activities have shrunk and its role diminished. There is a need to shore up its capacity and maintain it as a vibrant and valuable entity to conduct studies and outline policies to optimize the use of water resources.

The NEA has been playing an important role in the development of hydropower. Over the years, it has greatly expanded its activities and grown to be a mammoth organization as it handles all the three functions of generation, transmission and distribution.

Although serious debates and some halfhearted decisions have been made on unbundling the NEA into 3 independent companies, it still remains an integrated unit under one Board and Managing Director as its Chief Executive Officer. An unwieldy structure of this nature can lead to compromises on efficiency and effectiveness owing to a lack of initiative and enthusiasm throughout the organizational hierarchy. Under these circumstances, it is necessary to unbundle NEA into different separate independent entities. This course of action has been outlined in the draft Electricity Bill. The actual modality of NEA restructuring should be completed after a careful study of success story from different

countries in the Regions an around the world.

The Bureaucracy which needs to be independent and stable has been a casualty of the frequent changes in Government leadership. Leadership in the bureaucracy suffers from frequent transfer of Secretaries in the ministries and Director General in the Departments. Ministers insist on having their own ways rather than adhere to rules and system in their decision making. This has demoralized the bureaucracy whose leaders have lost the motivation to put forth their own considered and independent opinion. This bulldozing attitudes of political leader must be abandoned and the Secretaries and Director General should be encouraged to make their own judgment and take initiatives in decision making and program implementation.

In our negotiations with India on water resources co-operation, our level of preparedness at the technical and economic level falls behind that of India and we should put more effort to shore up our preparedness. Equally important is that the political leadership (Which is not entirely guided by national interest) often over rides the suggestions made by our technical teams and make decisions on an adhoc basis often compromising national interest, should be more thoughtful and futuristic.

Future Negotiation with India: Nepal should use its Water Resources as a vital strategic commodity and a barging tool while negotiating with India on water resources development. Should Nepal be obliged in Co-operating with India in building the Kosi high dam or another such high dam multipurpose project, we should only agree if the following conditions are satisfied:

a. India agrees to resolve the border disputes in the Kalapani-Lipulek-Limpiyadhura area and the Susta area through negotiation in good faith.

b. India agrees to accept the report prepaid by the Eminent Persons Group (EPG) comprising of members from both the countries and discuss on it with a view to revise the 1950 Peace and Friendship Treaty to make it mutually beneficial and the issue of border regulation to boost security across the border.

c. Annually the people of the Tarai Region along the border suffer from floods caused by India's construction of the roads touching the no man land zone, the dams and other such structures close to Nepali border on rivers flowing south from Nepal. This problem should be resolved and further such construction along or close to the border should be done only after due consultation between the two sides.

   On improving the Nepal India ties of friendship and goodwill, Ranjit Rae, former ambassador of India to Nepal in his book "Kathmandu Dilemma, Resetting India Nepal Ties" observes "mutual security is best ensured by happy and prosperous people living in harmony on both sides of the border. We should begin to coordinate our border development projects with Nepal in such a way that facilities of one side should also cater to the requirements of people on the other side.

d. There has been serious lapses in the design, construction and implementation in the Kosi and Gandak projects leading to heavy loses to both the government of Nepal and people of the area. Should the Kosi high dam or any other multipurpose project be built in the future, these lapses should not be repeated. Furthermore, the project design, construction and implementation should be jointly handled even if India were to bear the entire cost of the project.

Ranjit Rae in the same book further observes: "We should give up shibboleths of the past with an unhealthy and an eventually self-defeating focus on just the bilateral approach. In addition to bilateral projects, we have to strengthen trilateral co-operation and quadrilateral projects. We need a coordinated approach for the integrated development basins of the transnational rivers such as the Ganges and the Brahmaputra, with the participation of all stakeholders. Involving Bangladesh in the Kosi high dam project in Nepal will make it more politically acceptable for Nepal. The sale of Nepalese power to a Bangladeshi or Myanmar off taker will benefit the entire region. India should view such possibilities more strategically."

In brief, India must be more open and accommodative in its polices and attitudes in dealing with its neighbors on development of natural resources to mutual benefits. These days, Indian views, attitudes and dealing with Nepal have been shaped more by the Indian Bureaucracy and its 'modus operandi' of micromanagement and strategic maneouvres, rather than by political and diplomatic engagement that could win the hearts and minds of the people leading to increased cooperation towards peace and prosperity. Our leaders must themselves make more effort to establish better contacts with high level politicians and policy makers both at the Center and the States of Bengal, Bihar, and Uttar Pradesh. A building up of more goodwill and cultural contacts at the people to people level would also go a long way to foster and cement our "Roti-Beti" relationship.

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Dwarika Nath Dhungel rightly calls a 'Chakra Bihyu Ma Nepal ko Jalasrot'.

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KATHMANDU UNIVERSITY

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Thematic Areas

Sediment Erosion in Hydro Turbine

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Targets

- *Better Qualified Workforce*
- *Bridge Industry & Academia*
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Karnali Chisapani Dam Site indicated by Red line

Reflecting on

'Revival' of 10,800 MW Karnali Chisapani Project – *'Nepal's precious Kohinoor'*[1]

Lest We Forget Karnali Chisapani's Past 60 Year Old History!

SB Pun

A. **Foreword:** When the democratically elected Prime Minister GP Koirala returned triumphantly from his first State Visit to India in December 1991, he was quite unaware[2] of the heavy Tanakpur MOU luggage he was carrying that was to cause much furor in the country. The furor was entirely over the **'availability'** of 11.9 ha of Nepalese land[3] to India for the protection of the Tanakpur Barrage. But Prime Minister Koirala's MOU luggage also contained the following Indo-Nepal agreements reached[4] on water resources projects:

*There actually was a **gang up of sorts on the part of Nepal and Bangladesh on the question of Ganga waters and the construction of reservoirs in Nepal** to ensure greater flows into Bangladesh and both countries were quite unjustifiably accusing India of an obstructionist attitude.*

1 With the Himalayan Power Consultants reporting: *'There are very few other sites in the world at which a river of this size can be so readily dammed and raised'*, the Karnali Chisapani Project is truly the **'Kohinoor of Nepal.'** The 105.6 carat diamond, **Kohinoor**, presently graces the crown of British monarch Charles III. After the annexation of Punjab by East India Company in 1849, the Kohinoor is supposed to have been gifted to Queen Victoria by the 11 year old Sikh Maharaja Dillip Singh. Without any serious homework and quid pro quo, the Nepal Government is in intense hurry to gift Nepal's precious Kohinoor to a groom who had earlier adamantly refused that gift!

2 Unaware because both his Water Resources Minister Basudev Risal and Water Resources Secretary Gaurinath Rimal were found unnecessary to be included in Prime Minister GP Koirala's jumbo delegation to India. Immediately after his return from India visit, Prime Minister Koirala reshuffled his Cabinet wherein Basudev Risal was replaced by Laxman Ghimire as the Water Resources State Minister.

3 2.9 ha un-submerged and 9 ha submerged lands at Jimuwa village in Mahendranagar This **'availability'** of 11.9 ha of Nepalese land to India was later, when the Supreme Court termed the MOU a Treaty, changed to **'leased'** in the final Mahakali Treaty. Interestingly India took the advantage of Prime Minister GP Koirala's December 5-10, 1991 State visit, to put in a sentence in the MOU: '*The **availability of land for construction of bund** will be effected in such a way by HMG/N that the **work could start by 15th of December 1991.***' India was in desperate hurry to protect the Tanakpur Barrage from being bypassed by Mahakali River before the onslaught of the 1992 monsoon fury – much like what the Kosi River did later to Kosi Barrage in August 2008!

4 Nepal Gazette Vol. 41 No. 36, His Majesty's Government, Ministry of Water Resources, Kath-

1. ***Karnali (Chisapani)*** *Multipurpose Project* **2. *Pancheswar*** *Multipurpose Project* 3. *Kosi (Bhimnagar Barrage) Project* **4. *Sapta Kosi High Dam*** *Multipurpose Project* **5. *Burhi Gandaki*** *Project*[5] **6. *Kamala and Bagmati*** *Scheme.*

Strangely no furors were raised over the agreements Prime Minister Koirala reached with India over massive **Multipurpose projects** on all the four major Nepalese rivers (*Karnali, Mahakali, SaptaKosi and Gandak*) including the **Schemes** on two medium rivers (*Kamala and Bagmati*). India, through these agreements, clearly disclosed her strategic priorities in Nepal's water resources development – **Stored Water in the guise of Hydropower**. Fifteen years later in 2006, India's Union Energy Minister Shushil Kumar Sindhe further gave indication[6] of those priorities: '***5 projects on Nepal-India talks table***'. Minister Sindhe informed his Lok Sabha '*The government of India is holding talks with the officials of Nepal at different levels for the construction of the* ***Karnali*** *multipurpose project,* ***Pancheshwar*** *multipurpose project,* ***Sapta Kosi*** *High Dam,* ***SunKosi reservoir and diversion*** *scheme and* ***Budhi Gandaki hydel*** *project. The detailed project reports will first be prepared.*' By 2006, the same 1991 Karnali, Pancheshwar, SaptaKosi and Buddhi Gandaki projects remained whereas the Kamala and Bagmati Schemes were firmed up further as the SunKosi Reservoir and Diversion Scheme.

Fast forward from Minister Sindhe's 2006 to Prime Minister PK Dahal 'Prachanda's 2023: **Pancheshwar** multipurpose project, though its DPR is still ***'held in abeyance[7]'*** for the last 27 years, has been digested by the *'signed, sealed and done* 1996 Mahakali Treaty[8]; Nepal is moving *'full steam ahead'* through her own resources[9] on the 1,200 MW **Budhi Gandaki** hydropower project, the **SunKosi reservoir and diversion scheme** has already been subsumed by the 3,300 MW **SaptaKosi High Dam Multipurpose Project and SunKosi Storage-cum-Diversion**[10] **Scheme** and now Prime Minister Puspa Kamal Dahal 'Prachanda' of the coalition government of Nepal Congress, CPN-Maoists and CPN-Socialist boldly declared on August 19, 2023 at the 38th Anniversary of Nepal Electricity Authority '*I am* ***happy to reveal*** *that the government is moving ahead with* ***vision and plans to develop*** *mega projects like the* ***1,200MW Budhi Gandaki*** *storage project and the* ***10,800MW Karnali Chisapani*** *multipurpose project with the participation of the NEA.*'

Minister for Communication and Information Technology Rekha Sharma, the government spokesperson, confirmed to the journalists on November 9, 2023 that the Cabinet has decided to conduct a fresh study of the project involving the state-owned power utility. Energy Secretary Dinesh Ghimire told Kathmandu Post that there had been discussions at the ministry to conduct a new study to update the feasibility study prepared in 1989. Secretary Ghimire added '*As the Department of Electricity Development* ***does not have enough human resource****, there have been talks about* ***assigning the task to the NEA***'. He, however, clarified that no decision has been taken to award the project to NEA. '*After the study is conducted, the NEA can itself carry out the task of project development or any other modality can be explored,*' added Secretary Ghimire. Kul Man Ghising, NEA Managing Director, also said '*We will prepare a detailed project report after assessing its social and environmental impacts. Our focus is to ensure that the* ***project is feasible and ready so that we can get investment to develop it.*** *Our plan is to complete the DPR along with environmental and social impact studies in two to three years. These studies are expected to cost over Rs2 billion.*' As it will be the largest hydropower project in South Asia, MD Ghising further added *'It should be* ***developed as a regional [South Asian] project****. South Asian countries like India and Bangladesh will be major markets for the electricity it generates.*' This *'regional South Asian project'* comment is interesting as the Indian billionaire Gautam Adani's

mandu, December 29, 1991.

5 Note Budhi Gandaki at that time in 1991 was simply a 600 MW hydel project.

6 Himalayan News Service August 12, 2006;

7 Ranjit Rae, India's ex-ambassador to Nepal, conveniently used this terminology in his book **Kathmandu Dilemma** on the 10,800 MW Karnali Chisapani Multipurpose Project. *Abeyance* according to the Oxford Advanced Learner's Dictionary is *'not being used or* ***being stopped for a period of time.***' With the global COP 26/27/28 meetings about fossil fuel phase-out/phase-down, all indications are that the *'held in abeyance'* Pancheshwar and Karnali Chisapani Projects would likely have the *'Open Sesame'* called out!

8 *'Signed, sealed and done'* because in the 1996 Mahakali Treaty, India successfully enshrined the clauses on equal entitlement '***subject to the protection of existing uses***' and '***precludes the claim, in any form, the unutilized portion of the Mahakali waters***'. While Nepal, keen to sell Pancheshwar electricity at the **premium peak load time rate,** designed the power plant at 6,480 MW, India, on the other hand, required **Stored Water** and actually wanted the power plant at 2,000 MW. During the 27 years interval, India has successfully slashed down the 6,480 MW capacity to 5,040 MW.

9 Annapurna Express January 6, 2023 reported that Nepal in May 2015 introduced the tax of Rs 5 per liter on petroleum products to develop Budhi Gandaki Project and this tax in 2018 was increased to Rs 10 per liter. An estimated 58,000 ropanis of lands in Gorkha and Dhading need to be acquired. Massive sums of money have already been spent by the government to compensate the residents of the project affected areas for land acquisition. According to the project's Environment, Compensation Distribution, Resettlement, and Rehabilitation Unit, it has already spent almost Rs 41 billion toward that end. The estimated total cost of the project, as per the latest revised details, is Rs 380 billion, with Rs 73 billion allocated for compensation, restoration, and rehabilitation.

10 In March 1985, the JICA-funded Master Plan Study on the Kosi River Water Resources Development Report recommended two top priority projects for immediate implementation: on irrigation – the SunKosi Multipurpose Scheme (SunKosi/ Kurule-Kamala Diversion Project) that generates 93.4 MW of power and irrigates 175,100 ha in Dhanusa and Siraha; on electricity – 240 MW Arun 3. While the top priority irrigation project was skillfully subsumed in 1996 as the SunKosi Storage-cum-Diversion Scheme as complementary to SaptaKosi High Dam, the 402 MW Arun 3, awarded in 2008 to India's Satluj Jal Vidhyut Nigam, raised its head as the 900 MW Arun 3 in 2014!

officials had visited Nepal. This is discussed in the later part of this article.

With Prime Minister PK Dahal 'Prachanda' saying[11] '*When I became the Prime Minister for the first time, I had envisioned the development of mega projects, and among those, I had a dream of a hydropower project with more than 10,000 megawatts like Karnali Chisapani*' and senior government officials like the Secretary and Managing Director making the above statements, the Nepalese news media naturally went agog with: ***'Nepal gears up for 10,800 MW Karnali Chisapani project'*** *– Kpost November 11, 2023*; ***'Karnali Chisapani Back in the News'*** *– Annapurna Express August 28, 2023;* ***'Can Nepal harness its huge hydropower potential?'*** *Kpost November 26, 2023*. There were also a few sane articles advising[12] the government and multilaterals to stay out of financing[13] large hydropower plants and instead focus on health, education and social infrastructures. CK Lal, a veteran political commentator, finds[14] the Nepal Government's pursuit of **Hydropower** and Remittance '***the perilous path to quick-fire prosperity***'! On Power Sector Development, Lal believes '***Beyond ensuring energy security for the country, further investment in hydro-electricity is best avoided*** *……. develop its institutional capacity to handle geo-economic rivalry that invariably comes into play ….. **Exporting electricity to Bangladesh is a goal worth pursuing.***' Many agree with Lal that the pursuit of hydropower *'beyond ensuring energy security for the country'* is indeed the perilous path to quick-fire prosperity! On Agriculture, Lal further added '*…. **a country that cannot feed itself** has to perforce **hawk its independence to keep itself afloat**.*' To hawk its independence afloat, Nepal, a country that once proudly exported her grains, had to request[15] India for '*1 million tons of Paddy, 100,000 tons of rice and 50,000 tons of sugar*' in August 2023 because India imposed the export ban. Recently in December 2023 India also banned export of onions. An unashamed official of Nepal's Ministry of Industry, Commerce and Supplies again extended the begging bowl to India saying[16] '*As per the request by onion traders, we have decided to request the Indian Government to send onions to Nepal. We will send the request soon. …..if it takes time to get the approval from the Indian Government, we have an option to import from third countries including China.*' In fiscal year 2021-22, Nepal imported[17] 1.4 million tons of rice—1.38 million tons of non-basmati and 19,000 tons of basmati rice—from India, the highest import on record. In terms of value, rice imports came to $473.43 million or just over Rs 60 billion. That same fiscal year, Nepal imported 180,000 tons of onions worth Rs 6.75 Billion. It is inconceivable why the Nepal government barks up the wrong hydropower tree and adamantly refuses to support the agricultural sector with robust friendly policies to increase her agricultural production.

But Nepal is, undoubtedly, barking up the wrong tree with Prime Minister PK Dahal 'Prachanda' totally enthused[18] to create self-sufficient economy from power generation – putting all her eggs on hydropower instead of agriculture. Naturally such massive power generation from Pancheshwar, Budhi Gandaki, Karnali Chisapani etc. will need not only huge investments but a guaranteed market with an attractive and guaranteed tariff as well. Once that attractive tariff market is guaranteed investments will naturally flow in. But such massive generation projects will also avail Gratis valuable freshwater in perpetuity for irrigation – all stored by submerging vast tracts of scarce fertile lands and displacing hundreds of thousands of agriculture-dependent subsistence level Nepalese villagers! Unfortunately for Nepal's policy and decision makers, it is all about hydropower and Not Freshwater for India that has already become the most populous country in the world overtaking China in April 2023! For them, a huge market is desperately[19] awaiting just across the border in India. Many argue Sale of Electricity to India provides power for her huge developing industries and not only job opportunities for India's teeming millions but Gratis freshwater for her Green and White revolution! A visit by our policy and decision makers

11 Nepal Page August 18, 2023

12 Bishal Thapa, *Financing Large Hydro* – Kpost November 16, 2023;

13 Himalayan Times December7, 2023 (Mangsir 21, 2080) headlined **'WB and ADB join forces for sustainable development of Nepal's hydro sector'** specifically in the context of the proposed 1,061 MW Upper Arun and 635 MW DudhKosi Storage hydropower projects. The World Bank, having unilaterally walked out of the 402/201 MW Arun III in 1995 after nearly a decade of involvement, is now clubbing together with ADB after the COP 26/27/28 Dubai meeting's **'phase-out/phase-down of fossil fuels'** controversies. Whereas Upper Arun is a ROR project, DudhKosi is a storage project. It will indeed be interesting to see how these multilaterals tackle DudhKosi's downstream benefits along with the accompanying social and environmental issues.

14 Kathmandu Post, January 18, 2023 (Magh 4, 2079);

15 Kathmandu Post, August 11, 2023 – Krishana Prasai: '*Last week, we requested the Indian government through the foreign ministry to supply grains and sugar. We are yet to hear from the southern neighbour,*' said Ramchandra Tiwari, joint-secretary at the industry ministry.

16 Kathmandu Post, December 19, 2023; Nepal again hawked its independence by deciding to ask India for onions – *Hagne lai bhanda Dekhne lai Laj – a befitting Nepalese proverb!* According to the Department of Customs, Nepal imported 180,190 tons of onions worth Rs 6.75 Billion from India in fiscal year 2021/022.

17 Kathmandu Post, August 11, 2023 – Krishana Prasai: Nepal sends tomatoes to India and asks for Rice. India, till the 1960s, also hawked her independence by depending on US PL-480 cheap grain imports. Then when her heavy investments on Irrigation networks started to produce results, it flowered into India's Green and White Revolution – White meaning Milk (Amul) production when the fields became Green with crops!

18 Kathmandu Post August 22, 2023

19 No doubt a huge market but guided by the ***'Guidelines for Import/Export (Cross Border) of Electricity – 2018'*** and the accompanying ***'2021 Procedure for Approval and Facilitating Import/Export (Cross Border) of Electricity'***;

to the Paraguay-Brazil's 14,000[20] MW Itaipu Hydroelectric Project may, perhaps, be worthwhile to find out about '*fair market price, access to third party and parity in project management*.' Though Paraguay with a population of only 6.8 million has been selling 6,000 MW of power for over thirty years to Brazil with a population of 203 million, Paraguay's per capita GDP is 6,153 US$ while that of Brazil is far more at 9,455 US$!

B. **Karnali Chisapani's Sixty Year Old Story:** Winston Churchill is supposed to have once said '*A country that forgets its history has no future.*' In a similar tone, one can also add '*A country that forgets its past water resources history will have her water resources doomed*!' An attempt is, therefore, made in this article to chronicle the sixty year old history of the Karnali Chisapani Project.

i) 1960 – Origin of Karnali Chisapani Hydro-electric Project:

Unhappy with the inequities of the 1954 Kosi and 1959 Gandak projects with India, King Mahendra during his 1960 USA visit requested President Eisenhower for multilateral assistance in the development of the Karnali River. President Eisenhower's '*favourable actions*' resulted in the US$ 1 million grant from the United Nations Special Fund to conduct a survey of the Karnali River.

ii) 1966 – Birth of 1,800 MW Karnali Chisapani Hydroelectric Project:

To conduct that survey, UNDP in December 1962 awarded the contract to Nippon Koei of Japan. Nippon Koei, in 1966, presented its Karnali Hydro-electric Project report: an 1,800 MW Hydroelectric Project with six 300 MW units, a 207 meter high arched concrete dam at Chisapani, to produce an average annual energy of 10,700 GWh with three 400 kV transmission lines to evacuate power to Kanpur at an estimated total cost of US$ 391 million. The report did not study the irrigation and flood control benefits as these were not included in Nippon Koei's terms of reference. Nippon Koei assumed that if mobilization for construction of the Karnali project started in 1966 then the two units of the first stage could be commissioned in ten years by 1976.

iii) 1969 – Frosting of Indo-Nepal Relations:

Funded by UNDP, Nippon Koei's 1966 feasibility study was reviewed by Australia's Snowy Mountains Hydroelectric Authority in 1968. Instead of the arched concrete dam, Snowy Mountain recommended a gravel fill embankment dam and moved the dam site just downstream of the site proposed by Nippon Koei. All other parameters remained the same. In 1969 King Mahendra terminated the services of India's 17 military *'listening posts'* on the Nepal-Tibet border *'loaned*[21] *to Nepal'* along with the Indian Military Mission based in Kathmandu. India then resorted to her strategic tool, the Trade and Transit Embargo, and Indo-Nepal relations frosted.

iv) 1977 – Air of Optimism in Indo-Nepal Relations Revived:

With the visit of Prime Minister Morarji Desai to Nepal in December 1977, an air of optimism in Indo-Nepal relations developed with the following joint communiqué[22] regarding Karnali and Pancheshwar Projects:

a. Karnali Project: *India affirmed its desire to purchase the surplus power from the project. As a first step, it has already been agreed to* ***establish a committee*** *to examine the preliminary issues with regard to the execution of the project. India has already nominated her representatives for this committee. It was now decided that the terms of reference would be settled and the Committee will meet within a period of three months and submit its recommendations within one year.*

b. Pancheshwar Hydro-Electric project: *Both sides decided to nominate their representatives within a period of three months to start the joint investigations relating to the Pancheshwar Hydro-Electric Project, to be located on the borders of India and Nepal, on river Mahakali (Sarda). It was also agreed that both the countries will give all facilities and assistance for the early completion of the investigations.*

Though the Pancheshwar Hydro-Electric Project, not multipurpose project, raised its head for the very first time, an agreement ***'to establish a committee to examine the***

20 The first 700 MW Unit of Itaipu Hydroelectric Project was commissioned in 1984 and the last 18th Unit in 1991, making it at 12,600 MW the world's largest hydroelectric project. Though in 2007, two Units of 700 MW were added to make the installed capacity 14,000 MW, in 2012 China's 22,500 MW Three Gorges Project superseded it.

21 Regarding the word **'loan'**, the following is the statement of Surendra Pal Singh, Deputy Minister of Ministry of External Affairs, to the Lok Sabha on February 25, 1070: '*Under the agreement arrived at between the Governments of India and Nepal,* ***Indian personnel whose services had been loaned to Nepal for manning wireless communications in the check-posts on the Sino-Nepalese border*** *are being replaced ….*' Bhasin AS. Nepal's Relations with India and China. Documents 1947-1992. 1994. SIBA EXIM Pvt Ltd. Delhi

22 Joint communiqué after Prime Minister Morarji Desai's visit to Nepal in December 1977 - Bhasin, AS.

preliminary issues with regard to the execution of the (Karnali) project' resulted. This resulted in the creation of two Joint Indo-Nepal committees for the development of the Karnali Project: **Committee on Karnali (CK)** at Secretary level for policy issues and a technical team **Karnali Coordinating Committee (KCC)** to resolve technical matters.

That same year in 1977, in view of the warming Indo-Nepal relationship, UNDP contracted Norconsult/Electrowatt (*Norway/Switzerland*) to conduct the second feasibility study of the Karnali Chisapani Project. This study recommended a 210 meter high embankment dam at the same site identified by Snowy Mountain in 1968 but raised the installed capacity to 3,600 MW, 12 numbers of 300 MW Units, for generating 15,072 GWh of average annual energy of which 8,505 GWh is firm energy and 6,567 GWh secondary energy. The consultants planned to have the first four Units operational by 1991/92 and the rest of the eight Units within two years. The total project cost was estimated at US$ 1,489 million (dam/power plant US$ 1,313 million and switchyard/transmission US$ 176 million). Due to increased flows, the Karnali Chisapani Project will also provide considerable benefits to irrigated agriculture in the downstream areas. The consultants noted meaningful financial rates of return could only be derived from reliable data which has not been done on the Indian side. The consultants have also noted an ***'important prerequisite for irrigation developments is an agreement between Nepal and India on Water Rights'***! With the 1996 Mahakali Treaty's clause '*without prejudice to their Existing Consumptive Uses ….*', this Water Rights issue on Karnali Chisapani Project's '**live storage of 16.2 billion cubic meters**' will be India's top agenda!

v) 1978 – USA President Jimmy Carter and British Prime Minister James Callaghan Visit India:

The air of optimism to implement the 3,600 MW Karnali Chisapani Project developed further when USA President Jimmy Carter during his visit to India in his speech to the Indian Parliament on 2nd January 1978 said:

*'One of the most promising areas for international cooperation is in the regions of eastern India and Bangladesh, where alternating periods of drought and flood cut cruelly into food production. Several hundred million people live in this area. **They happen to be citizens of India, Bangladesh and Nepal.** But they are also citizens of the global community. And the global community has a stake in insuring that their needs are met.*

*Great progress has already been made in resolving water questions, and **we are prepared to give our support when the regional states request a study that will define how the international community, in cooperation with the nations of south Asia,** can help the peoples of this region use water from the rivers and the mountains to achieve the productivity that is inherent in the land and its people.*

British Prime Minister James Callaghan also visited India and in a press conference in New Delhi on 9th January 1978 he offered his country's assistance in the development of the common rivers and expressed his hope that **India, Bangladesh and Nepal would cooperate in the matter.**

vi) 1978 – Committee on Karnali (CK) Constituted:

In such a positive environment, the First Meeting of the Secretary level Committee on Karnali (CK) was held on 4th April 1978 at Kathmandu. Nepal was led[23] by KD Adhikary, *Secretary/Ministry of Water and Power (MOW&P)* and India led[24] by YK Murthy, *Chairman/Central Water Commission.* Secretary Adhikary underlined the importance and urgency of the tasks before the Committee as stipulated in the Joint Communique of 11th December 1977 arising out of the visit to Nepal of Prime Morarji Desai. Secretary Murthy agreed with Adhikary on the need for the Committee evolving a concrete time bound action program on this major Project of benefit to both countries and noted that some more studies and pre-construction investigations would have to be completed for firming up the costs, technical and other features of the project to finalize the project document. To supplement Nepal's **man-power resources for the Karnali Project**, the Committee also considered the need for ***'providing to Nepal by Government of India about 50 scholarships every year for the study of engineering in the educational institutes for a period of 5 years.'***

vii) 1981 – Karnali Chisapani's Strategic Importance Discussed at Indian Lok Sabha:

With the 1980 election in India, the Indian Congress was back in power with Mrs. Indira Gandhi as Prime Minister. Her Minister of Energy, ABA Ghani Khan Chaudhary, reported[25] to the Lok

23 Other members of Nepalese team: Devendra Raj Panday/MOF, KP Koirala/MOFA, SK Malla/Electricity Department, Ajit N Thapa/Industrial Services Centre, MS Rana/CEDA, NK Agrawal/Irrigation Hydrology & Meteorology, AP Pradhan/MOW&P, SN Bastola/Electricity Department and Dr. HM Shrestha/MOW&P;

24 Other members of Indian team: R Gopalaswamy/Department of Power Ministry, RK Kaul/Finance Ministry, CV Ranganathan/Ministry of External Affairs, SK Arora/Indian Embassy, SS Varma/Indian Cooperation Mission and AN Chandrasekharan/Indian Cooperation Mission. Three members of the Indian team were based at Kathmandu.

25 Bhasin, AS. 1994. Nepal's Relations with India and China, Documents 1947-1992.Siba Exim Pvt. Ltd. Delhi.

Sabha in March 1981 *'It has been agreed with His Majesty's Government of Nepal that a* ***comprehensive study of the Karnali Hydro-Electric Project*** *will be undertaken and steps taken to prepare a detailed project report…..The extent of* ***benefits likely to accrue from the project*** *relate mainly to* ***(1) power supply (2) irrigation benefits and (3) flood control benefits.*** *The details of benefits will be available only after the detailed project report is finalized.'* MP Madharao Scindia of Indian Congress at the same session added[26] *'The Karnali Hydro-Electric Project is capable of* ***producing 4,500 MW power which is equal to almost one sixth of India's total power generation today.*** *Therefore, it is a* ***very important project for India.'*** This *'****one sixth of India's total power****'* **from tiny land-locked Nepal** must have raised *'****strategic, national and economic****'* alarm bells both at Lok Sabha and New Delhi's South Block.

At the 3rd Committee on Karnali meeting in January 1981, Nepal informed that the *'****first batch of 50 trainees had already joined the Roorki University and commenced training.'*** This was made possible through the kind courtesy of UNDP that had also financed the consultancy services of the two feasibility studies and the review of the Karnali Chisapani Project. UNDP agreed to finance the studies of 250 engineers[27] at India's Roorki University for the Karnali Chisapani Project.

viii) 1984 – India Demands '*Parallel Actions on both Karnali and Pancheshwar Projects*' arguing they are '*Complementary to each other*':

At the Secretary level meeting held from 21st to 24th February 1984 at Kathmandu, India's MG Padhye, Secretary Ministry of Irrigation, *'…. emphasized the need to make progress on the three major projects – viz.* ***Karnali, Pancheshwar and West Rapti****……. stressed on the need to* ***make forward movement on both Karnali and Pancheshwar Projects.***' India had been eying West Rapti for a very long time. But India, for the very first time, raised the necessity of moving both Karnali and Pancheshwar together. Nepal's Madhusudan Dhakal, Secretary Ministry of Water Resources, informed that '*negotiations with the* ***World Bank had already taken place and they have agreed to provide more than US$ 10 million to conduct the Phase I study [of Karnali Chisapani]*****……***'* Secretary Padhye, stating no major hurdles were expected, *'****re-emphasized that Pancheswar Project should also make a headway simultaneously.****'* India's Power Secretary S Venkitaramanan further stressed that *'****parallel action should be taken on both Karnali as well as Pancheswar Projects as both the projects were complementary to each other.'*** Secretary MS Dhakal replied that *'Nepal also was anxious to* ***make progress on the Pancheswar Project.*** *But* ***since Karnali was at a more advanced stage both sides should agree to make efforts to expedite the study.'*** Thus, by insisting *'****parallel action should be taken on both Karnali as well as Pancheswar Projects****'*, India in 1984 clearly indicated **her intention to veer away from the very-much-inside Nepal Karnali Project towards the on-the-border Pancheshwar Project.**

ix) 1984 – India Insists '*Exclude any reference to Navigation in the TOR of Consultants*':

At the 4th Committee on Karnali meeting of February 1984, India wanted **'navigation'** to be removed from the Consultants' Terms of Reference (TOR). To Nepal's request to withdraw that reservation, India emphatically responded '*that it was* ***not in a position to agree to any study on navigation in its territory being carried out by the consultant on Karnali Project.*** *They were not aware of any noteworthy traditional navigation uses for commercial purposes of Karnali river in India. More importantly, however,* ***the issue of navigational facilities across Indian territory was altogether separate & not directly relevant to the Karnali Project.*** *Therefore it* ***could not be dealt with in the Karnali Committee.*** *However,* ***if Nepal desires, it can undertake the study within its own territory.***' Thus Nepal's desire to study navigation[28] on the Karnali River ended.

At that same 4th Committee on Karnali meeting, India began to question the very viability of the Karnali Chisapani Project unless *'the successful* ***conclusion of agreements on tariff and bulk purchase of power by India'*** and *'the* ***arrangements for the management of construction and operation of the project'*** were mutually agreed on. Undoubtedly, Indian concerns were on **agreements on tariff and bulk purchase of power**. But India's far more strategic concerns were on the **'management of construction and operation of the 10,800 MW Karnali Chisapani Multipurpose Project'**. Unlike the Pancheshwar Project, the Karnali Chisapani Project is well inside Nepal, about 40 km upstream from the Indo-Nepal border and hence her sensitivity.

x) May 1986 – Feasibility Study of Karnali

26 Bhasin, AS. 1994. Nepal's Relations with India and China, Documents 1947-1992.Siba Exim Pvt. Ltd. Delhi.

27 Karna DhojAdhikary, former Secretary of Water Resources/Finance/Chief Secretary and Ambassador to India, told this writer that due to availability of funds, UNDP further financed the studies of 160 more engineers at Roorki University for Irrigation Department to implement irrigation works in Nepal arising out of the Karnali Chisapani Project.

28 Despite such vehement opposition on the Karnali River navigation study, India is now pressing for such navigational studies on Nepal's major rivers. Many believe this is to introduce large Storage Projects in Nepal so that the augmented flows will support, in the name of navigation, India's *'existing, committed and planned'* irrigation requirements during the critical dry season.

Chisapani Multipurpose Project awarded to Himalayan Power Consultants, India shy in supplying data to Consultants:

The Himalayan Power Consultants (*joint venture of Acres International Ltd. Canada, Ebasco Overseas Corp. USA, Shawinigan Engineering Co. Ltd. Canada and SNC Corporation Canada*) was awarded the contract in May 1986 to carry out the Feasibility Study of Karnali Chisapani Multipurpose Project. To be noted here is that from 1985 the Roorki-graduated engineers started to arrive[29] in Nepal in batches of 50 per year. Hence, Secretary MS Dhakal at the 7th Committee on Karnali meeting in October 1987 requested his Indian counterpart MM Kohli, Secretary/Power *'to **expedite the study** of the Karnali (Chisapani) Multipurpose Project, especially in view of the fact that the IDA credits for the purpose have to used by 30th June 1988, the target date for this study project completion …… it was **essential to provide the Consultant the data required in order complete the necessary economic analysis…**'* Secretary MM Kohli replied that *'the consultants should be made aware of the urgency of completing the detailed feasibility study in that time-frame…... that the data relevant to the study will be provided by the Indian side. However **requests for excessive data, some of which are not relevant would unnecessarily retard the progress of the project.**'*

The supply of *'relevant data'* by India to the Consultants and India's grouse of *'excessive data demands'* had been a major problem in slowing down the preparation of the feasibility study of the Karnali Chisapani Multipurpose Project. The Government of India is extremely shy in providing data and even Indian writers like **BG Verghese** complained[30] that India has become *'**needlessly paranoid** about classifying water resource data …… **merely sown suspicion and undermined credibility**…….Being by far the largest partner and placed centre-stage, India enjoys a commanding position and **should have little to fear**.'* **Suresh Prabhu**, a Lok Sabha MP, Union Cabinet Minister and who was the Chairman of the Task Force on Interlinking of Rivers further added[31] *'One of the main controversies was the government's **lack of willingness to share all of the information** with the people of India. I have yet to understand **the logic of holding everything so close to one's chest** that even the holder also can't see what he/she is holding. …… It was **my opinion that unless all the data was available for public scrutiny it would not inspire confidence** or encourage engagement.'*

xi) 1989 December – Detailed Feasibility Report of Karnali Chisapani Submitted:

In December 1989, the Himalayan Power Consultants submitted its Detailed Feasibility Study (DFS) of Karnali Chisapani Multipurpose Project in accordance with the terms of reference jointly prepared and agreed upon by Nepal and India. The Consultants noted the attractiveness of the Karnali Chisapani site: *'There are very **few other sites in the world at which a river of this size can be so readily dammed** and raised.'* Hence, while the 10,800 MW Karnali Chisapani is truly Nepal's **'precious Kohinoor'**, the 300/900 MW Upper Karnali, handed over to India's GMR, is Nepal's **'Jewel in the Crown'**. The DFS recommended a 270 meter high gravel fill embankment dam at the same site recommended by Nippon Koei in 1966 and having a **live storage of 16.2 billion cubic meters with the reservoir extending 100 km upstream**. The 10,800 MW power house located on the left bank would have 18 units each of 600 MW size generating an annual average energy of 20,842 GWh at ***'roughly half that of alternative generation sources'*** in India – displacing about 10 million tons of coal consumption annually. The re-regulating dam 8 km downstream would generate another 84 MW – six number of 14 MW units. Five 765 kV transmission lines from the power house would be connected to Indian grid. The DFS envisaged a five year pre-construction period from 1990 with the large scale construction beginning from January 1995 and the first two 600 MW units coming on line in November 2003. The remaining 16 units were tentatively planned to come on line at a rate of one every three months and terminating in November 2007. The 1988 capital cost of the project was estimated at US$ 4,890 million.

While the irrigation potential in Nepal was 191,000 hectares, India would have a gross irrigation potential of 3,200,000 hectares *(Sarda Sahayak 2,000,000 ha and Saryu 1,200,000 ha)*. **Karnali Chisapani reservoir will increase dependable dry season flows about four fold** resulting in annual crop production in excess of 18 million tons per year. The DFS further noted that Chisapani also ***'generates substantial social and environmental impacts'*** **with the need to resettle about 60,000 people**.

xii) 1990 – Change of Guard in Nepal:

29 When the Roorki-graduated engineers started to arrive in batches of 50 annually from 1985, Nepal could adjust only some of them at Nepal Electricity Authority and some at Irrigation Department. But the vast majority of them were made jobless when India refused to even concede that the completed feasibility report is also acceptable to her. It is believed that many of these jobless engineers went abroad to various countries thus making **utterly worthless** the goodwill assistance of UNDP to Nepal! Nepal needs to seriously chew why India, despite producing 410 engineers from their own premier Roorki University for the Karnali Chisapani Project, refused to move ahead with the project when President Carter, Prime Minister Callaghan and World Bank were all ready to finance it.

30 Verghese, BG. 1990. **Waters of Hope**. Centre for Policy Research, New Delhi. Oxford & IBH Publishing Co. New Delhi.

31 Prabhu, Suresh. 2008. **The Vital Links in Interlinking of Rivers in India: Issues and Concerns**. Edited by MMQ Mirza, AU Ahmed and QK Ahmad. CRP Press/Balkema, Taylor & Francis Group London.

Charging Nepal of importing arms and anti-aircraft guns[32] from China, India again resorted to her tool, the Trade and Transit Embargo, when the treaty expired in March 1989. After struggling for over a year with the international community all mute on the embargo, the 30 year old Monarchial Panchyat rule tumbled down with open Indian support[33] for multiparty democratic system. From 1990 to 2023, Nepal framed, instituted and claimed two of the best constitutions in the world, one a monarchial democracy and the other a Republican democracy. Thirty three years of rule under these two Constitutions resulted in chaos with twenty seven ***'Rajahs[34]'***, all making hay when the sun shone! An American ambassador, hence, commented in the media about Nepal's hydra-headed democracy filled with strange bedfellows!

The full set of the detailed feasibility report, costing more than **NC Rs 50 Crores**[35] **(about US $ 18 million)**, comprising of 24 volumes[36] were sent to India for final approval. India, however, had her reservations on all the project parameters recommended by the consultants:

i) ***Probable Maximum Flood*** *value to be reviewed as it was on much higher side;*

ii) ***Sedimentation rate*** *adopted in the study also high, almost three times the value adopted by India*

iii) *On* ***Seismicity,*** *India questioned the tectonic model used in the study*

iv) ***Dam height/reservoir capacity*** *should be fixed to meet the* ***existing and committed Indian irrigation demand*** *as well as taking into consideration the* ***probable upstream storage*** *reservoir sites on Karnali*

v) ***Initial Optimum Installed Capacity*** *to be in the range* ***5,400 MW to 7,200 Mw*** *with provision for ultimate installed capacity of 10,800 MW and*

xiii) ***Studies also of 500 MW generating unit size instead of 600 MW units.***

India remained eloquently silent on the 1989 feasibility report that firmly stated '***Karnali Chisapani will generate substantial social and environmental impacts* with the need to resettle about 60,000 people.'** Many believe this figure could have, now 35 years later, jumped easily to over **150,000 people.**

The detailed feasibility study of Karnali Chisapani assessed the **benefits** as: ***power 80.96%, irrigation 18.88% and others 0.16%.*** India, however, strongly contended **that irrigation and flood control benefits were *'negligible'*** and that only the **power benefit was *'considerable'*.** At the Secretarial level 8th Committee on Karnali meeting held in March 1991, BK Pradhan, Nepal's Water Resources Secretary requested his Indian counterpart S Rajgopal Power Secretary **to agree** that ***'the completed feasibility report is acceptable to both the sides.'*** But Secretary Rajgopal stressed instead on the need ***to resolve*** the above mentioned outstanding issues – confirming India's strategic long-term interest to hold Karnali Chisapani Multipurpose Project ***'in abeyance'!***

C. Final Words on *'Revival'* of 10,800 MW Karnali Chisapani Multipurpose Project *'held in abeyance'*:

The above is the sixty year history of the 1,800/3,600/10,800 MW Karnali Chisapani Multipurpose Project that is being *'held in abeyance.'* Prime Minister PK Dahal 'Prachanda' has now, with the wand of his magical stick, revived it jubilantly in August 2023. After the 24 volume feasibility report was submitted by the consultant to both the governments of Nepal and India in 1989, Nepal needs to judiciously chew and mull over some of the following comments before '***Gearing up for 10,800 MW Karnali Chisapani project***':

i) Karnali Chisapani through some of the **Indian Eyes:**

32 King Birendra: As I knew Him - Narendra Raj Panday; copyright Nalini Panday 2019 – '***India made a big mess of Nepal's import of arms from China. Nepal had asked India but it was not economical.***'

33 **King Birendra: As I knew Him - Narendra Raj Panday**; copyright Nalini Panday 2019 – '*Historians should not fail to record for the benefit of posterity* ***how Indian leaders were invited to the Chaksibari meeting of 2046 Magh*** *to slander Nepal's honoured institutions at a time* ***when the Nepalese were subjected to untold hardship due to India's economic blockade for more than a year*****…..** ' At Chaksibari, supporting the Nepali Congress, were very senior Indian leaders like Chandra Shekhar, Subramanian Swamy, Surjit Singh Barnala etc. etc.

34 Of the 27, one was King GB Shah and another Chief Justice KR Regmi. From April 1990 till December 2023: 1- **KP Bhattarai** 2- **GP Koirala** 3- **MM Adhikari** 4- **SB Deuba** 5- **LB Chand** 6- **SB Thapa** 7- **GP Koirala** 8- **KP Bhattarai** 9- **GP Koirala** 10- **SB Deuba** 11- **LB Chand** 12- **SB Thapa** 13- **SB Deuba** 14- **King GB Shah** (February 2005) 15- **GP Koirala** 16- **PK Dahal** 17- **MK Nepal** 18- **JN Khanal** 19- **Dr. BR Bhattarai** 20- **Chief Justice KR Regmi** (March 2013) 21- **S Koirala** 22- **KP Sharma Oli** 23- **PK Dahal** 24- **SB Deuba** 25- **KP Sharma Oli** 26- **SB Deuba** 27- **PK Dahal** (till December 2023). Source till 25th Rajahs: *Nepalka Mantri ra Sansadharu 2007-2075 BS* Bhairab Risal, Bharat Pokharel. Sikai Samahu Pvt. Ltd. Anamnagar, Kathmandu. The arrival of democratic dispensation in 1990 caused an Indian working in an Indian-aided project in Nepal to gleefully exulted ***'Nepal me bhi Democracy aye huwa hai! There would be chaos for another 15/20 years!'*** But unfortunately this chaos in Nepal has continued for over 33 years with the luckier Rajahs wearing the crown 4/5 times and the lesser lucky ones wearing the crown at least several times!

35 This was the figure stated by Harsha Man Shrestha, leader of Nepalese delegation (former Chief Engineer Electricity Department and Managing Director Nepal Electricity Authority), at the 8th Karnali Coordinating Committee meeting of March 4 to 6, 1991. The Indian delegation was led by Dr. HR Sharma. On the actual World Bank loan for the feasibility study, various figures like US$ 12 to 14 Million are floated around.

36 During the Mahakali Treaty Track Two Exercises funded by Nepal-India BP Koirala Foundation, a group of Nepalese, including the writer, visited the still under-construction Tehri dam in 2003. One of the middle ranking Indian engineers of Tehri Project, in conversation with the Nepalese, praised the quality of the Karnali Chisapani Feasibility Study. He said the Feasibility Study assisted him very much to obtain his Master's degree!

- **Jagat Mehta,** India's former Foreign Secretary, recorded[37]: '*India should categorically recognize that hydel projects in* ***Karnali and Pancheshwar should be facilitated at breakneck speed at whatever price – even if it means subsidies*** *and cooperation from acceptable non-Indian international involvement,* ***if Nepal so prefers.***' Secretary Mehta lamented: '***My greatest unfilled ambition was not to have been able to initiate discussions or at least come to grips on eventual power supply from Karnali*** *which even with antiquated technology promised greater surplus than the entire consumption of adjoining Uttar Pradesh.*'
- **BG Verghese**, the scholar journalist also recorded[38]: '*…… there was a* ***fear of being too dependent on Nepalese power in some Indian circles.*** *…. in the belief that [international consultants or even international interest would] favour the smaller country or foster sinister designs ….. P****resident Carter, Prime Minister James Callaghan, the World Bank et all were spurned*** *when they expressed willingness to support Himalayan water resources development.*'
- **Maharaja Krishna Rasgotra,** Foreign Secretary and also ex-Indian ambassador to Nepal, charged: *'There actually was a* ***gang up of sorts on the part of Nepal and Bangladesh on the question of Ganga waters and the construction of reservoirs in Nepal*** *to ensure greater flows into Bangladesh and both countries were quite unjustifiably accusing India of an obstructionist attitude.*'

  Mehta and Verghese genuinely believed that India as the larger nation must go more than halfway in its dealings with Nepal. But the hawks like MK Rasgotra at South Block, who ramble about *'ganging up of sorts against India,'* were far more powerful. These hawks indeed feared that the embargo tool, regularly indulged in on India-locked Nepal, may boomerang with '***too much dependence on Nepalese power.***' Cross-border electricity trade for these hawks meant '***issues of strategic, national and economic importance.***' The 2016 **'Guidelines on Cross Border Trade of Electricity'** was, hence, superseded by **'Guidelines for Import/ Export (Cross Border) of Electricity – 2018'** to be further dexterously qualified by the **'2021 Procedure for Approval and Facilitating Import/Export (Cross Border) of Electricity'** that categorically barred ***'third country with whom India shares land border and that third country does not have a bilateral agreement on power sector cooperation with India.'*** That is, India does not want the Chinese dragon working in its backyard in Nepal on hydropower and other infrastructure projects with much better technology at far cheaper prices!

ii) Karnali Chisapani through the **Norwegian Eyes:**

Odd Hoftun, a Norwegian, in an interview[39] made the following deep introspection of his over 40 years of work experience[40] in Nepal's hydropower:

- Nepal's vast water resource is ***both a Blessing and a Curse!***
- Indian market as ***Potential Source*** for Nepal's water resources development is ***tremendous***;
- ***That does not mean Nepal should Rush into Big Projects***;
- ***Big projects should and must be undertaken*** but that is ***Only Possible through Export to India;***
- ***For something like that to work, there has to be Fair Agreements and a very High Level of Trust between the two countries***!

Though India's South Block regularly contends that Indo-Nepal relationship ***'is deep, intense and wide-ranging, a relationship nonpareil'***[41], does that *'fair agreements and a very high level of trust between the two countries'* Odd Hufton calls, the prerequisite to big project development, ***exist*****?** The status of the few Indo-Nepal nonpareil relationship:

- **Eminent Persons Group on Nepal-India relations (EPG-NIR):** When Prime Minister Narendra Modi made the rapturous visit to Nepal in August 2014, he and Prime Minister Sushil Koirala agreed '*to review, adjust and update the Treaty of Peace and Friendship of 1950 and other bilateral agreements …… Foreign Secretaries of the two countries to meet and discuss specific proposal to revise the Treaty of Peace and Friendship of 1950 …. better reflect the current realities and aim to further consolidate and expand ….. .*' The two Prime Ministers, hence, *'welcomed the decision to establish an Eminent Persons Group on Nepal-India Relations (EPG-NIR) to look into the totality of Nepal-India relations ….. and suggest measures to further expand and consolidate the close and multifaceted relations ….*' Thus, Nepal and India established in January 2016 the **Eminent Person Group (EPG)** headed by Dr. Bhekh Bahadur Thapa for Nepal and Bhagat Singh Koshyari[42] for India to prepare the report. The comprehensive EPG Report was submitted in July 2018 but so far it has been

37 Jagat S. Mehta's article India and Nepal Relations in **India-Nepal Relations.** 2004. Observer Research Foundation. Rupa & Co. New Delhi

38 BG Verghese, **Waters of Hope**. 1990. Oxford & IBH Publishing Co. Ltd. New Delhi.

39 Nepali Times Issue 376 (30 November – 6 December 2007). At the age of 95 years, Nepal sadly lost the good friend and well-wisher Odd Hoftun. He passed away on March 14, 2023 in Norway. Kunda Dixit Nepali Times March 16, 2023;

40 United Missionaries in Nepal (*1 MW Butwal, 5.4 MW Andhi Khola, 12 MW Jhimruk and partly also in 60 MW Khimti*),

41 Rae, Ranjit (India's ambassador to Nepal September 2, 2013 – February 28, 2017). Kathmandu Dilemma. 2021. Penguin Random House India Pvt. Ltd. Haryana, India.

42 While other members of Nepalese team were: Nilamber Acharya, Suryanath Upadhyay and Rajan Bhattarai those of Indian team were: Jayant Prasad, Dr. Mahendra P Lama and Dr. BC Upreti.

collecting dust in some New Delhi's South Block cupboards. Prime Minister Narendra Modi, the signatory and brain behind the EPG birth, just could not find a slot in his precious schedule to accept the Report for the last five years.

- Take the other case of the **Gautam Buddha International Airport** that Nepal has built with a large loan assistance of Asian Development Bank to develop her tourism industry particularly for Buddhist pilgrims from as far away as Sri Lanka and East Asian countries. India, in an age of satellites and Google zooming down from above, citing security reasons because of the Indian Air Force base at Gorakhpur, has adamantly refused to give Nepal the air traffic route to Lumbini. During Prime Minister Modi's rapturous visit to Nepal in August 2014, the joint statement of the two Prime Ministers stated: '*The Nepalese side requested India to allow* ***three additional air entry points at Janakpur, Bhairahwa and Nepalgunj*** *and cross border direct routes …… between regional airports Pokhara-Bhairahawa-Lucknow as this would save time and cost for air travelers and also improve air connectivity between India and Nepal. The two Prime Ministers directed the concerned authorities to meet within 6 months and resolve this issue ……*' Despite the lapse of nine years, the Gautam Buddha International Airport languishes as India has yet to give the entry permit!
- There is then the classic case of the five months' **Trade and Transit Embargo India imposed in 2015** when Nepal was in the throes of over 8,600 deaths, around 24,000 injured and with about 800,000 houses along with valuable national monuments destroyed by the earthquake of 7.8 Richter scale. India, oblivious of this tragedy, argued that the embargo was caused not by them but by the Tarai Nepalese voicing anger against the promulgation of the 2015 Constitution. Actually, India had asked Nepal for the deferment but for reasons best known to our political parties the 2015 Constitution was promulgated. India, hence, watched the 2015 embargo sitting sedately on the fence.
- But India gave the **most painful *'Et tu Brute?'* stab in 2019** when she annexed Nepal's Limpiyadhura, Kalapani and Lipulekh as her territory! It is important here to bring up the recent history of Kalapani. During the ratification of the Mahakali Treaty in September 1996, the then CPN-UML General Secretary MK Nepal made the following[43] written request to Prime Minister SB Deuba:

  '*Demarcate and manage the entire Nepal-India border within a fixed stipulated time in a scientific manner.*' This was in particular reference to the Source of the Mahakali/Kali River.

  Prime Minister Deuba immediately gave the following[44] written reply:

  '***His Majesty's Government of Nepal and Government of India have already decided to send a Joint Survey Team in the coming winter to the Mahakali river origin region*** *and demarcate the border in a scientific manner based on the Sugauli treaty, maps and other documents.* ***No foreign military or police will be permitted within the Nepalese territory so demarcated.***' Note the Joint Survey Team in the coming winter (of 1996) to the Mahakali River Origin region!

  Then fast forward to Prime Minister Modi's rapturous August 2014 visit to Nepal, the Joint Statement of the two Prime Ministers of India and Nepal (Narendra Modi and Sushil Koirala) stated:

  '*The two Prime Ministers also underlined the need to resolve pending Nepal-India boundary issues once and for all. They welcomed the formation of the Boundary Working Group (BWG) to undertake the construction, restoration and repair of boundary pillars including clearance of 'Noman's land' and other technical tasks. They also welcomed the Joint Commission's decision to direct the* ***Foreign Secretaries to work on the outstanding boundary issues, including Kalapani and Susta*** *receiving required technical inputs from the BWG as necessary. The Indian side stressed on early signing of the agreed and initialed strip maps of about 98% of the boundary. The Nepalese side expressed its desire to resolve all outstanding boundary issues.*'

  Yet, despite that 1996 survey of the Joint Survey Team and despite directing the Foreign Secretaries in 2014 to work on outstanding boundary issues including Kalapani, India unilaterally went ahead and annexed Limpiyadhura/Kalapani/Lipulekh, the source of Mahakali/Kali/Sarada, in 2019. Next, Susta is awaiting its karma/fate!

  Despite Nepal's Limpiyadhura/Kalapani/Lipulekh remaining as Chuchche Maps hanging from Singha Durbar and Baluwater walls, the ***'relationship nonpareil'*** continues to exist between Nepal's Investment Board (IBN) and India. The Investment Board, established in 2012 by Prime Minister Dr. Baburam Bhattarai, has become a powerful political tool of the ruling government as it is chaired[45] by the Prime Minister. With the exception of Arun-3 and Upper Karnali, the Board has, since its 2012 inception, doled out on a mere MOU and not competitive basis, the following hydropower

43 MOWR/HMGN Publication in Nepali dated Kartik 29, 2053 (November 14, 1996) on Mahakali Treaty;
44 MOWR/HMGN Publication in Nepali dated Kartik 29, 2053 (November 14, 1996) on Mahakali Treaty;
45 The other members of the Board are: 1. Finance Minister 2. Energy, Water Resources and Irrigation Minister 3. Industry, Commerce and Supplies

projects to the Indian companies:

- 402/900 MW Arun-3,
- 490 MW Arun-4,
- 300/900 MW Upper Karnali,
- 750 MW West Seti Storage,
- 450 MW SR-6 Storage,
- 669 MW Lower Arun – cascading to 900 MW Arun-3
- 480 MW Phukot-Karnali

Grand Total of 4,639 MW

Chaired by the Prime Minister, the Investment Board, without any quid pro quo (*EPG, Lumbini airport, Limpiyadhura/Kalapani/Lipulekh, downstream benefits from storage projects*), is happily doling out blank cheques of all highly feasible water resources projects of Nepal. In fact, at the Board's 51st meeting on 6th June 2022 chaired by Prime Minister SB Deuba, he directed the Board to give greater stress to Storage Hydropower Projects without any downstream commitments from India!

iii) Karnali Chisapani through the American Eyes:

Paul Terell[46], an American, wrote an article for Himal in 1991 about the Karnali Chisapani Multipurpose Project. Having been an adviser to the Nepal government on the feasibility study being carried by the US-Canadian consultant on Karnali Chisapani Project, the following are his very genuine deep thoughts:

- *Nepal **can decide NOT to build** the Karnali Project,*
- *but **Nepal alone cannot decide TO BUILD** the Project. Not even the **World Bank**, which has been generous in loaning money to fund the feasibility study, can implement a decision to build the Project.*
- *Although it is the **undeniable owner** of the resource base, **Nepal cannot develop large projects without the co-operation and encouragement of the buyer of the products** and of the international financial community.*
- *Both buyer and financiers, in turn, will have to answer to **world opinion on environmental and ecological matters** as to the desirability of the project.*
- *Nepal will thus **only have a veto voice** in the final decision as to **whether the project should be built or not.***
- *Nepal should **beware of unintentional "giveaways" in hydro development,** and not rush to compromise the optimum development for the sake of a quick deal with the buyer. A less than optimum power dam on the Karnali River could preclude optimum development for all time.*
- ***The present institutions should be wary of giving away Nepali children's rightful inheritance.***

The American Terell believes that Nepal has only the Veto voice on: *to build or not to build Karnali Chisapani.* Terell genuinely advises Nepal to be **aware of unintentional giveaways – of giving away Nepali Children's rightful inheritance!** Later around 1998, Paul Terell's sentiment was also expressed by a Black American at a meeting in the hall of Water and Energy Commission in Singha Durbar. I do not remember his name but he was President Clinton's Assistant Under-Secretary of Energy who had come to Nepal for the first time. During his talk, he said '*I see that **Nepal has plenty of water resources.** When developing it, **do not compromise the Future of the future Nepalese generations to come**.*'

iv) Karnali Chisapani through the Eyes of the **Nepali**, **Ms Shailaja Acharya,** former Deputy Prime Minister and Water Resources Minister:

- Some media reported in 2022 that the **Indian billionaire Gautam Adani**[47] expressed interest in the development of the Karnali Chisapani and other projects in the Karnali Basin. Representatives of the **Adani Group** came to Nepal and met Pampha Bhusal, former Minister of Energy, Water Resources and Irrigation, as well as senior officials of her ministry. But Secretary Dinesh Ghimire expressed his ignorance, the media reported.
- Like the **Adani Group**, many will still remember that **Enron Renewable Energy Corp.**, USA's 7th largest multinational company, had also come to Nepal around September 1996s hunting for the Karnali Chisapani license. The then Prime Minister SB Deuba was all prepared[48] to dish out the license but fortunately the then Water Resources Minister Pashupati SJB Rana intervened for competitive bidding.
    - When GP Koirala became the Prime Minister in 1998, Enron made another attempt to get the Karnali Chisapani license. Shailaja Acharya, the then Deputy Prime Minister and Water Resources

Minister 4. Forest and Environment Minister 5. Vice-Chairman of NPC 6. Chief Secretary 7. Rastra Bank Governor and 8. Four experts from the Private Sectors.

46 Terell, a former employee of the American firm Overseas Bechtel Incorporated, had been hired as an adviser to His Majesty's Government when the Himalayan Power Consultant was preparing the feasibility report of the Karnali Chisapani Multipurpose Project.

47 Billionaire Gautam Adani, one of Asia's richest man and who is reportedly close to Prime Minister Modi's ruling BJP party, has recently been in the news. MP Mahua Moitra of Trinamool Congress Party has been accused of asking questions in the Parliament targeting the Adani Group in exchange for gifts and cash bribes. A parliamentary ethics committee has started hearing the case. A US firm, Hindenburg Research, accused the Adani Group '*of engaging in decades of "brazen" stock manipulation and accounting fraud.*' – BBC News, October 27, 2023 by Nikhila Henry and Cherylann Mollan.

48 When Enron declared bankcruptcy in 2001, ex-Prime Minister Sher Bahadur Deuba is reported to have told the media '*Enron le malai dhandai*

Minister, delivered the **fatal coup de grace to Enron.**

- Her Water Resources Ministry's letter of July 1998 to David Ramm, Enron's Managing Director, categorically stated as '*… the development of Karnali Project would* ***create substantial additional irrigation benefits to India*** *…… We are trying to* ***develop such an understanding with India*** *……. regarding the development of the 6,450 MW Pancheshwar Project …… you will understand* ***our sensitivity and concerns on this issue of d/s benefits accruing from this huge multipurpose project.*** *…….. Once such a precedence,* ***for sharing the d/s benefits, is established in Pancheshwar,*** *this concept could be replicated for the Karnali Project as well. ….. Once an* ***understanding is reached with India for fair and reasonable settlement of d/s benefit issue,*** *Karnali could be developed with significant mutual benefit for both Enron and Nepal …*'
- There were uproars in the Parliament among both the Nepali Congress and CPN-UML MPs venting their ire at the Deputy Prime Minister, Shailja Acharya, for having dashed their dreams of making Nepal rich quickly. In December 2001 Enron declared bankruptcy[49]. In 2004 Enron's President Kenneth Lay and Chief Executive Officer Jeffrey Skilling were indicted for fraud and insider trading and in 2006 found guilty. Kenneth Lay is dead and Jeffrey Skilling is serving a 24 year jail sentence.

  At meetings in Water Resources Ministry, DPM and Water Resources Minister Shailaja Acharya used to say, '*Mero ta bachcha bachchi chaina,* ***tapaiharu ko bachcha bachchi ko Bhabisya ko lagi*** *kehi na kehi garnu parchha!*' The same sentiments expressed by the two Americans, Paul Terell and the US Assistant Under-Secretary of Energy. Though Ms Shailaja Acharya is sadly no longer in this world, all the other principal political actors during those great ***'Mahabharat yuddhas'*** on Karnali Chisapani and Pancheshwar are alive and still un-sheath their khukuris once a while on various '*water resources yuddhas*'. While BG Verghese mentioned of the *'fears in some Indian circles*' and MK Rasgotra railed about *'some sort of ganging up*' between Nepal and Bangladesh against India, Jagat Mehta lamented about his unfilled ambition of '***not ….. at least come to grips on eventual power supply from Karnali.***' But the Norwegian Odd Hoftun categorically believed that **big projects in Nepal should be undertaken** only when ***'Fair Agreements and a very High Level of Trust exists between the two countries.***' The American Paul Terell went a step further warning Nepal '***of unintentional "giveaways" in hydro development - of giving away Nepali children's rightful inheritance.***' That '***right of Nepali children's inheritance***' DPM Shailaja Acharya attempted to protect by requesting Enron to have patience until the ongoing negotiations with India on Pancheshwar's **downstream benefits** are finalized. Unfortunately India, for the last 27 years, is negotiating not only about Nepal's downstream irrigation and flood control benefits but many A to Z issues to be enshrined in the Revised 1996 Mahakali Treaty. This Treaty Revision is most likely to occur soon. This is because the global Dubai's COP 28 conclave in December 2023 concluded after intense debates on ***'phase-out/phase-down of fossil fuels'*** with ***'fossil fuel transition'*** – the exact wordings of the final agreement being '***transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner'***! India, China and the Middle-east Oil/Gas producers were instrumental in watering down the phase-out to transitioning in an equitable manner. The global pressure is for Renewable energy and though Nepal's stored freshwater is very much on India's radar screen, hydropower is merely a byproduct guise!

With the Trade and Transit embargo tool still hanging like the Damocles sword, with the EPG Report and Lumbini Airport locked up in the cupboards and the Chuchche Maps hanging gracefully not on New Delhi's Parliament House but on the Singha Durbar/Baluwater walls, has that **very high level of trust**, the Norwegian Hoftun called the prerequisite for large hydropower project development, **exist between the two countries?** A white paper[50] probably prepared by Water and Energy Commission Secretariat recommended the then CPN-UML government of 1995: ***'Until the matter with Tanakpur is fully settled, both in the House of Representatives and with India, any further step towards entering into any treaty with India on overall use of waters of Mahakali basin will be Premature'.*** Not only the CPN-UML government, but also the coalition government

fasyayeko!'

49 When Enron's big 5-foot tilted E went for sale in September 2002 to pay off the debtors, Houston's Microcache Computer store bought it for US$ 44,000/-. Scott Bui, attorney for Microcache said '*The reason we bought this was to preserve this business icon. It also* ***signifies a lot of sweat, greed and fraud in business.***' With Lay and Skilling jailed and Enron bankrupt, the 4,500 employees at Enron not only lost their jobs but their savings for old age in Enron stocks. Enron has been a bye-word for corporate scandal and **its financial auditor, Arthur Anderson**, also sank with Enron.

50 Many believe this white paper was written by Dr. Hari Man Shrestha who was, at that time, with WECS.

(*Nepali Congress, RPP and Sadhbhavana parties*) of Prime Minister SB Deuba totally discarded that recommendation as 'rubbish' opting instead for ***'Sarada Barrage of Yesterday, Tanakpur Barrage of Today and Pancheshwar Dam of Tomorrow'***.

Regarding the Pancheshwar DPR, it may not be out of place to go through the following joint press statements of Nepal's three Prime Ministers but only one of India:

i) Narendra Modi and Sushil Koirala when Prime Minister Modi visited Nepal in August 2014:

'The two Prime Ministers witnessed the signing of the Exchange of Letters regarding Terms of Reference of the Pancheshwar Development Authority. They agreed that the two Governments would set up the Authority within 6 months and ***finalise the DPR of Pancheshwar Development Project and begin implementation of the Project within one year.'***

Sushil Koirala, suffering from cancer, passed away at the age of 76 on February 10, 2016.

ii) Narendra Modi and 4th time Prime Minister Sher Bahadur Deuba in August 2017:

Under Prime Minister Modi's invitation, 4th time Prime Minister Sher Bahadur Deuba made a State visit to India from August 23-27, 2017 and on Pancheshwar DPR the Joint statement stated:

'***The two Prime Ministers, noting the positive and productive discussion on the Pancheshwar Multipurpose Project, directed the concerned officials to finalize its Detailed Project Report within a month***.'

It should not be forgotten that 21 years ago in February 1996 1st time Prime Minister SB Deuba and his Indian counterpart PV Narasimha Rao had signed the Mahakali Treaty in New Delhi wherein the Treaty stated ' *The DPR shall be finalized by both the countries within six (6) months from the date of the entry into force of the Treaty.*' The treaty came into force on June 5, 1997 when both countries exchanged the instruments of ratification during Prime Minister IK Gurjaral's Nepal visit. PV Narasimha Rao passed away at the age of 83 on December 23, 2004. But apparently the 4th time Prime Minister Deuba suffered no bad conscience in signing '***finalize its (Pancheswar) Detailed Project Report within a month***' when in February 1996 only six months had been given.'

iii) Prime Minister KP Sharma 'Oli' also went on a State visit to India April 6-8, 2018 at the invitation of Prime Minister Modi. In the two Prime Ministers' Joint Press Statement there was no mention at all of Pancheshwar DPR, in fact, none on water or power, only on PM Modi's ***'Sabka Sath, Sabka Vikas'*** and PM Oli's ***'Samriddha Nepal, Sukhi Nepali'*****!**

iv) Narendra Modi and Pushpa Kamal Dahal 'Prachanda' in June 2023:

More recently when under Prime Minister Modi's invitation the 3rd time Prime Minister Pushpa Kamal Dahal 'Prachanda' made the Official visit to India from May 31 to June 3, 2023, the joint statement on Pancheshwar again stated:

' *…. expedite the bilateral discussions towards early finalization of the* ***Detailed Project Report (DPR) of the PMP within a period of three months.***'

Thus on the Pancheshwar DPR finalization, three Prime Ministers of Nepal and one of India had given the above assurances of '***within one year in August 2014 – Sushil Koirala and Modi, within a month in August 2017 – SB Deuba and Modi and then within a period of three months in June 2023 – PK Dahal 'Prachanda' and Modi***' ! This article is being written in December 2023 and there is no new news yet about the Pancheshwar DPR having been finalized. Neither is there any news[51] about the financial closure of the 300/900 MW Upper Karnali, *Nepal's Jewel in the Crown*, that was awarded to India's GMR in 2008. Like Upper Karnali, the Pancheshwar DPR has been hanging like the albatross around Nepal's neck for 27 years waiting for the '*sun to rise from the west and Rs 120 Arab to tinker annually into Nepal's coffers from sale of electricity to India*'! Hence, in the true spirit of the 2014 joint press statement of Prime Ministers Modi and Sushil Koirala '***until the DPR of Pancheshwar Multipurpose Project***

is finalized and Implementation of the Project begins'**, reviving the sixty year old 1,800/3,600/10,800 MW Karnali Chisapani, Nepal's precious Kohinoor with a live storage of 16.2 billion cubic meters (BCM) of freshwater[52], will not only be Premature but totally quixotic!** This is the final concluding reflection on Nepal government's jubilant revival of the *'held in abeyance'* 10,800 MW Karnali Chisapani Multipurpose Project – **Nepal's precious Kohinoor!**

The author is the former Managing Director of the NEA

51 GMR so far in 2023 has failed to achieve Financial Closure for the umpteenth times. However, GMR regularly brings out the news of its 500 MW power sale deal with Bangladesh when during Prime Minister PK Dahal 'Prachanda's June 2023 India visit Nepal was permitted to export only 40 MW of power to Bangladesh.

52 Nepal's Kohinoor, Karnali Chisapani, has a live storage of 16.2 BCM increasing Karnali River's dry season flows four folds! India's famous Bhakra Nangal Dam has a live storage of only 6.9 BCM and yet that kick-started the Green and White Revolution of India, freeing it from USA's cheap PL 480 grain imports. Tehri Dam has a live storage of only 3.5 BCM. It is sad and embarrassing that Nepal has to beg India not only for 10 lakh tons of paddy, 1 lakh ton of rice and 50,000 tons of sugar in August 2023 but also for Onions in December 2023!

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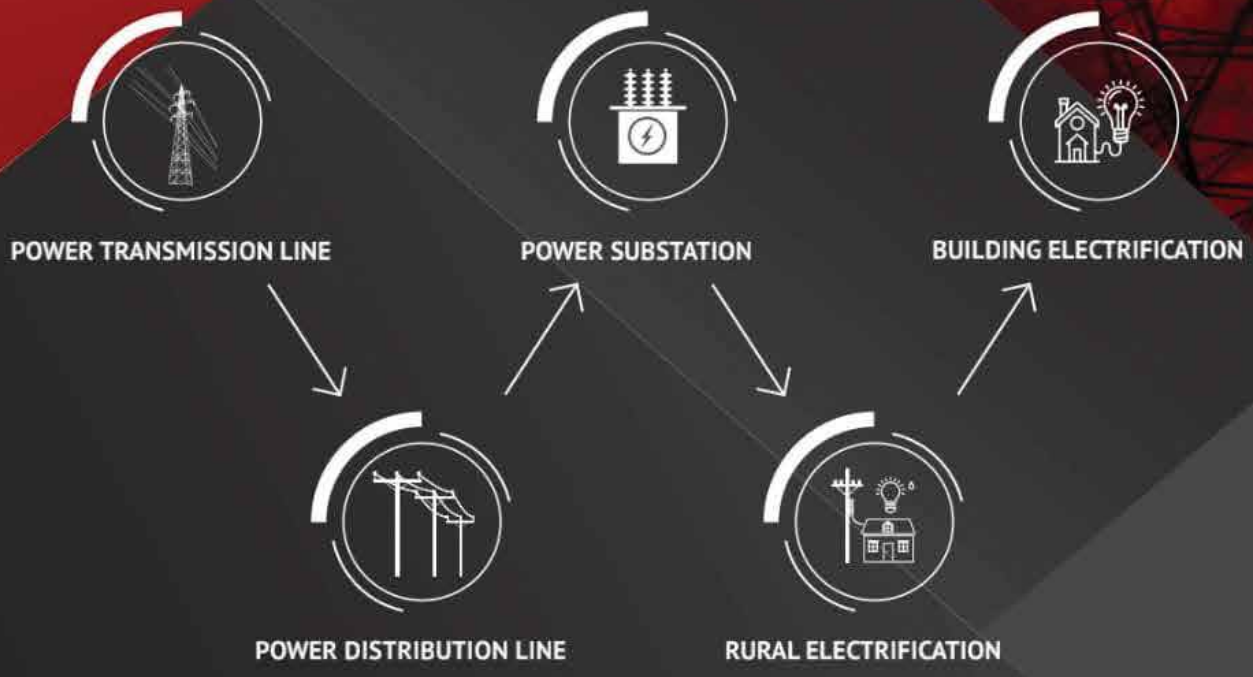

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Switching to hydrogen fuel; prospects and challenges

Rajesh Khanal

Although an attraction for use of hydrogen fuel in vehicles has been growing, citing it as the zero -emission transport mean, the hydrogen gas powered cars are yet to get proper recognition in the line of electric vehicles.

With a growing call for introducing measures to tackle the challenges of climate change including global warming, the concern for the alternative energy has been raised to switch to green energy from traditional energy sources.

The key pillars of decarbonising the global energy system are energy efficiency, behavioural change, electrification, renewable, hydrogen and hydrogen-based fuels and Carbon, Capture, Usage and Storage (CCUS) system. Of these the hydrogen-based fuel system is drawing attention of the entire world.

It is believed that the first internal combustion engine about 200 years ago used hydrogen and oxygen gases as the main fuel source. However in the modern time, hydrogen has been used as fuel cell and a battery to store energy. Although an attraction for use of hydrogen fuel in vehicles has been growing, citing it as the zero -emission transport mean, the hydrogen gas powered cars are yet to get proper recognition in the line of electric vehicles.

A report of the Asian Development Bank (ADB) shows that the current global demand for hydrogen is around 90 MMT per year, which has grown by just two percent since 1975. Its demand in India alone is 6 MTPA, driven by captive consumption of refineries and fertilizer units. The demand is expected to grow up to 25 MTPA by 2040, a growth between 2.5-3.5 times.

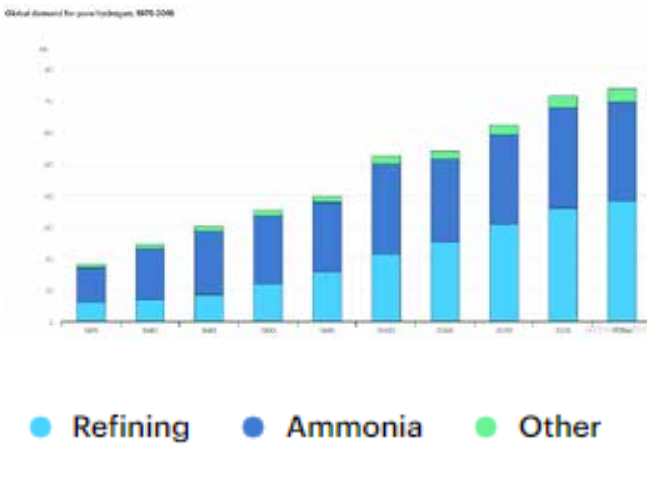
According to Wall Street Journal, demand for hydrogen as a main source of energy is set to rise sharply over the next two decades. A study report prepared by the consulting firm McKinsey has projected that there will be a fivefold rise in hydrogen demand to 600 million metric tons a year by 2050, if climate change is limited to 1.5 degree Celsius.

But major bottlenecks such as long permitting times, higher equipment costs and lack of access to capital could slow growth in supply. "The supply could be between 175 million to 291 million metric tons a year if steps aren't taken to speed up permitting and lower both equipment and investment costs," the report warned.

Gaseous and liquid hydrogen are the primary methods of storage across the globe. However, higher storage costs for liquid hydrogen make it unviable at small distances, reads the ADB report.

The World Bank report states that the demand for hydrogen reached an estimated 87 million metric tons (MT) in 2020, and is expected to grow to 500–680 million MT by 2050. From 2020 to 2021, the hydrogen production market was valued at $130 billion and is estimated to grow up to 9.2% per year through 2030.

Uses for hydrogen are expanding across multiple sectors including power generation, manufacturing processes in industries such as steelmaking and cement production, fuel cells for electric vehicles, heavy transport such as shipping, green ammonia production for fertilizers, cleaning products, refrigeration, and electricity grid



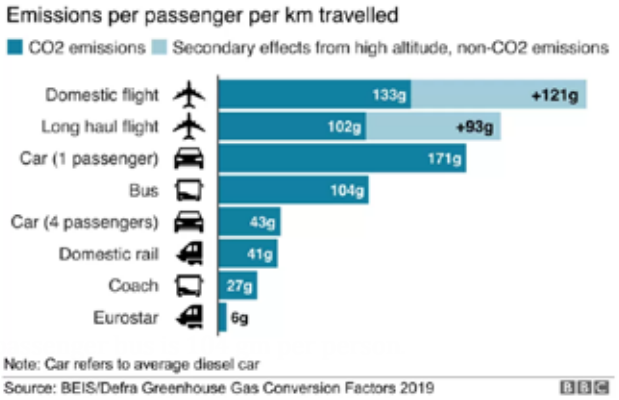
In 2022, the global hydrogen market was valued at USD 155.35 billion, and it is gaining momentum. During 2021 and 2022, nine countries unveiled national strategies for hydrogen, which will cover about 30% of global energy sector emissions. While most of the hydrogen produced is for the chemical and petrochemical sectors, hydrogen demand in new applications has also slowly grown.

The Asia-Pacific region has emerged as the biggest hydrogen market in 2022. China is the largest producer of hydrogen fuel cell trucks and cars. These vehicles are becoming increasingly popular among consumers and corporations looking for more viable low-carbon transportation options.

Given the pressing need to reduce carbon emissions and mitigate the impacts of climate change, there is a growing demand for low-carbon energy solutions that can power homes, businesses and transportation systems. This demand drives innovation and investment in various technologies, including solar, wind, geothermal and hydroelectric power.

Transport means- the main source of emissions

According to a study, single passenger car emits the largest CO2 emission per person compared to any other transport means. Single using car emits 171 gm per person of emissions, while the emissions attributed to domestic flight is 133 gm per person and that of the



The above info-graph shows that flying is one of the most carbon-intensive things. Domestic flights have the largest emissions per person per km. Train journeys can have less than a fifth of the impact of a domestic flight, although they might be more expensive.

In the COP 28 held last month in Dubai, many nations including the US, UK and European Union had pushed for a phase out from fossil fuels. Almost all of the participating nations agreed to "transition away' from coal, oil and gas.

For the first time, countries agreed on the need to "transition away from fossil fuels in energy systems". The agreement calls for this to be done "in a just, orderly and equitable manner". This is seen as an important recognition that richer countries are expected to move away from coal, oil and gas more quickly.

Many groups - including the US, UK, EU and some of the nations which are most vulnerable to climate change - had wanted a more ambitious commitment to "phase out" fossil fuels. The agreement includes global targets to triple the capacity of renewable energy like wind and solar power, and to double the rate of energy efficiency improvements, both by 2030.

The COP28 agreement highlights "the growing gap" between the needs of developing countries and the money provided to cut emissions - but there is no requirement for developed countries to provide more support. Ultimately, the success of COP28 will be determined by the changes if the world puts into practice in the years ahead.

It also calls on countries to accelerate low- and zero-emission technologies like carbon capture and storage. In the context, electric cars are becoming more widespread, but they are still prohibitively expensive for some people and charging infrastructure is limited in places.

Prospect of hydrogen fuelled automobiles

For the last two decades or so, hydrogen power has been spoken of as a potential future for the car, but its adoption into the mainstream has never materialised.

Going green is top of the agenda for car manufacturers right now, and turning to hydrogen seems an alluring prospect. It's abundant, safe for the environment when properly used and, thanks to some clever engineering, can be topped up as quickly as one would at a petrol or diesel pump.

But all the perks aside, its development has been slow and vastly upstaged by the advent of the battery-powered electric vehicle, commonly referred to as the EV.

The world class brands of automobile sectors including Mercedes Benz, Toyota, Hyundai and BMW, along with the startups have also stepped up in the use of the hydrogen fuelled vehicles. Recently, hydrogen-powered concept cars were unveiled by BMW and Renault – the iX5 Hydrogen and the Renault Scenic Vision respectively.

The two are indicative of both manufacturers' commitment, along with the already established leaders of the field, Hyundai and Toyota to develop this type of fuel, even if not for the passenger car market.

According to a report, the United Kingdom had 300 hydrogen powered vehicles plying on the road in the beginning of 2023. Till the date, there are two fuel cell car models including Hyundai Nexo and Toyota Mirai available in the US market. California is reported to be the only state with a long-distance hydrogen network. There are 59 stations clustered in Los Angeles and the Bay Area.

As the initiative is now in preliminary stage, it might take lot more time to expand market of such vehicles. One of the main set back seen in the segment is lack of relevant infrastructure including the refueling stations. Although many countries have thrived for the use of hydrogen run automobiles, they also lack the easy availability of the refueling centers.

The COP 28 declaration has acknowledged that renewable and low-carbon hydrogen and hydrogen derivatives will play an essential role in meeting global energy needs and decarbonizing our industries as part of a people-centered energy transition to net zero that leaves no-one behind.

The mega gathering inked intended agreement to unlock decarbonization opportunities and cost-efficiency gains with global trade in renewable and low-carbon hydrogen and hydrogen derivatives in order to build a sustainable and equitable global hydrogen ecosystem that benefits all nations.

The participant countries sought accelerated development of technical solutions to enable mutual recognition of their certification schemes, including through cooperation of the Participants with and under the framework of the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) and the Hydrogen Technology Cooperation Programme (Hydrogen TCP);

Role of Green Hydrogen

Green hydrogen is produced by using renewably generated electricity that splits water molecules into hydrogen and oxygen. Green hydrogen holds significant promise to help meet global energy demand while contributing to climate action goals.

Clean hydrogen can help to decarbonize a range of sectors, including long-haul transport, chemicals, and iron and steel, where it has proven difficult to reduce emissions. Hydrogen-powered vehicles would improve air quality and promote energy security. Hydrogen can also support the integration of variable renewables in the electricity system, being one of the few options for storing energy over days, weeks or months.

Using green hydrogen as fuel for steelmaking can cut emissions by up to 95 percent, according to H2 Green Steel, a Swedish low-carbon steel startups.

Global leaders have agreed to substitute fossil fuels with green hydrogen, which will be the most feasible source of green energy by 2050. Sweden, for instance, has already begun work in heavy industries such as iron and steel. This has sparked a global rush to produce green hydrogen, with countries like Australia, China,

Japan and the European Union leading the production.

Nepal is expected to have produced at least 10,000 megawatts of hydropower by 2030, with a demand of approximately 7,000 megawatts. The total capacity is expected to be 39,000 megawatts by 2040. Thus, surplus hydropower could be channelled to produce green hydrogen at a competitive price. It is anticipated that the cost of producing green hydrogen will be below $1 per kg by 2050.

How hydrogen-powered cars work?

Hydrogen-powered cars are similar in design to conventional EVs as they both use electric motors to drive the wheels.

However, while EVs deploy stored electricity from a battery to power the electric motors, the fuel cell stacks in hydrogen cars produce electricity on the go through a chemical reaction between hydrogen and oxygen. That electricity then either powers the car directly or is stored in a smaller battery until needed. These cars give out water vapour as waste product.

Initiative of Nepal

This time in COP 28, Nepal strongly raised the issues related to adverse impacts to Himalayan and mountainous regions due to the ongoing climate change. Identification of actual losses, fixation of target for climate suitability, minimization of carbon emission, migration due to climatic factor, carbon emission and gender inclusion and its impact on the indigenous groups were the main agendas that the country tried to draw global attention into.

In the UN climate conference held in Glasgow in November 2021, Nepal expressed its commitment to reach a net zero emissions by 2045. In the line, Nepal has also stepped up for various initiatives including maximum usage of electric vehicles, while the country has also moved on to assessing feasibility of widening use of hydrogen powered vehicles.

Kathmandu University (KU), in this regard, has introduced hydrogen gas-powered car and the necessary equipment for its refueling station for the first time in Nepali market. Earlier, the KU and Nepal Oil Corporation (NOC) had jointly conducted a study project on how Nepal's transport sector can be operated using hydrogen as fuel.

Dr Biraj Singh Thapa, head at the Hydrogen Lab, KU, said hydrogen is being understood as only a bomb, but a hydrogen car is safer than a petroleum car. "If petroleum leaks out of a car, then it can set fire in the entire vehicle. But hydrogen being lighter than air, rises in the air instantly, that is why it can result in minimal damage to the vehicle," Thapa said.

According to him, generally, hydrogen is considered as a more flammable substance than petrol. "Studies however show that hydrogen cars are 3 to 5 times safer than petroleum cars."

Thapa said a hydrogen car is similar to an electric car. It is called 'Fuel Cell Electrical Vehicle' (FC EV). It also runs through electricity-based mechanisms. The motor connected to it is driven by electricity, which is generated by hydrogen gas. The car brought by KU is equipped with a 6 kg hydrogen gas tank. Electricity is generated by the hydrogen filled in the tank and the electricity drives the car.

In an electric vehicle, electricity is supplied by the battery through charging. The battery is heavy and its power storage capacity is also low. Current EVs are capable of traveling a maximum of 500 kilometers from a single full charge. However, a hydrogen car can run 200 km from 1 kg of hydrogen. In other words, it can run up to 1,200 km by using 6 kg of hydrogen, according to Thapa.

Challenges

Despite having numerous benefit of hydrogen fuel usage, there are lots of underlying hurdles to expand hydrogen fuel commercially. The infrastructural and technological constraints need attention before introducing green hydrogen in the respective sectors. Nepal may not be able to introduce green hydrogen in every mentioned sector immediately, so it requires careful examination of early adoption of green hydrogen.

Green hydrogen can be utilized in the chemical industry to produce ammonium-based fertilisers, including urea. Using green hydrogen in the iron and steel industry is another potential medium-term application.

The residential use of green hydrogen, especially for heating and cooking can be feasible for a long-term prospect. Also, as the technology and infrastructure mature, Nepal can also consider using green hydrogen in the transportation sector. However, the country needs to maintain short-term, medium-term and long-term goals, along with investing in the necessary infrastructure to harness the maximum benefits out of the green hydrogen uses.

Enabling Net Metering Based
Solar Rooftop System in Kathmandu Valley

Consumers are not willing to give all shade free roof top are for PV installation because roof top are used for other purposes like drying clothes, and cultural aspects etc.

Prof. Dr. Jagan Nath Shrestha

Debendra Bahadur Raut

Abstract: The power shortage problem faced, especially during the dry periods, by Nepal since last two decades is one of the major hurdles for its socio-economic development. At present load shedding is being managed by significant import of electricity from India thus increasing trade deficit of Nepal. The accelerated alternative methods of generation of electricity in Nepal need to be explored. This paper assesses the potential of net metering-based rooftop solar Photovoltaic (PV) system in residential buildings in Kathmandu valley. The data indicated in this paper are collected from the predefined set of questionnaire and field survey in the randomly sampled households in 2016. Based on the quantitative analysis of the data; it is found that the average rooftop area available for PV installation in residential buildings is 14.5 sq.m for Kathmandu. Considering 557,027 residential buildings in Kathmandu, total PV power potential is estimated to be 810 MWp in the city. To estimate the energy potential the annual average peak sun hour considered is 5.54, data taken from Solar and Wind Resource Assessment (SWERA) report. If shade free rooftop space available of the 50% residential buildings are utilized for PV installation (333,762 numbers), about 12% of the Nepal's utility electricity sold in the fiscal year 2017/18 could be saved annually. The technical barriers for the grid connection of rooftop solar is not a major issue now as NEA has set the guidelines for it.

Keywords: Rooftop Solar, Residential Power Potential, Grid Connection, Energy Yield

1. Introduction

Nepal lies in the solar belt region. About 600 GWh of electricity can be generated per day considering just 0.1% of area of Nepal and solar insolation value as 4kWh/m2/day. To resolve the existing severe power crisis and enhance energy security by diversifying Nepal's energy mix, abundant solar PV potential need to be harnessed. Therefore, the need for promoting solar PV energy has been rightly emphasized in the recent report by Ministry of Energy, Government of Nepal entitled "National Energy Crisis Mitigation 2016". A study show that about 300,000 residential buildings in Kathmandu valley itself are using battery-inverter backup systems that consume heavily subsidized cheap grid electricity during peak demand times and drastically increases the pressure on national grid, and hence impose more pressure on the current

supply system and exacerbates the already severe load shedding.

Although efficiency of electrical inverter backup system is low, users are compelled to use this due to the high initial investment for solar energy. At present, in major cities of Nepal such as the Kathmandu valley, rooftop solar PV systems have not been broadly installed yet either by residential or by commercial and industrial users. Better understanding of the market from the demand, supply, and the regulatory aspects is urgently needed before decisions on proper intervention can be made.

The overall objective of this paper is to assess the potential of roof top solar PV in Kathmandu valley. This paper also explores the barriers to further development of roof top PV and recommends proper interventions required to address the barriers. To meet the principle objectives, analysis was done from the demand, supply, financing, and regulatory point of view. Demand side analysis explored the consumer's electricity consumption pattern and roof top PV installation capacity on residential buildings whereas the supply side accessed the key data from the financing institutions, solar manufacturers and suppliers.

2. Methodology adopted

Quantitative research methodology is used to analyze the data which is gathered from the structural survey in the targeted area. Five sets of questionnaires were prepared each for the residential, commercial, industrial consumers as well as for the financing institutions and solar PV suppliers.

2.1 Data collection

Primary data wascollected from baseline survey on demand side, supply side and financial institutions that are financing solar PV business in Nepal. Information collected as part of the baseline survey on demand side includes the demographic and buildings characteristics, current electricity usage pattern, customer awareness and interest, availability of PV modules in the current market, reasons for customer purchase or non-purchase, willingness to pay etc. Survey engineers have visited the buildings and measured the detail parameters including the snaps of sampled of roof top.

Information collected on supply side survey includes the records on supply of PV modules, prices, and market share of the major suppliers, supplier's offer to the consumers in "back-up" mode or only "feed-in" mode, services (pre-and-post sales) provided by supplier, financing methods and terms of conditions, awareness of government subsidy programs, fiscal incentives such as waiving of VAT and import duties, and any regulations on quality assurance and quality control (NEPQA 2015 revised version) standards, major barriers to roof top solar PV installation etc.

Also, secondary data about the utility consumers, total numbers of buildings etc. were collected from the NEA (Nepal Electricity Authority) and Nepal Census Report 2011.

Similarly, meteorological data for the study area were taken from ***Solar and Wind Energy Resource Assessment (SWERA)*** report. From Fig. 1, the annual average peaksun hours used to estimate the energy in this study is 5.54.

2.1.1 Sampling

Under the predefined sample size, the random samples were selected based on the economic status, classes and power consumption profile.

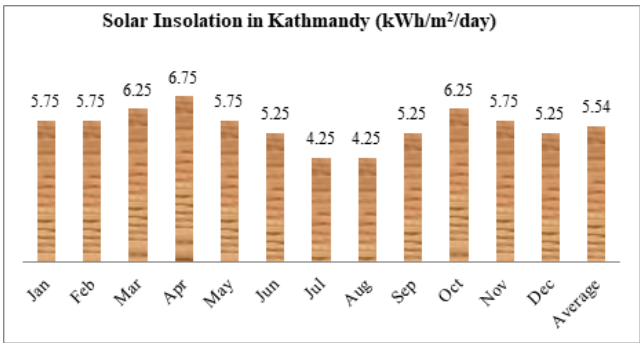


Figure 1: Solar insolation at flat plate tilted to latitude, kWh/m²/day

2.1.2 Population

The estimated total number of residential buildings in 2015 is projected to reach 557,027, with an annual growth rate of 6% calculated from the 2011 census data. Residential buildings considered are only cement bonded bricks/stone and with RCC structure only and buildings with mud bonded bricks/stone and wooden pillar are excluded in all the cities.

2.2 Data analysis

Statistical analysis tools is used with precision level (e) = ±7% and 95% of confidence level and P=0.5. Data collected from residential buildings are classified with the foot print area as small (<100 m²), medium (100m² -150m²) and large (>150 m²). The sample mean and sample standard deviation of each categories area calculated as E and s respectively. The statistical tools are used to determine the population mean and extrapolate the total roof top solar potential of the whole population.

2.1.1 Key assumptions considered to estimate shade free area and PV potential

The available shade free PV installation roof top area estimation, kWp potential and final yield from PV estimation are the major technical challenges of roof top PV study. Consumers are not willing to give all shade free roof top are for PV installation because roof top are used for other purposes like drying clothes, and cultural aspects etc. Therefore, based on the respondents statements considering all these Nepalese social-cultural aspects, on an average 30% of the shadow free areas of roof top are

considered in this study as available space for PV modules in residential sectors.

Energy calculations for example, residential buildings in Katmandu valley will produce 0.67*5.54=3.7 kWh/kWp/day of end use energy however; it may vary as it depends on the efficiency of BOS used in real field project.

3. Results and discussion

3.1 Existing power backup system

It is quite interesting to know that about 35% of the residential buildings use solar PV system to power their home during load shedding hours. In addition, more than 60% of residential buildings use less than 100 Wp solar PV system for lighting purpose during the power outages among which the most common size were 20 Wp and 40 Wp PV modules. However, the most common use of inverter in inverter-battery-backup mode was 600 VA to 850 VA for Kathmandu. In Kathmandu, more than 60% of the PV backup full hours of load shedding with designed loads and 5% backups the load shedding hours for less than 50% of the peak load shedding hours. Also, it is revealed that more than 40% of the consumers satisfied with their PV systems. Regarding the age of existing PV backup, 22% of the PV systems in Kathmandu are more than 5 years old and likely to replace the storage battery.

Regarding the source of income, about 80% of the consumers in Kathmandu purchased their PV system from service income. It is to be noted that the number of consumers purchasing solar PV systems with subsidy are insignificant. Though government of Nepal provide subsidy for urban roof top solar system since 2015, it can be said that almost all consumers in three cities purchased their PV systems without subsidy.

3.2 Existing power consumption profile

The study revealed that there are more than 200,000 residential buildings in three cities that have 5A utility meter and use basic electrical appliances only, also about 19% residential buildings in Kathmandu consume less than 80 units per month, which is nominal unit set by NEA.

3.3 Consumer awareness and major barriers

Consumer awareness is the major challenge for adopting and promoting urban roof top solar program in Nepal. This study shows that more than 80% of the respondents either do not know or partly know about the government subsidy via "Urban Solar PV Subsidy Program 2015". This factor clearly indicates that effective awareness campaign is essential immediately. Regarding the awareness of quality assurance, almost all respondents (97%) are not aware ***of Renewable Energy Test Station (RETS)*** and ***Nepal PV Quality Assurance (NEPQA)*** standards.

Most of the respondents are very much concerned with the initial cost of PV systems. They also pointed out that after sales service and low battery life are hampering wide spread use of PV systems. Some respondents expressed their opinion that they are unable to use PV systems as they do not have enough sunny space; quality of BOS etc. Study show that 23% of the respondents are ready to pay up to Rs. 15/unit should they be provided 24/7 hours reliable electricity by the utility. This is almost two times higher than the average unit cost of electricity in Nepal. 31% of the respondents are ready to pay as per NEA set tariff for 24/7 hours interruptible electricity supply. This clearly indicates the importance of electricity supply in Nepalese society.

3.4 Roof top PV potential and technical feasibility

The estimations of roof top potential includes following:

- Gross roof top area
- Shade free roof top area
- Area available for PV installation
- Estimated kWp potential
- Estimated energy generation (kWh/year) potential

It has been observed that Kathmandu valley has diversified roof top size and building height ranging from 4 meter to 20 meter.

Statistical data analysis (confidence level of 95% and Z=1.96) shows that the sample mean of gross roof top area of Kathmandu is 80.39 m^2 (sampled data varies from 12.55 m^2 to 208 m^2). From this scenario, the population mean is 76.21 m^2 gross roof top areas of residential buildings in Kathmandu valley. From Table 1, it can be conclude that every residential building have ~15m^2 area available for PV modules. In summary, 72.66 m^2 is the gross roof top area, 51.32 m2 is the shadow free area and 15.39 m2 is the roof top area available for PV installation with total PV potential of 810 MWp in Kathmandu valley alone.

According the methodology presented in this report, the calculated annual energy potential (GWh/year) from roof top of residential buildings are 1097 which is about 20% of the total utility energy sold which is 5526.12 GWh for the country in the fiscal year 2017/18 and 43% of the imported electrical energy in the same year. The imported electrical energy in fiscal year is about 2582 GWh.

Table 1: Summary of roof top PV potential in residential sectors

Measuring Parameters	Ktm
Total gross roof top area (km^2)	42.45
Total area available for PV Installation (km^2)	8.10
Average gross roof top area (m^2/building)	76.21
Average shade free roof top area (m^2/building)	48.48
Average area available for PV installation (m^2/building)	14.54
Average PV potential (kWp/building)	1.45
Total estimated PV potential (MWp)	810

3.5 Benefits of rooftop PV system

For simplicity the following comparison between large scale 100 MWp PVPS installed in one location and 1 kWp PVPS installed in 100,000 rooftops with the same solar insolation value will generate same energy output i.e. 400 MWh/day, if specific yield is 4kWh/kWp/Day.

Description	100 MW installed in one location	1 kW in 100,000 rooftops (equivalent 100MWp)
Cost of Land	Low to High	Free
Land Restriction	Not allowed in arable land forest area	No restriction
Power Evacuation Cost	Very high, Tx Lines, land compensation	Free
Operation Cost	Low to medium	Free
Maintenance Cost	Low	Free
Licensing / completion time	Up to 2 years	Free/some weeks
Security	Low	High
Cost of Installation/ Transportation	High	Low
Cost of BOS	High US$X	Almost same cost or relatively less
GoN Subsidy	None	75% on Bank Loan interest
NEA as Energy Storage Facility	None	Yes
Net Metering Facility	None	Yes
System Distribution Loss	High	Insignificant
Voltage Improvement	Not certain	Yes
Time Needed for EIA	Needed	Not needed
Vehicle to grid (via net metering)	None	Yes
Roof cooling effect	None	Yes

The major advantages of rooftop system (1kWp installed per household in 100,000 houses) in comparison to the centralized power system (100MWp in one location) can be summarized as:

- Rooftop system does not need additional land so it has no issue of arable/agriculture land restriction,
- It does not need long and expensive high voltage transmission infrastructures and passing over private lands,
- It is expected to have a lower OPEX,
- It does not need to go through a time-consuming licensing processes so it can be implemented faster,
- It does not need environmental assessment studies,
- It is more stable as energy generation is distributive in nature,
- It is less affected by natural calamities, and
- NEA infrastructure can be considered a s a huge storage battery.

3.6 Supply side and regulatory side assessment of rooftop PV market

Supply side assessment covers the supply chain of solar PV modules in the market, supply of solar PV system in different modes, financing options by the suppliers, major barriers on adopting roof top urban solar program by supplier's point of view etc. In the present market context of Nepal, almost 70% of the PV modules are imported from China. There is a small PV market share of other countries namely Korea, Japan, USA etc in Nepal.

Taking about the strength and services provided by PV suppliers in Nepalese market, 50% of them provide free of cost site survey and energy audit service to the consumers. Also, 80% suppliers provide free of cost after sales service up to 2 years, 10 % for 1 year and another 10% for 3 years. 90% suppliers have their own in house team for operation and maintenance, the technical personnel ranges from 2 people to 12 people in each company.

Financing mechanism is another important aspect of roof top solar market development. There are five commercial banks authorized to finance under the government subsidy program in Nepal. Out of five listed bank, only one bank has more than 7 years of experience on solar lending. Without subsidy, it has been charging 12% per annum interest on solar lending but under the subsidy program, all bank lending at 2.25% per annum interest rates on residential use and 4.5% per annum on institutional use considering the proposed solar PV system itself as a collateral and validity of loan is 5 years i.e. 60 EMI.

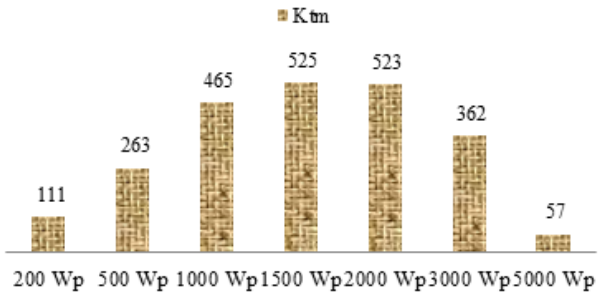


Figure 2: PV potential in MWp with different system

3.7 Energy Generation Potential

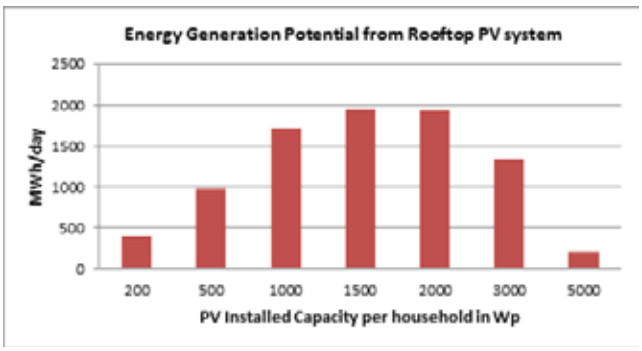


Figure 3: Energy Generation Potential from Rooftop PV system

From figure 2 and 3, it is clear that, for example 1kWp system can be installed in **465,000** houses in Kathmandu valley which would produce around 1700 MWh **(ac)** energy per day. In this way, if 1kWp rooftop system is installed in 100,000 residential buildings in Kathmandu valley, 400 MWh (dc) (**at 4hour peak sun/day**) or **about** 370MWh (ac) energy can be generated per day.

3.8 NEA Requirements for Grid Connection

Following minimal criteria is set by NEA for grid connected solar PV (PVGC) system through directive which is approved by NEA Board on 2074/01/13

- Frequency: 50 Hz
- Voltage Level: 230 V/ 400 V/ 11 kV ±5%
- Voltage Waveform: Sinusoidal
- Phase Voltage Imbalance in case of Three Phase System: 1% (maximum)
- Harmonic Distortion (THD): <= 3%
- Power Factor in between: 0.85 Lag and 0.95 Lead
- Energy to be injected to Grid: Not more than 90% of Energy consumed from NEA
- Energy Meter: Bi-directional (Grid Side), Solar Generator Meter (PV Generator Side)
- Power Level Injection: 500 Wp min to up to 5 kWp at 230 V level; more than 5 kWp to up to 40 kWp at 400 V level; more than 40 kWp at 11 kV level

NEA has added the following amendments as per its Board meeting number 823 dated 2076/10/23:

- Directives as mentioned in 2074 directive will be effective until the end of Asad 2079
- Executive Director of NEA or his nominee will be authorized to carry out necessary negotiation on agreement with energy supplying agency/person.

Similarly, NEA has added the following amendments as per its Board Meeting number 927 dated 2079/10/12:

- Energy bill will be adjusted in the same month should the customer sells more energy to NEA than it consumes energy from NEA grid
- Buying price of photovoltaic based energy will be NRs.5.94 per unit and the bill adjustment will be carried as per the difference between supplied energy and consumed energy as mentioned in annex 2
- Above mentioned amendments will be valid until Asad 2082.

4. Conclusion

The gross roof top area of each residential building was found to be 76 m^2 in Kathmandu. After deducting the sunny roof top space to be used for other purposes, the net area for PV installation in Kathmandu valley comes to be 8.1 km^2 (~ 20% of gross roof top area). Total PV potential is 810 MWp available in Kathmandu Valley alone. If all the residential buildings totaling 557,027 numbers are installed with a roof top PV system in their sunny space, 20% of the NEA electric energy sold in fiscal year 2017/18 could be saved annually. In addition, the estimated rooftop PV potential could save 43% of the electric energy imported from India in fiscal year 2017/18.

One important thing to be noted in Nepal is that whenever there is enough rainfall during wet seasons, there is less solar insolation and there is maximum solar insolation during dry periods. This is a gift of Nature for Nepal for formulating its energy security policy.

There is a good market potential of roof top solar in Nepal as NEA has already set the guidelines for net metering system using smart meters supported by high frequency communication link for residential buildings and there is no load shedding in the [6] day time in major cities. However, a clear financing mechanism and implementation modality are the major challenges for the promotion of rooftop grid connected solar system in Nepal.

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Nepal Unlocking Cross-border Power Trade

Dr. Madhusudhan Adhikari

According to the NEA, it spent as much as NRs 19.44 billion to buy power from India, while its export to the southern neighbor stood at NRs 10.10 billion in the last fiscal year 2022-23, suggesting the country still needs to struggle to be self-reliant in electricity.

Background

Nepal is blessed with extraordinary water endowments in the form of snow cover, rivers, springs, lakes, and groundwater. However, its most important water resources are the over 6,000 rivers and rivulets across the country. They not only provide a reliable source of water for different purposes but, together with the steep topography of the country, also offer significant opportunities for hydropower generation.

The technically and economically feasible hydropower potential of Nepal has been estimated at 83,000 and 42,000 MW, respectively. Though hydropower development started in 1911, it progressed slowly until 1990, and only around 600 MW was developed. After 1992, Nepal developed a Hydropower Policy and Electricity Act, which provided the opportunity to bring private sector engagement in hydropower generation. As a result, there was a steep rise in the generation curve, and as of today, the total generation capacity of the country has crossed 2800 MW, providing electricity access to more than 96% of the population. In the wet season, there is more than 1000 MW of surplus electricity in the country. Hence, in the wet season, Nepal has to export electricity. Recent developments along the India-Nepal border have paved the way for cross-border energy trade (CBET), offering opportunities for coordinated resource utilization and economic growth. This article explores the history, status, challenges, and opportunities in power trade between India and Nepal.

History of Power Trading Agreement

The history of the Power Trade Agreement between Nepal and India has been marked by three unsuccessful attempts. The first initiative was undertaken 25 years ago around 1997 when an important step in the Nepal-Indo Power Exchange was the Power Trade Agreement, an agreement signed with a condition to be ratified by the respective parliaments. The Power Trade Agreement signed in 1997 couldn't even be tabled in the Nepalese parliament due to domestic political issues. Compounded by the constitutional requirement for a two-thirds majority in the parliament for the ratification of agreements involving the sharing of natural resources, the Electric Power Trade Agreement was intricately linked with this constitutional provision. Despite being an exchange of 'finished electricity,' a product given the argument as natural resources, the agreement faced significant hurdles, and the failure to ratify it had a detrimental impact, as Nepal became a power surplus country after the commissioning of the Kali Gandaki-A Hydropower project in 2002.

The second attempt in 2010 involved Nepal presenting another draft of the Power Trade Agreement to India. Unfortunately, India did not respond for four years, rendering the second draft void. In the third attempt, initiated in 2014, India presented a new draft that leaned towards a broader cooperation agreement on the development of hydropower in Nepal and its marketing. However, Nepal was uncomfortable with such a comprehensive

agreement, akin to the Indo-Bhutan cooperation model. Later, as a fourth attempt, with extra-long diplomatic and bureaucratic efforts and a revision of some of the clauses in the original draft, finally, the Power Trade Agreement signed in 2014 opened doors for Nepal to access the Indian power market, dispelling initial apprehensions about fair deals with a larger neighbor. The agreement has provisions for any party in Nepal or India (government, semi-government, or private) to agree to power trade between Nepal and India. The recent amendment in the Indian government guidelines on the Cross-Border Electricity Trade (CBET) policy further facilitates better power exchange, which eased Nepal's power trading on Indian exchanges and softened Nepal's concerns long term.

India-Nepal power trade is set to become a regional game-changer, say officials in Delhi and Kathmandu, pointing to the possibilities of buying power from Nepal and making it available over an electric grid system to consumers in India, Bangladesh, and even Sri Lanka. However, India's reservation about buying power from projects developed by the use of Chinese contractors and equipment in the projects is still one of the serious concerns for the Nepal Electricity Authority and independent power producers (IPPs) of Nepal.

Markets for Nepal's Power

India has allowed Nepal to sell electricity in the long term and its Real-Time Market (RMT). On July 31, the southern neighbor opened the door to Nepal, Bhutan, and Bangladesh to participate in its real-time energy market by amending the 'Procedure for approval and facilitating import/ export (cross border) of electricity by the designated authority' issued in February 2021. It is for the first time that the southern neighbour has granted project-wise approval ensuring that Nepal could now start selling power in India's RTM. "Nepal was the first country to participate in the RTM from South Asia,"

In May 2023, Nepali and Indian authorities signed a 5-year (medium-term) agreement that will allow Nepal to sell an additional 200 MW of hydroelectricity to India. This is in addition to the 452.6 MW that Nepal already has permission to sell in India's Real-Time Market (RTM). The new agreement applies to the wet season only (from June up until November). In June 2023, during PM Dahal's visit to India, Nepali and Indian PMs agreed to a long-term energy deal, which targets 10,000 MW of electricity import by India in 10 years. This is a significant step toward the development of the Nepal-India power trade. This landmark decision comes after several months of discussions and negotiations, and it holds immense potential for the energy sector and economic development in both nations.

Recently, on the 6th of December 2023, the Bangladesh government decided to import 40 MW of electricity from Nepal. After a long discussion at political and bureaucratic levels among the countries, India finally agreed to allow Bangladesh to initially import 40 MW of electricity from Nepal through Indian transmission infrastructure. The Baharampur-Bheramara transmission line will be used to import electricity from Nepal through the territory of India. Bangladesh will import electricity from Nepal through the Indian nodal agency NTPC Vidyut Vyar Nigam as a service provider, this has opened a new market for Nepalese clean energy.

Electricity Trade Status:

Since November 2021, the southern neighbor has been allowing Nepal to sell its power in its day-ahead market. Nepal has started exporting surplus electricity to India during the wet season, but it has to import electricity in the dry season to meet the power demand. The NEA has planned to export up to 1,200MW of electricity to India this year. The NEA is exporting 200 MW by signing the medium-term PPA and the rest to the Indian energy exchange. NEA plans to export power generated from six power projects - 83.42 MW Solukhola (DudhKosi) Project, 40.74 MW Mistry Khola Project, 34.92 MW Upper Balefi A Project, 28.17 MW Likhukhola-1 Project, and 12.75 MW Upper Chaku Khola Project.

According to the sources, NEA is planning to sell electricity at a rate of INR 5, which is equivalent to NRs 8 per unit. The authority has been purchasing electricity from domestic power developers at NRs 4.80 per unit. NEA has been selling electricity real-time market through the Indian energy exchange for up to INR 12 per unit. However, Nepali officials say it will be difficult to get the same rate in the case of medium and long-term PPA. In the day-ahead market of Indian Energy Exchange Limited (IEX) through daily bidding.

According to NEA, Nepal has successfully exported electricity worth NRs 11.80 billion to India during the peak production season this year. This revenue was generated over a period of more than four months, from June to October, and the selling of surplus energy is going on. The NEA has set ambitious projections, aiming to earn NRs 16 billion from the electricity business this season. Since early September, India has permitted Nepal to sell a total of 632 MW of electricity in the Indian market, reflecting a significant increase from the previous 452 MW. The approved projects for electricity export include Chilime, Solu Khola, Kabeli B-1, Likhu-4, Lower Modi, Solu-DudhKosi, Dordi Khola, Upper Kalanga Gad, and Upper Chamelia. In the fiscal year 2021/22, Nepal's electricity exports reached 493 million units, generating an income of NRs 3.88 billion, with a notable increase to 1.34 billion units and NRs 10.45 billion in the following year.

However, Nepal is trying to push as much electricity as possible to India and aims to become a net exporter, but still, Nepal continues to spend more on buying electricity from India than earning through its exports. As Nepal's electricity production is dominated by run-

of-the-river projects, domestic production declines sharply in the dry season, requiring power import from India. Since fiscal year 2019-20, Nepal's power import has been on a downward trend amid increasing domestic power generation in the period. According to the NEA, it spent as much as NRs 19.44 billion to buy power from India, while its export to the southern neighbor stood at NRs 10.10 billion in the last fiscal year 2022-23, suggesting the country still needs to struggle to be self-reliant in electricity. The NEA aims to be self-reliant on electricity by 2026. By the end of the current fiscal year 2022-23, Nepal's power generation capacity is expected to reach 3000MW, 4,507 MW by mid-July 2024, and 5,251MW by mid-July 2025, according to the power utility. But domestic consumption is expected to be half the potential generation by 2025, forcing Nepal to sell electricity abroad.

India recently introduced a new rule allowing Indian distributors to incorporate imported hydropower into the renewable energy quota set for them. This may give Nepal a better chance to export more hydroelectricity to India. A new notification issued by the power ministry set a new quota of renewable energy that distribution companies should meet starting from the fiscal year 2024-25. Earlier, they were told to fulfill the quota by buying only the power produced domestically.

Challenges for Power Trade:

Transmission Infrastructure Development: To achieve the ambitious goal of exporting 10,000 MW in 10 years, there is a need for the rapid development of hydropower projects and cross-border transmission lines. The construction of new projects and transmission lines is a prerequisite, and power purchase agreements (PPAs) need to be resumed with private developers.

Building hydropower projects and transmission infrastructure is highly investment-intensive. Without a stable, long-term conducive policy and an institutional environment in place that ensures payment security, it is unlikely that investors will put their money into this risky business.

To keep the framework insulated from political volatility, a simplified legislative framework may be more desirable. The pressing need for cross-border transmission lines between Nepal and India arises from the government's ambitious goal to export a significant 10,000 MW of electricity to India in ten years.

The Nepal Electricity Authority (NEA) mentions their plan for ongoing efforts to build transmission lines of 132 kV and 400 kV capacities at multiple locations. The NEA has completed seven 132 kV transmission lines and a 400 kV Dhalkebar-Muzaffarpur line, capable of exporting 2,000 MW to India, to be the maximum available capacity for the existing infrastructure. Planned projects, including a double circuit 400 kV transmission line from Dirding to Sitamadhi and pipeline ventures like the 679 MW Lower Arun and 490 MW Arun-4, underscore the commitment to bolster transmission infrastructure to meet the growing demand for cross-border electricity trade. Initiatives like the 400 kV transmission lines from Lamki to Bareli, Duhabi-Purniya, and Butwal-Gorakhpur further underscore the comprehensive strategy in place to enhance power connectivity between the two nations. These border transmission lines must be constructed in war foot to match the increase in generation capacity.

Climate Change Challenges: India and Nepal share multiple rivers that flow from the Himalayas, each central to the lives and livelihoods of millions of citizens, and these rivers are vulnerable to the impacts of climate change and the hydropower projects built there. In particular, the Ganga River Basin (Asia's most populous) lies mainly within India and Nepal and is beset with water-management issues, including poor river conservation, a lack of research on water resources, and insufficient groundwater recharge. Despite these factors, high-profile intergovernmental discussions between India and Nepal usually overlook climate change issues. Rather than talking about the various climate vulnerabilities of their shared rivers, India and Nepal use these meetings only to explore the potential of hydropower. This is unsurprising, given that hydro represents approximately 96% of Nepal's installed electricity capacity, which comes from Run-of-River Power Plants, challenges during climate change impact in the wet season due to unexpected high rainfall lead to surplus generation but pose a serious threat to the safety of the hydropower structures, whereas severe drought could cause the shortfall, which will harm the smooth flow of agreed energy exchanges.

Lack of Well-Defined Framework: The approval for electricity trading between Nepal and India has been granted, but there is a lack of a well-defined framework for exporting the substantial electricity supply of 10,000 MW from Nepal to India and more to come in the future.

Policy and Structural Arrangements: Concerns are raised about the existing structural and policy arrangements, which might pose formidable challenges in achieving the export target. The specific export model and mechanism, including whether Nepal should seek an independent exporter or have a government agency oversee procurement, remain unresolved. Nepal also needs to develop policies to safeguard carbon trading rights, ensure carbon revenue belongs to Nepal, and harness maximum renewable resources for energy generation.

Guidelines and Diplomatic Relations: India's 'Guidelines for Import/Export (Cross-Border) of Electricity-2018' contain clauses linking electricity trade as a strategic issue, and open trade depends on international diplomatic relations, presenting significant hurdles. The document mentions specific clauses

that might hinder electricity exports from Nepal to India.

Cybersecurity Threats: The incidences and risk of potential cyber strikes on India's electricity infrastructure in the energy exchanges also introduce a new challenge, suggesting the need for robust cybersecurity measures to safeguard against such threats and potential additional conditions for Nepal's electricity procurement.

Delay in Permissions: Private sector companies eager to engage in electricity trading face challenges in obtaining necessary permissions in both countries. The absence of a clear policy framework, despite existing provisions in the Electricity Acts, is also a major hindrance.

Coordination and Planning: In Nepal, despite the smooth growth in electricity generation, the data highlights concerns about the coordination between production, demand, and supply, posing a risk of power failures in the country which raises social concerns about export power. Comprehensive studies and planning are deemed urgent in this regard to have a clear target for national consumption and a possible amount for export as we move to the future.

Financial Requirements: Meeting ambitious targets, including generating 30,000 MW of electricity and building necessary infrastructure, requires significant financial resources, estimated to be around NRs 6 trillion. Therefore, the government of Nepal should work hard to secure soft funds from the international market and climate finance and establish legal provisions for private investors to access such funds.

Conditionality in India's Commitment: India's commitment to purchasing electricity from Nepal comes with conditions, including sourcing exclusively from projects supported by Indian or Nepali investments and not engaging in transactions with projects backed by Chinese and other investments. The government of India should not delve into the details of each project and give project-based approval for export. It is interested in energy produced from clean sources and is only concerned with the total electricity it imports, leaving all the details for the government of Nepal to monitor and regulate.

Legislative Delays: Nepal's delay in passing the Electricity Bill, 2023, is highlighted as a factor contributing to the prolonged wait for government permissions for open access and electricity trading by private sector companies.

Operational Challenges: Despite the approval of the power purchase agreement with the 'Take or Pay' condition and opening for electricity trading, operational challenges, such as curtailment of production and surplus power during the wet season, are noted. This emphasizes the need for streamlined processes and unrestricted purchase of electricity by NEA from IPPs. Managing the export quota efficiently to avoid wastage during the wet season and addressing the surplus power issue is a challenge for NEA.

Dependency on Indian Market: Nepal's heavy dependency on the Indian market for electricity export raises concerns about the stability and sustainability of the export initiative, considering potential geopolitical and economic fluctuations. Even a single buyer with regulated and unpredictable pricing of electricity in the Indian market poses challenges in pricing negotiations and revenue generation for sellers.

Conclusion:

Hydropower is one of Nepal's untapped resources. The full-fledged development of Nepal's hydro potential requires market assurance. The current level of economic development, the standard of living, and the purchasing power of the Nepalese population do not guarantee higher growth of domestic consumption. The government of Nepal is talking about the energy transition to replace traditional biomass and imported fossil fuels used in cooking and transport but lacks a definitive plan with a target to move ahead. Meanwhile, the hydropower project pipeline development by IPPs ensures that if the government of Nepal or NEA does not create hurdles in the development of identified projects, Nepal is going to get at least an annual increase of electricity production by 1500-2000MW per year. Therefore, Nepal urgently needs to increase the export potential for its surplus electricity in the days to come.

The main challenge to energy trade is the availability of additional capacity in cross-border power transmission capacity, cheaper finance, and, most importantly, simplified operational guidelines to facilitate fast and cost-effective power trade between the two countries. Electricity trading between Nepal and India has significantly benefited the socio-economic development of both countries. Nepal can gain by developing its major resource, hydropower potential, for which it will have a market, and export earnings can boost its economy and human well-being. India, on the other hand, can promote renewable energy sources like solar and wind power, whose intermittency can be balanced by importing from Nepal's flexible hydropower. Electricity import reduces the generation of coal and gas, thereby reducing the emission of greenhouse gases. Nepal's journey toward a sustainable energy future faces challenges, but a comprehensive approach involving policy reforms, strategic collaborations, and diplomatic efforts with neighboring countries, especially India, can unlock the country's vast potential in clean energy generation. This not only achieves the net-zero emission goal for Nepal but also helps neighboring countries reach their targets as planned.

The author is the former Managing Director of AEPC & Senior Energy Expert as well.

Interview

Sunil K.C.
Chairman; Nepal Bankers' Association (NBA)

'Nepal should consider attracting foreign investment to promote green energy'

For fostering prosperity, there is an urgent and compelling need for more robust infrastructure development. Currently, the focus lies on both the rapid advancement of energy and the intensive development of renewable energy sources. While numerous nations worldwide have acknowledged the commitment to carbon emission reduction as a fundamental principle, it has also become a global urgency. However, despite facing a shortage of investable capital, Nepal struggles with the elusive development of renewable energy infrastructure.

Illustrative examples include the Karnali-Chisapani Hydroelectric Project with a capacity of 10,800 MW and the Budhigandaki Hydroelectric Project with a capacity of 1,200 MW. These mega-projects could significantly contribute to Nepal's economic resilience. Unfortunately, Nepal has not yet mustered the economic strength to propel forward with such multi-dimensional, beneficial mega-projects. While financial institutions have recently started investing in hydroelectric projects, the infusion of capital remains insufficient to drive the country's progress in energy development.

What is the current status of investment in Nepal's green and renewable energy sector? What risks are associated with it? Excerpt of an energy talk with veteran banker and President of the Nepal Bankers' Association (NBA) Sunil K.C., who is also serving as the Chief Executive Officer of NMB Bank Ltd:

To what extent has the current global economic recession affected Nepal's banking sector, and how do you analyze the latest situation of the liquidity in our banking system?

After the global spread of the COVID-19 pandemic in 2019, worldwide economic turmoil ensued, marked by currency depreciation, increased interest rates, and geopolitical changes. This upheaval impacted the global economy, leading to a precarious situation. Nepal's economy also experienced the reverberations, with notable improvements in key economic indicators over the past six to seven months.

The country's monetary situation and external sector conditions have shown signs of progress. Remittance inflows have increased significantly, surpassing a 23 percent growth in US dollar terms. Foreign exchange reserves have reached 12.7 billion dollars, and there is stability in current accounts and savings balances. Import payments, totaling Rs 125 billion monthly, have contributed to a favorable balance in the foreign exchange position.

Despite these positive developments in the foreign exchange scenario, the financial sector is still under pressure. Reduced imports have led to decreased revenue, and the financial sector remains constrained. While the improvement in the foreign exchange situation cannot be denied, challenges persist within the financial sector. Timely adjustments are required to address ongoing market pressures. Although the global economic downturn has impacted Nepal's banking sector to some extent, the recent positive trends in economic indicators suggest an overall improvement in the country's financial landscape.

The current liquidity situation appears to be favorable with positive indications in number of areas like balance of payment, current accounts, and foreign currency reserves. This suggests a semblance of stability. Notably, the deposit and lending interest rates, as well as the average interest rate on loans, have seen a decline compared to the pre-COVID situation. The ease of investment in the private sector is evident, but there still exists cautious approach regarding the demand for loans.

In the first four months of the current fiscal year, there has been a substantial increase in deposit collection, while the demand for loans has decreased to 4 percent. Despite this, the deposit growth has reached 14 percent, signaling increased liquidity in the market. However, if the flow of loans does not increase proportionally, liquidity management might pose a challenge.

The ongoing post-pandemic has been a significant challenge, and despite the difficulties faced since the outbreak of the COVID-19 pandemic, Nepal somehow has managed to navigate through. The situation of Non-Performing Assets (NPA) has improved after the pandemic, and Nepal's status in terms of NPA is comparatively better than some neighboring countries. The reduced demand for loans and the increase in NPA have made the banking sector more vigilant. The policies adopted by Nepal Rastra Bank, along with some government initiatives, have instilled confidence easing credit demand, economic activities, and liquidity management.

While the government has increased investment, making loan flows more accessible, the recent rise in the number of Nepali nationals going abroad might have an impact on consumption. Staying alert towards such developments is crucial for an effective liquidity management.

The accumulation of loanable funds in banks suggests a lack of proactive involvement by both the public and private in development sector. How to address this issue while several solutions can be considered?

Amid the challenging situation, we are gradually moving out. Although the monetary condition has become more stable, the financial situation is still not easy. Revenue collection is not increasing at an impressive rate while the collected revenue is not spent on time and money is not flow smoothly to the grass root level. Without the continuous flow of money, the demand for production may not increase. Furthermore, the negative impact of the youth's migration abroad is apparent. Lack of self-confidence in the private sector is the main problem at present. Therefore, primarily, the ongoing issues need to be addressed by the government. Building confidence in the private sector is essential for investment.

The first issue is that we plan the project before the construction of transmission lines, and during the construction, there emerge various problems such as obstacles from local residents, contractors and the authorities, while unnecessary delays and irregularities in addition.

Currently, increasing investment in large-scale infrastructure projects is crucial to boost the flow of money until the grass root level. This alone can stimulate economic activities. Currently, the ratio of our debt to investment is less than 81 percent. The banking sector is in a position to invest significant amounts of money. Unlike the previous year when there was not enough liquidity, the situation now allows the banking sector to contribute to the growing economic activities.

Sometimes ago, there was a demand to waive the loans of banks, financial institutions, and microfinance. With the issues in place, what impacts have been experienced in banking business?

Banks and financial institutions are specialized and sensitive. They mobilize savings of depositors in the form of investments as trustees. Currently, more than 50 million depositors have entrusted banks with over Rs 5.6 trillion. We survive due to this money of the depositors. Therefore, seeking solutions by pressuring banks for loans, whether from the streets or at the political levels, is the wrong approach. This has undermined the morale of the banking sector. Additionally, challenges have been added to the security of bank employees."

This has shifted the perspective of foreign investors towards Nepal's banking sector as well. Currently, banking facilities are available in all local levels, including those of hilly and Himalayan regions. In this scenario, the government needs to provide further encouragement with an assurance of the security. The money lent by the bank is not the bank's own property; it needs to be returned to the depositors. Therefore, there is no exemption from repaying loans for anyone.

Is it possible to get out of this problem or not?

The personal security of the banks' employees providing loans has been put into question of late. Employees responsible for loan disbursement have been threatened, leading to incidents of their layoffs in branch offices. The absence of state presence for employees' security has been apparent. Such incidents have created distress among bank employees. In the current global economic downturn, a collective effort is needed to find solutions. Problems cannot be solved by resorting to threats and intimidation.

Energy development, including the renewable energy, is a priority of the government. However, there is a criticism that banks and financial institutions are not actively investing in this sector. What is your take in this matter?

Today, Nepal's banking sector has invested around Rs 322 billion in hydroelectricity and other renewable energy. The central bank has also increased the provision to raise banking investment in the energy sector by 6 percent for this year, escalating it to 10 percent. While the total investment of the financial sector is Rs 5 trillion, the investment in the energy sector alone amounts to Rs 322 billion. In the last 4-5 years, banks' investment in this sector increased by a notable amount. We did not take risks to invest in hydroelectric projects at the initial stage of the development of hydropower sector, but now the situation is different.

Banks' investment in the energy sector has played a significant role on getting rid of the load shedding at present. Now, we have reached at a point where export of electricity is possible. In the last two years alone, the banking sector has made an impressive investment of around Rs 200 billion in energy production. In the past 2-3 years we also issued bonds specifically to raise funds from the local market for this purpose. Energy is a unique sector where loans are still being obtained at a single-digit interest rate. As energy has been a priority sector for the banks, loans are made available at a fixed rate for up to 15 years.

NMB Bank, in particular, is continuing to advance in this sector because it holds immense potential in the present context. In the context of NMB Bank, we have approved a 34.384 billion loan for 46 hydropower projects with a total capacity of 737 MW, and we have disbursed 19.362 billion to date.

The recent initiation of electricity export is a testament to this potential. If the bank continues to support this sector, the domestically produced electricity can not only fulfill the local demand but can also compete with other industries, contributing to export growth. According to the latest provision of the central bank, if the total investment of banks reaches Rs 10 trillion until the fiscal year 2030, it is expected that Rs 1 trillion will be poured alone in the energy sector. Therefore, as bankers, we can anticipate an additional investment of Rs 700-800 billion in hydropower and other renewable energy.

While preparing for investment, especially in the electricity, market is crucial. What kind of preparations has the banking sector made to ensure the security of investments in a situation where the market for electricity is uncertain?

Investment in this sector has exceeded to Rs 322 billion. The commitment to investment is also significant, and investment is expected to increase further. Currently, Nepal's

electricity production capacity has surpassed 3,000 MW. With financial management for projects of around 7,000 MW, there is a possibility of short-term investments. The government's commitment was to achieve 15,000 MW by 2030, and now, with an increased target of 28,000 MW within the next 12 years, there is a substantial prospect for electricity production in Nepal. The Nepal Electricity Authority acts as the sole buyer of the produced electricity. However, if challenges persist in selling this electricity tomorrow, it will pose a significant challenge.

Recently, India has expressed its interest to purchase 10,000 MW of electricity from Nepal. There is also the possibility of engaging in energy trade with Bangladesh. The Russia-Ukraine war has led to an increased demand for renewable energy. Being the world's fifth-largest economy and on track to become the third-largest, India's growing economy is contributing to the rising demand for renewable energy. Therefore, effective management is essential to address these challenges. The establishment of energy trading companies, either private or from the banking sector, could be a viable option.

Additionally, the state needs to invest in strengthening and expanding the distribution infrastructure to increase domestic consumption. We too have been investing in the electrification of transportation, and banks have been providing loans for electric vehicles at affordable rates. There is a growing need to expand charging stations, and we are working towards the e-cooking while replacing the use of fossil fuels.

Blended finance has played a crucial role in acquiring affordable funds for infrastructure development. The main challenge now is to efficiently utilize the generated electricity. Constructing infrastructure alone will not be beneficial unless the government ensures effective distribution of electricity. As Nepal has become a significant player in the energy export, especially electricity, prioritization of this sector is imperative.

With an increasing demand for electricity, the NEA estimates an investment of around Rs 700 billion to build the domestic market. If the government's plan to increase investment in energy infrastructure by creating a Special Purpose Vehicle (SPV) is implemented, will the banking sector be ready to invest?

As of today, there is a liquidity surplus of Rs 700 billion in Nepal's banking sector. Currently, there is a provision to invest up to 50 percent in a single project. Based on this, if about 20 commercial banks collectively invest, they can invest in a single project of up to 350 billion rupees. Such a project can be undertaken by Nepali banks themselves, but the government needs to create an environment where risks can be mitigated efficiently. On the other hand, long-term projects are not the focus of commercial banks; rather, development banks are more suited for such investments. If the government creates a SPV or issues bonds, the banking sector can participate. Currently, without developing the large-scale infrastructure and reservoirs, it might be challenging to export electricity in regional market even if there is a huge demand.

There are examples like the Upper Trishuli-1, where foreign institutions can also actively be involved in organized investments. Projects with investments of more than 435 million dollars are currently underway. Nepal's banking sector has been collaborating with foreign banks and investors for the past 3-4 years and actively participating in investments in renewable energy and small to medium-sized businesses. We have created an environment of self-confidence to attract investments from abroad. By utilizing this, we can bring in money from abroad and invest it here. Therefore, if the banking sector is allowed to work freely, we are ready to move forward. For the construction of major infrastructure projects in Nepal, we need to develop capacity of other sectors as well.

If that is the case, does it imply that the funds will be available as long as the conditions persist?

We also need to have policy back up along with working in collaboration with the environment.

If we enter into a consortium or syndicate financing, can we also establish a medium-scale storage project?

We can do so systematically. Additionally, we can form syndication with local and foreign investors.

The central bank has introduced the concept of 'Green Taxonomy' in monetary policy for the promotion of green energy. What is its relevance and potential in Nepal?

Now, we have to move towards building a green economy; that's the future. There are 2-3 reasons behind this – Nepal is a country that, even with low carbon emissions, falls among the top 10 nations in the lists that are most affected by the climate change. When looking at this, our investment plans and investment risks are over Rs 300 billion. So, it is necessary to be aware and work towards it. The concept of Green Taxonomy is introduced by the central bank in the final stage. The guidelines on how to move forward or what to do next are also provided by the central bank. Therefore, it will be easier for us to work accordingly.

Has the banking sector achieved the targeted progress in the energy sector so far?

Progress has been made, but there are many challenges. The signing of the Power Purchase Agreement (PPA) for hydropower projects was delayed, and in addition, there was an ambiguity in it. Without clear policies, banks cannot invest. Therefore, policy clarity is needed. Banks that are interested to invest from abroad should also be provided an access. Recently, there has been a global trend of establishing climate funds for investment, and our rights should be asserted for such funds. Banks can work with such funds and contribute to the development of the country. The central bank has stated that it is not easy to achieve the target of 10 percent of the renewable energy by 2030. Clear policies are essential, and banks need to invest with adequate funds from abroad. The recent establishment of climate funds globally for investment in climate projects could be a right move that banks should assert. The central bank also mentions that achieving 10 percent of the renewable energy by 2030 will not be an easy task.

The investment made by the bank is facing a challenge due to reasons such as lack of PPA, delayed construction of transmission lines, and not being able to sell the generated energy in the market. Where is the problem of disbursement?

The first issue is that we plan the project before the construction of transmission lines, and during the construction, there emerge various problems such as obstacles from local residents, contractors and the authorities, while unnecessary delays and irregularities in addition. The main risk is in financing. This has led to problems in the cash flow, and if the project cannot be operated at full capacity, electricity generation is affected. Additionally, the PPA rate for hydropower production has remained constant and has not been reviewed over the time. Looking from the perspective of financiers, the project's cost has increased. Interest rates or exchange rate fluctuations have also caused the project to operate at very low profits.

Furthermore, social and environmental issues have added risks to the project. Natural disasters such as earthquakes, floods, and environmental and social reasons cause delays, closures, and non-operation for an extended period. Therefore, the estimation that hydrology itself will change due to climate-related issues is the main risk, as initially estimated costs and work may not be accurate.

For large projects like hydropower, availability of affordable funds is essential. Foreign funds can be utilized for this purpose at a time when Nepalese banks are not self-reliant in terms of liquidity internally. When it comes to long-term projects, tools like green bonds must be made available for banks to invest in the project. This makes both short-term and long-term investments easier. For this, the government needs to implement mechanisms like hedging and country rating, among others. Even though work has been done principally on these issues, practical implementation is lacking.

Currently, when we borrow money from abroad, we have to pay a 10 percent withholding tax, while countries like Sri Lanka and Bangladesh don't have to pay such taxes. This raises the question on how we can be competitive. All parties need to pay attention to making this provision effective. The mechanism of the Environment Impact Assessment (EIA) is not proper; rather it should also involve the role of society and governance. Every project cannot be financed with Nepal's money; if we want to bring in funds from abroad, banking and other infrastructure need to be developed accordingly.

Why don't policies seem to be implemented effectively despite the government setting targets for hydropower production from 15,000 to 28,000 MW at different times?

Being optimistic and setting high goals is a positive thing, but before anything else, we need to accurately assess our capabilities to determine our goals. For example, generating 28,000 or 40,000 MW of electricity is technically possible. However, what is the capacity of the banking industry to invest in such projects? If banks cannot invest, what other sources are available? Where are the commitments? Apart from the banks, what are other potential investors? We need to consider local resources beforehand.

How many experts do we have in Nepal for that? How can we attract them? The project's success lies in the company's realistic situation in the business community. If we only create goals and do not involve in other sectors, we obviously face challenges at some points. Perhaps there are issues in project implementation. Establishing a mechanism to expedite fast track work is necessary, but certain legal obstacles may arise. Now, focusing on pure projects and moving forward by keeping them in mind is essential. In this way, we can incorporate energy in other industrial sectors. To balance payments, banking needs to invest in energy, even if it may subject to facing losses. In this sector, we can progress further. For this, facilitation is needed.

When the government sets long-term goals involving the banking sector along with business stakeholders, can you anticipate achieving the expected results?

Yes, when determining any goal, identification of investment and revenue sources is crucial. If any internal or external challenges or issues are identified during the planning phase, it is imperative

to address them instantly. In this context, thorough discussions with all stakeholders, including the government, in the early stages can help prevent potential problems.

Nepal has set a goal for zero emissions by 2045. What financial instruments are necessary to bring in green hydrogen and clean energy production in Nepal?

World markets are witnessing the creation of new energy sectors. The identification and development of these sectors are not entirely achievable through Nepal's internal resources alone. For the production and storage of green hydrogen in Nepal, significant financial resources are required. To bring these possibilities to fruition, substantial investments are necessary in Nepal's clean and green energy. Many individuals are already prepared to invest in clean and green energy in Nepal because the country has the potential to advance to climate change and achieve zero emissions.

Nepal's banks need to gain recognition and approval from Green Climate Funds or other similar sources. This is our right, and with such recognition, there is an opportunity to see significant growth in long-term investments in projects over an extended period. Green bonds, sustainable bonds, sustainable financing, and creating impact through collaboration are all tools that contribute to the sustainable development of projects. The ongoing campaign to mitigate climate change also benefits from supporting instruments.

The current concept of blended financing, incorporating both commercial and philanthropic funds, is helping to make finance more affordable, fostering the development of financial sectors within Nepal. This approach also supports the development of financial sectors within Nepal. Additionally, the operation of tools such as hedging funds, guarantees, and risk mitigation tools must be implemented.

Could you observe any preparations on the part of the government for this?

The government has also implemented this practice in the annual budget. With extensive development taking place, let's keep a hope. The central bank has also moved forward with the concept of Green Taxonomy.

What kind of modality is necessary for Nepal to adopt for the development of clean and green energy?

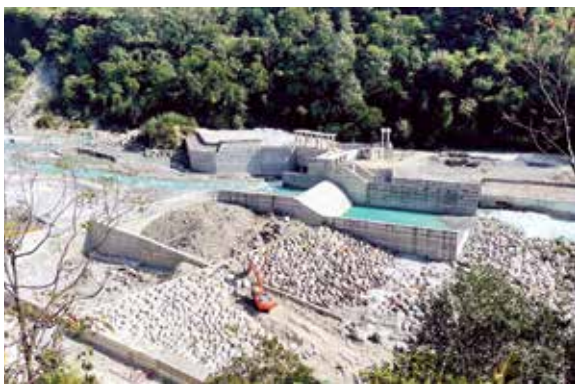
Nepal is in a very favorable position in terms of renewable energy. We are connected with India and China, the world's second-largest and fifth-largest economy, and addressing the growing demand for renewable energy in India presents an opportunity for us. Developing countries like Bangladesh, which are economically vibrant, can gain the lessons in the political, economic, private, and government sectors in addressing this issue.

Along with hydropower, exploring new concepts like green hydrogen production based on our available capacity can bring maximum benefits and meet domestic demand. Attention must be given to developing a technology for hydrogen storage and utilizing it for the advancement of green energy. While we are in the initial stages of technical development, focusing on hydrogen storage technology can be beneficial for advancing green energy. Nepal, being a landlocked country, needs to pay attention to resource mobilization and capacity development, especially in the field of green and sustainable energy.

Nepal can acquire grants or loans through economic diplomacy, utilizing both public and private banks. Efficient management of electricity trading in the form of a commodity, coupled with the increase in the effectiveness of electricity distribution, can significantly propel the private sector forward in this sector. To meet the rising demand for electricity, particularly emphasizing the fulfillment of peak demand, focusing on alternative energy sources like biofuels becomes imperative. Working on this model can make Nepal more adaptable, and by concentrating on electricity export, Nepal can become a central player in the region. Given India's large population and increasing industrialization, making it the world's third-largest economy within 5-7 years, Nepal could potentially become a viable supplier of electricity. The future of Nepal may lie in this, making it crucial to focus on carbon trading. Nepal has the potential to leap ahead in energy conversion. Playing a significant role in the "Energy Transition" in South Asia is possible for Nepal.

Is it necessary to prioritize this matter at the political and economic levels?

It is not limited to a specific bank or the Federation of Nepalese Chambers of Commerce and Industry (FNCCI); it is essential for all business entities. This initiative is not just for us but is necessary for future generations as well. With the advent of hydrogen, discussions about ammonia have emerged, aligning with agricultural development. With an average income of $1,450 per capita, our country can potentially reach a prominent position in the future. To achieve that goal, we must move forward with firm determinations.



SETI RIVER

VISION LUMBINI URAJA COMPANY

Butwal, Rupandehi

The murky political waters have proved a fertile ground for national and international politics to play out in hydroelectric development (Schulz & Saklani, 2021) and for vested interests of politicians or international development organizations to prevail over national interests (Singh, et al., 2020)

Suman Basnet

Abstract

Nepal wants to aggressively develop its hydroelectric potential for its overall development. However, the seasonal variation in electricity generation of mostly run-of-river based hydroelectric generation in Nepal is a major problem. Nepal hopes to address this challenge by policy options of developing more storage hydroelectric projects, through more electricity trading with its neighbours, developing more non-hydro renewables or a mix of these options. Resilience of Nepal's hydroelectricity generation against socio-economic, environmental and techno-political vulnerabilities will be the metrics for assessing these policy options. The metrics include increasing disaster resilience and reducing population displacement, cost of electricity, carbon intensity of generation, financing needs, reliance on imports and feasibility of implementation. Such a policy options analysis to address this issue has not yet been carried out.

Based on the assessment of the status quo and the three policy options for addressing Nepal's seasonal electricity generation variability against the resilience criteria, the policy option to promote an optimal mix of run-of-river and storage hydroelectricity, along with solar PV and electricity trading is recommended as the best policy option. This policy option has the lowest adverse social, environmental and economic impacts. The concerted and effective implementation of the 2018 White Paper by the Ministry of Energy, Water Resources and Irrigation is also recommended to be the best means of implementing this policy option.

Introduction

Problem Description

Issues in Nepal's Electricity Generation

Only about 6% of Nepal's immense hydroelectric potential has been developed (NEA, 2023). Accelerated and sustainable development of Nepal's hydroelectricity potential is taken to be crucial for the country's overall development through increased use of electricity in the domestic, industrial, commercial, agricultural and transport sectors (Singh, et al., 2020; Crootof, et al., 2021). Nepal also aims to export excess electricity to neighbouring countries and thus contribute to clean energy use in the region (Dixit, et al.,

Towards a Resilient Electricity Generation System in Nepal

2004). An Asian Development Bank study indicates that developing only 20% of Nepal's hydroelectric potential could increase Nepal's real gross domestic product by 87% by 2030 (Gunatilake, et al., 2020). Therefore, Nepal wants to aggressively develop its hydroelectric potential.

However, the seasonal variation in electricity generation of mostly run-of-river[1] based hydroelectric generation in Nepal is a major problem. During the rainy season, there is surplus electricity, whereas electricity production is greatly reduced in the dry months (Dixit, et al., 2004; Hurford, et al., 2014). Therefore, Nepal is needing to import electricity from India during the dry months and spilling energy in the form of water over the dam during the wet season.

Besides the status quo of continuing to develop more run-of-river hydroelectric plants, Nepal has three technological options to address this challenge:

Developing more storage hydroelectric projects (Dixit, et al., 2004; NEA, 2014)

Increasing electricity trade with its neighbours, especially India (Dixit, et al., 2004; Bhatt, 2017)

Promote an Optimal Mix of Run-of-river and Storage Hydroelectricity, along with solar PV and Electricity Trading

Goals for Nepal's Electricity Generation

Nepal aims to make its electricity system as resilient as possible (Basnyat & Watkiss, 2017). Resilience is a multi-dimensional concept (Gasser, et al., 2020). It may be defined as the electricity system's capacity to absorb shocks and maintain full functionality (Molyneaux, et al., 2012). In Nepal's case, when addressing the vulnerability of the current hydroelectricity generation regime, socio-economic, environmental, and techno-political resilience will be the most important metrics for assessing the impacts of the different technological approaches to increasing Nepal's electricity system resilience.

This article will assess the resilience of Nepal's electricity system for each of the options for addressing the current electricity generation variability in Nepal. It will do so by assessing how each option can overcome the socio-economic, environmental, and techno-political vulnerabilities that Nepal's electricity system may potentially face.

Review of Relevant Research

Nepal's hydroelectric development experienced a paradigm shift after Nepal transformed from absolute monarchy to multi-party democracy in early 1990s. A private sector friendly policy environment resulting in increased participation of the private sector and flow of foreign direct investment was a major outcome of this shift (Dixit, et al., 2004; Dixit & Basnet, 2005; Bhatt, 2017; Schulz & Saklani, 2021). There is extensive literature available about the opportunities and challenges faced by Nepal's electricity sector after the 1990s. However, it mostly highlights the political climate (Bergner, 2013), sharing of benefits of hydroelectric development (Dixit, et al., 2004; Dixit & Basnet, 2005), and mobilizing investment, as major issues of hydroelectric development in Nepal. Other issues include impacts of climate change (Bhatt, 2017; Crootof, et al., 2021), addressing socio-environmental impacts (Nepal Hydropower Association, 2016), insufficient human and financial resources, high development costs (Singh, et al., 2020) and lack of effective corporate or public governance (Crootof, et al., 2021). Quite a few studies have also compared different sizes of hydroelectric plants sizes and have advocated for small (Bergner, 2013) or medium scale (Singh, et al., 2020) hydroelectric development. However, even though the issue of seasonal variation of electricity from Nepal's mostly run-of-river projects is covered quite extensively in the literature (Dixit, et al., 2004; Hurford, et al., 2014; Bhatt, 2017; NEA, 2014), a comprehensive policy options analysis to address this issue has not been carried out.

Criteria to Assess Policy Options

Vulnerabilities of Nepal's Electricity Generation

Nepal's electricity generation faces several vulnerabilities but, mainly, they have social, environmental and techno-economic characteristics.

Social-economic vulnerabilities

Hydroelectricity development usually have negative impacts in the social environment around the project site. This includes either physical or economic displacement of people, households, and livelihoods caused by inundation by storage project reservoirs, or by reduced water flow in sections of a river (Bhatt, 2017; Crootof, et al., 2021). Furthermore, additional costs and longer developmental time associated with transporting, storing, constructing, operating and maintaining hydroelectric projects in remote hilly locations is another major vulnerability (Sovacool, et al., 2011). Equity and energy justice is also an important consideration while assessing social vulnerabilities.

Environmental vulnerabilities

Climate change vulnerability is another major problem for Nepal's hydroelectricity development. Nepal has witnessed an increase in extreme events, like flooding, landslides and glacial lake outburst floods. There is also dramatic decrease in the Himalayan glacier volumes (Dixit, 2019). Another potential environmental vulnerability is the loss of land and water biodiversity (Bhatt, 2017). Carbon emissions from electricity generation in India is also an environmental consideration. India's predominantly coal-based electricity generation contributes close to 2.4% of global carbon emissions, a third of India's carbon

1 Hydropower plants that operate on the flow of the river without modification by upstream storage (Merriam-Webster)

emissions, and around half of its carbon emissions linked to fuel use (Trivedi, 2022). Therefore, importing electricity from India can increase Nepal's carbon footprint but exporting can help reduce India's carbon emissions.

Techno-political vulnerabilities

These are vulnerabilities in the electricity system that depend on reliance on one type of technology. Secondly, costs associated with the internal politics related to hydroelectricity and solar PV development and geo-politics of electricity trade in the Indian sub-continent are also very significant. Finally, insufficient financing and foreign investment are other major challenges (Sovacool, et al., 2011).

Criteria for Assessment

Therefore, the policy options to address Nepal's current electricity generation variability will be assessed against the following criteria that are considered important for ensuring a resilient electricity system in Nepal:

Socio-economic resilience

Socio-economic resilience would mean that the population displaced by an option is as low as possible. This will lessen local opposition to the option. In addition, it should also consider the positive benefits it may bring to the local communities around the project site. Secondly, it would also mean that the total cost of electricity generation because of minimization of costs associated with land acquisition, compensation for lost property, resettlement and rehabilitation, can be reduced.

Environmental resilience

Environmental resilience that ensures that the option is least impacted by disasters, which are increasing in intensity potentially due to climate change. Furthermore, the option would also contribute the least to increasing carbon emissions.

Techno-political resilience

Techno-political resilience encompasses the concept of an electricity system being a socio-technical system. Such systems are a complex amalgamation of technical, economic, political and social aspects (Sovacool, et al., 2011). Since social, economic and environmental issues are dealt with separately here, techno-political resilience emphasizes the close relationship between technical and political aspects of electricity generation in Nepal. To ensure this resilience aspect, an option needs to attract adequate financing and decrease reliance on imports which, in Nepal's case, is heavily influenced by ever-changing geo-politics in the region.

Feasibility of Implementation

The ease with which the policy can be implemented, from both political and administrative perspective is a very important evaluation criterion. This criterion will consider how easy will it be to enforce the policy option with existing regulations because radical policy options are more difficult to implement than options that only seek to make incremental changes to the status quo (David L. Weimer, 2017).

Therefore, to summarize, the policy evaluation criteria to be used for evaluating the options will be as follows:

Resilience	Policy Evaluation Criteria
Socio-economic	• Population displacement • Cost of electricity
Environmental	• Disaster resilience • Carbon intensity of generation
Techno-political	• Financing • Reliance on imports
Feasibility of implementation	• Ease of implementation of the policy option from political and bureaucratic perspectives

Landscape, Regime and Niche in Nepal's Hydroelectric Development

Landscape

Nepal's hydroelectric development is tied to the use of Nepal's rich water resources. This has made it very political (Becker & Naumann, 2017). However, an unstable political environment with frequent government turnover, mostly coalition governments and frequent intra- and inter political party squabbles (Zou, et al., 2022), have led to insufficient political desire to improve the policy environment for the energy sector (NEA, 2014) and has resulted in frequent changes in rules and regulations creating uncertainties for investors (Singh, et al., 2020; Zou, et al., 2022). The murky political waters have proved a fertile ground for national and international politics to play out in hydroelectric development (Schulz & Saklani, 2021) and for vested interests of politicians or international development organizations to prevail over national interests (Singh, et al., 2020). Manipulation of existing legal provisions by vested interests is also a concern for effective implementation (Nepal Hydropower Association, 2016).

Regime

Nepal's electricity development is dominated by run-of-river hydroelectric projects (Policy Entreprenuers Inc., 2021). Consequently, the governance structure has been established to promote this. The resulting lock-ins and path dependencies tries to protect sunk costs, revenue flows and the "network effect" of the currently dominating run-of-river hydroelectric projects (Araújo, 2014). Consequently, the government also emphasizes construction of run-of-river projects with a vast transmission line network for Nepal's industrial development and electricity export to neighbouring countries (MOEWRI, 2018).

Niche

The nascent solar PV development, electricity trading, federalization and digitalization aspects of the electricity sector can be considered the socio-technical niche for Nepal's electricity sector. Even though grid connected solar PV currently constitutes only 3% of the total installed capacity, there are efforts to develop solar PV more aggressively going forward. NEA is in the process of signing PPAs with IPPs for 100 MW solar PV projects (NEA, 2023). Furthermore, 14 solar PV projects totalling about 100 MW have construction license and 2 projects totalling 5 MW have applied for it. Similarly, 45 projects totalling 761 MW have survey license and 2 projects totalling 101 MW have applied for it (DOED, 2023). Since 2022, export of electricity to India has dramatically increased and may soon become a major percentage of Nepal's hydroelectric generation and an important source of revenue. Nepal's federal governance structure opens the possibility for a multilevel governance system (Dobravec, et al., 2021) that combines both centralized and decentralized approaches. Given Nepal's federal structure with the government mandates on energy development distributed among all three tiers of government-federal, provincial and local, the multilevel governance approach may be the best governance option for Nepal going forward since it emphasizes cooperation and coordination over control and conflict. Finally, digital technologies can help to seamlessly integrate various systems in Nepal's electricity generation system, making it more smart, efficient and resilient (IEA, 2017).

Need for Policy Mix

Each of the policy options will need to address multiple failures and uncertainties. Therefore, each option will have to be a policy instrument mix, namely a combination of policy instruments for meeting the goals of a policy option (Bouma, et al., 2019).

Governance

Over 30% of electricity is currently produced by the private sector in Nepal, with many more projects under development. However, the government-owned utility, the Nepal Electricity Authority (NEA) has a "monopsonic[2] position" in Nepal's electricity sector because it is the only buyer of electricity from independent power producers (IPPs). NEA has been criticized for preferential treatment through more favourable power purchase rates with its subsidiary companies than with IPPs. It has also resisted past government efforts to unbundle it to improve its efficiency (Schulz & Saklani, 2021). Even though Nepal has an Electricity Regulatory Commission (ERC), it is completely under the control of the MOEWRI making electricity regulation prone to influence of vested interests and political interference. Ensuring the autonomy of ERC is a major governance challenge in Nepal (Jamasb, et al., 2017). These two major governance issues may have an impact on the policy options described below.

Therefore, the assessment of the policy options will have to be carried out within the contextual environment described above.

Policy options

Four policy options for addressing Nepal's seasonal electricity generation variability will be discussed below.

Policy Option 1 – Promote Run-of-River Hydroelectric Projects (Status Quo)

Description

This option will continue the government's current policies that primarily support development of run-of-river hydroelectric plants. The current policy instruments comprise of fixed power purchase rates, providing generation licenses on a first-come-first-served basis, and other requirements and incentives that favour run-of-river projects.

Advantages

This option is seen to be the least cost method to develop Nepal's abundant hydroelectric potential (NEA, 2014), with the least adverse impact of hydroelectric plants on local environments (Crootof, et al., 2021). It is also the most politically feasible option because it requires no change (Bergner, 2013). Therefore, the private sector is most comfortable to develop such projects (NEA, 2014).

Drawbacks

However, this option still requires significant investment in infrastructure, including roads and transmission lines (Bergner, 2013). It is responsible for the current generation variability because, as dry season river flow is significantly less than the average monsoon flow, electricity generation from run-of-river drastically decreases in the dry season (Hurford, et al., 2014). Finally, such plants are also the most susceptible to climate change impacts, including reduced river flow, and more frequent and extreme events like landslides, flooding and glacial lake outburst floods (Bhatt, 2017). It is estimated that the economic cost of climate change by 2050 in hydropower and agriculture because of water induced disasters could be 2–3% of current annual GDP (Bhatt, 2017).

Policy Option 2 – Promote Storage Hydroelectric Projects

Description

This option will promote accelerated development of storage hydroelectricity projects in Nepal. Even though there are many feasible storage projects, their cost and their social and environmental impacts are of major concern. Therefore, these projects can best be developed through a public-private partnerships

2 Many sellers, one buyer

(PPPs) model (Schulz & Saklani, 2021). This is important because such projects require a lot of support for building the necessary roads, bridges, transmission lines and other similar infrastructures (Schulz & Saklani, 2021), where public funding will be crucial.

Such a policy option will require various policy instruments to mitigate risks and incentivize investments. They may include requirements of a strategic environmental assessment that considers cumulative impacts of hydroelectric plants to reduce inundation impacts and lessen socio-environmental impacts, having higher limits on dam height to reduce costs and lower limits on reservoir size to ensure adequate storage capacity (NEA, 2014). It may also encompass ensuring effective relocation, rehabilitation, compensation and royalties distribution to avoid local resistance (Nepal Hydropower Association, 2016; Schulz & Saklani, 2021), having appropriate tariff setting (NEA, 2014), addressing foreign currency exchange risks, establishing financial hedging mechanisms, and providing additional financial incentives for such projects (Schulz & Saklani, 2021).

Advantages

The advantage of storage projects will be that they can store water during the monsoon season and generate electricity during the dry season (Hurford, et al., 2014) and they can also help to reduce some impacts of climate change by storing water for hydropower production to mitigate the adverse impact on river flow because of more floods and famines that climate change may precipitate (Bhatt, 2017).

Drawbacks

These projects require significant investment in infrastructure, including roads and transmission lines. They may also face more local opposition because of the need for more resettlement and the negative environmental impacts from inundation. There are examples of many such failed projects, such as Karnali and West Seti projects in Nepal and the Sardar Sarovar Dam in India (Dixit & Basnet, 2005; Bergner, 2013).

Policy Option 3 – Promote Electricity Trading

Description

This policy option seeks to secure access for Nepal's electricity in India's power market (NEA, 2014). However, to make it successful, there is a need to establish institutions, procedures and other mechanisms for a competitive wholesale power market (NEA, 2014)

Advantages

The advantage of this option is the potential export revenue that can be generated, which can have big impact on Nepal's domestic economy (Bergner, 2013). Furthermore, it can also pave the way for a South Asian energy market, where other neighbours like Bangladesh and Sri Lanka could also be a part (Schulz & Saklani, 2021). This may further enhance Nepal's export revenues.

Drawbacks

However, its success relies on the region's geopolitics. Nepal's almost total reliance on India for electricity trading (Rana, 2020; Zou, et al., 2022) will be its biggest disadvantage. Furthermore, it has been proven many times that Nepal's unstable government has made Nepal's negotiators weaker during bargaining and they are often seen to be willing to get into agreements quickly without adequate homework (Schulz & Saklani, 2021).

Policy Option 4 – Promote an Optimal Mix of Run-of-river and Storage Hydroelectricity, along with solar PV and Electricity Trading

Description

This policy option seeks to implement the aspirational objectives of the Government of Nepal to optimally develop Nepal's run-of-river and storage hydroelectricity potential, along with solar PV and electricity trading with neighbouring countries. This aspiration is clearly reflected in the White Paper on Present Status and Future Roadmap published by MOEWRI in 2018. It presents the concept of generation mix that comprises concurrent development of run-of-river and storage hydroelectric projects complemented by development of other renewable energy projects. It also emphasizes electricity trade, both internally and internationally through a multi-seller and multi-buyer model (MOEWRI, 2018). Effective implementation of the White Paper would in effect be an implementation of this policy option.

Advantages

The advantage of this option is that Nepal can develop its hydroelectricity potential in the most cost effective and socially and environmentally responsible manner and complement the seasonal variability and climate change impacts on hydroelectricity generation in a dynamic manner, through development of other renewable energy resources, primarily solar, and also through cross border electricity trading.

Drawbacks

The major drawback of this option will be that it will inherit some of the drawbacks of all the other options. This option will still require substantial investment in infrastructure as for Options 1 and 2, though perhaps to a lesser degree. Furthermore, it's success will still be rely on the region's geopolitics like Option 3. However, some of the drawbacks may be mitigated because Nepal will have more options, so that if at any time one aspect of the policy option poses difficulties, Nepal can focus on the other easier implementable aspects of the policy option while parallelly trying to address the hurdles.

Comparison of Policy Options

The four options will now be assessed against the four policy evaluation criteria described above.

Socio-economic resilience

The electricity trading option will result in no population displacement resulting in no local opposition to this option. The run-of-river projects may have a smaller impact than storage projects and consequently less local resistance.

Given the higher infrastructure requirements and environmental and social mitigation costs of storage projects, their cost of electricity generation will be higher than that of run-of-river projects. Given Nepal can export its surplus electricity, the environmental and social mitigation costs for electricity trading may be the lowest.

Environmental resilience

Electricity trading of surplus electricity will be least impacted by disasters. The only components that can be impacted may be the transmission lines. However, storage projects and run-of-river projects will be highly impacted by disasters. From a climate change perspective, storage projects – because of the water storing capacity – may be slightly less affected by climate change impacts.

From a carbon emissions perspective, net export to India will contribute to reducing carbon emissions from India's predominantly thermal electricity generation. However, net imports will have the reverse impact. Furthermore, storage projects may have higher carbon emissions that run-of-river plants. Run-of-river projects typically have minimal or no reservoirs and thus have a lower impact on carbon sequestration compared to storage projects. This also minimizes the displacement of vegetation, reducing the potential for decomposition and methane emissions.

Techno-political resilience

Techno-political resilience will be the most important yet complex parameter to assess the policy options. Run-of-river plants will be the most techno-politically resilient because they are part of the socio-technical regime. That makes them the most politically feasible option. Storage projects, because of high investment requirements and their social and environmental impacts have always been at the periphery of the hydroelectricity development regime in Nepal. It makes them politically more complex and therefore less feasible. With the construction of 400 kV cross-border transmission lines, electricity trading has become technically very feasible (Aryal & Dhakal, 2022). However, the trade-off is the geo-political complexity (Huda & McDonald, 2016). Since Nepal is totally dependent on India for this option, there is intense debate within Nepal on how much Nepal should rely on electricity export for its future development.

Implementation Feasibility

This is an instrumental goal which can help or hinder the accomplishments of the above goals. Implementation of the status quo will be the easiest option. Electricity trading, especially with India, is also implementable because there has already been a start to it. However, there are hurdles, especially political that still need to be overcome to scale up the trade with India and begin trade with other neighbours, for example, Bangladesh. Developing storage projects still faces immense hurdles, especially financial, environmental and social, and will therefore still be difficult to implement. Finally, implementing the policy option for an optimal generation mix will also be difficult unless there is serious political and bureaucratic will to do so. It is the author's belief that effective implementation of the MOEWRI White Paper of 2018 will also ensure the implementation of this policy option.

Based on the above discussions, a comparative assessment of the policy options against the criteria is given in the table below.

Resilience Dimension	*Policy Evaluation Criteria*	*Resilience Assessment*			
		Option 1	*Option 2*	*Option 3*	*Option 4*
		Run-of-river (Status Quo)	*Storage*	*Electricity Trading*	*Optimal Generation Mix*
Socio-economic	*Population displacement*	*Medium*	*Low*	*High*	*High*
	Cost of electricity	*Medium*	*Low*	*High*	*High*
Environmental	*Disaster resilience*	*Medium*	*Low*	*Medium*	*High*
	Carbon intensity of generation	*Low*	*Medium*	*Low*	*Medium*
Techno-political	*Financing*	*Medium*	*Low*	*Medium*	*Medium*
	Reliance on imports	*Medium*	*High*	*Low*	*High*
Implementation Feasibility	*Ease of implementation of the policy option*	*High*	*Low*	*Medium*	*Low*

Please note: High is good, low is bad

Recommendations

Based on the above analysis, policy option 4 (which promotes an optimal generation mix) is recommended as the best policy option. This policy option has the lowest adverse social, environmental and economic impacts. The electricity trading component of this policy option, especially with India, is tied closely to regional geo-politics. This has always been very complex. Therefore, the trade-off is that Nepal will have to be dependent on Indian goodwill. However, if Nepal can accelerate the development of its run-of-river plants, solar PV potential, and the most feasible storage hydropower projects and export significant amounts of power, the geo-political relationship with respect to energy could transform from that of dependence into one of interdependence.

The author believes that the concerted and effective implementation of the 2018 White Paper will be the best means of implementing policy Option 4. The White Paper highlights the need to promote foreign and domestic investment, establish a hedging fund to address foreign currency exchange risk and streamline the license approval process. It also emphasizes promoting a robust electricity market with multiple buyers and sellers, building a robust transmission interconnection, developing adequate human resources, and promoting innovations like smart meters, smart grid, smart street lighting, pumped storage hydropower projects, back-to-back DC inter-country connections, online payments, and e-governance. It also delves into demand-side energy management. This includes building an extensive electric vehicle charging station network and promoting electric cooking in each household, providing reliable electricity to special economic zones to promote electricity-intensive industries, bringing about pricing reforms and aggressively promoting energy efficiency. The White Paper also emphasizes the need for energy projects to benefit Nepali citizens by providing them with investment opportunities. It discusses energy for and with social justice, gender equality and social inclusion. The White Paper also presents an electricity generation mix of storage, peaking run-of-river, and run-of-river hydropower projects to be complemented by non-hydro renewable electricity generation. It emphasizes the need for good governance, accountability and transparency, and the corporate reform of the Nepal Electricity Authority. The White Paper also links energy with irrigation, modernization and industrialization, flood control, drinking water, irrigation, tourism, environmental services and water transport and emphasizes the need for projects to be resilient to disasters. It highlights the need for a national integrated water resources policy and integrated basin development. The paper also emphasizes the urgency to transition away from unsustainable to sustainable energy use in domestic, commercial, industrial transport, agricultural, education and health sectors and highlights that energy efficiency and waste-to-energy is critical for Nepal's shift to a sustainable and resilient future (MOEWRI, 2018). Therefore, the effective and concerted implementation of the White Paper will be the surest way to achieve Policy Option 4 related to developing an optimal electricity generation mix for Nepal together with its utilization.

The author is the Energy Experts.

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Gender-Inclusive Hydropower Development in Nepal

CA Sanju Adhikari

Due to male dominated foreign migration for employment, women have sheer number of population in rural areas where majority of project development and expansion take place.

Background

Nepal is a rich country in terms of natural resources and budding opportunities. Even though a country's topography has been the biggest challenge for infrastructure development, it is also a valuable resource for various needs, including hydropower. We have huge hydropower potential. Based on the water resources availability, Nepal's technical potential for hydropower has been estimated to be 83 gigawatts (GW). Usually all the technically potential water resources will not be developed due to other constraints. Hence, about 42 GW is considered economically viable (ADB south Asia Working Paper Series No 20, June 2020). As per Nepal Electricity Authority's annual report 2023 - NEA's hydropower plants generated 2,930 GWh of electricity in the year 2022/23. The perennial nature of the rivers and the steep gradient of landscape provide ideal settings for the generation of large hydroelectric projects.

Nepal's Small and Vulnerable Economy

Nepal is one of the least developed countries of the world that needs to come up with a well thought out plan to bring economic prosperity for poverty alleviation. Nepal is an import-reliant economy where more than 40 percent of its revenues come from import taxes (Government of Nepal, 2022). Imports have increased throughout trade history of Nepal. The over reliance on imports versus weak exports is reason for the chronically widening trade deficit, which has adversely affected development.

The reliance on imports also causes many other negative impacts ranging from slow industry growth, vacuum in human capital development, lack of innovation and entrepreneurship, ballooning trade deficits, depleting foreign currency reserves and stifling of fast paced economic growth. All these problems are evident in various proportions in Nepal. To implement import substitution the government have to replace its most substantial revenue contributors with alternatives. At present agriculture, energy and tourism are believed to be the foundations for game changing transformation. The country has continued to prioritize energy production for export to neighboring countries.

Hydropower Electricity in Nepal

Although hydropower is produced in 150 countries, Nepal's economically feasible hydropower generation capacity is one of the highest. Nepal's first hydropower project, Pharping (500 kw) was started in 1968 B.S.(May 1911). Based on the water resources availability, Nepal's technical potential for hydropower has been estimated to be 83 gigawatts (GW). Usually all the technically potential water resources will not be developed due to other constraints. Hence, about 42 GW is

considered economically viable (ADB south Asia Working Paper Series No 20, June 2020). Nepal's total installed capacity of electricity has reached 2,532.36 MW in April 2023. (My Republica, 15 April 2023)

Besides, Nepal has not yet fully realized the multipurpose, secondary, and tertiary benefits from hydro resources – drinking water, irrigation and flood management, etc. Nepal's water resources endowments are extraordinary. It endows approximately 6,000 rivers with a total length of 45,000 kilometers (km). Average water runoff from these rivers is about 220 billion cubic meters annually. The major river basins are Sapta Kosi, Karnali, Sapta Gandaki, Mahakali, and the Southern rivers (Gurung and Oh 2011); their respective generation capacities are presented in Table 1.

Table 1: Major River Systems of Nepal and Their Hydropower Potential

Major River Basin	Theoretical Potential	Technical Potential		Economic Potential	
	MW	Project sites	MW	Project sites	MW
Sapta Kosi	22,350	53	11,400	40	10,860
Sapta Gandaki	20,650	18	6660	12	5270
Karnali and Mahakali	36,180	34	26,570	9	25,125
Southern Rivers	4110	9	980	5	878
Total	83,290	114	45,610	66	42,133

Source: K.C. Surendra et al. 2010. Current status of renewable energy in Nepal: Opportunities and challenges. Renewable and Sustainable Energy Reviews, 15 (2011).

In a situation where country is not yet fully self-sufficient in energy, it is important to increase its energy dependency on electricity generated from hydropower projects. Obligations to spend substantial sums of money for importing fuel while having an immense potential for hydropower development is distressing. Developing adequate hydropower can help to change this and also towards achieving the Sustainable Development Goals (SDGs) that can contribute to protecting the environment, improving the economy, and enhancing health of children and women with increased access to energy. Therefore, it is a high time to realize the benefits from hydropower sector to address the social and economic sectors limitations such as the economic growth, natural resources conservation, and increasing investment opportunities and improving the trade balance.

Women and their Role in Nepal

The total population of Nepal on Census Day (25 November 2021) was 29,164,578. Of this, the males population was 14,253,551 (48.87 %) and that of females, 14,911,027 (51.13 %). The sex ratio was 95.59 males per 100 females. According to the detailed census report, the literacy rate of the population aged five years and above is 76.3 percent: the male literacy rate was 83.6 percent and female literacy 69.4 percent. Owing to deeply rooted gender discrimination, the participation of women in economic affairs is limited to household work, which, however, is not accounted in the Gross Domestic Product. The life expectancy of women is comparatively lower than that of men. In addition, women face discrimination in their homes, communities, and workspaces. There are multiple intersecting forms of discrimination across women in societies such as Nepal, where caste, ethnicity, and location (urban vs. rural) influence the outcomes differently.

As per UNDP Report, September 2022, Nepal improved its ranking from 144th to 143rd position in Human Development Index. Similarly, a study by World Economic Forum ranked Nepal in the 105th position out of 149 countries on the Global Gender Gap Index 2018, indicating the critical need to focus on gender equality in different sectors.

In global scenario, a fairly large number of women are engaged in the energy sector. According to a 2019 study by the International Renewable Energy Agency (IREA) entitled "A Gender Perspective", women comprise 32 percent of the renewable energy workforce i.e. hydro power sector. The proportion of women in wind energy was 21 percent and that is solar PV, 40 percent in global.

Women's representation and participation in politics has improved over the years due to constitutional mandates of women representation. (Article 312 of Constitution of Nepal 2015). Their participation in public services, including the security forces has also improved. They make up about 41 percent of elected representatives in local bodies, and close to 34 and 25 percent in the provincial and federal parliaments, respectively. The ownership of assets and property by women is around 34 percent. (Table-1)

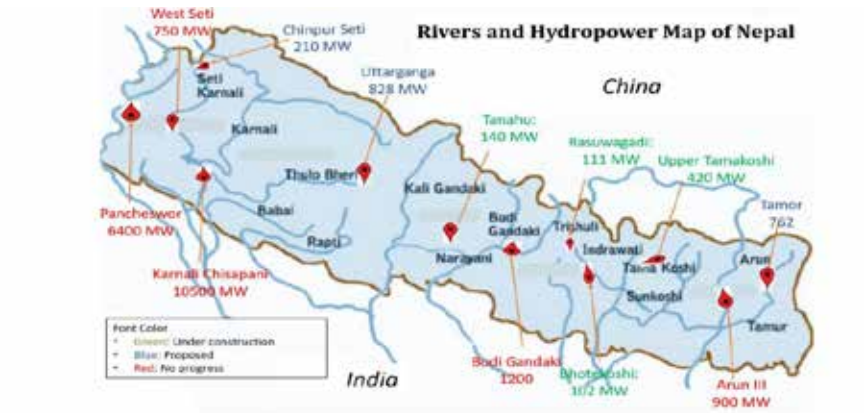

Table-1: Women's participation in various sectors in Nepal

Women Representative in various sectors	Women Presence
Federal Parliament	33.35%
Province Parliament	34.45%
Local government	40.85%
Nepal Civil Service	26%
Ownership in Land and Property	33.93%
Security – Nepal Police	11.02%
Security – Nepal Armed Police Force	8.85%

Source: Sustainable Development Goal Achievement Report (2016-2019)

Legal provisions for women rights

The Constitution guarantees women's rights as a fundamental right, reaffirms the right to safe motherhood and reproductive health, education, health, employment, equal pay, social security, and property rights and guarantees inclusion of women in all state bodies on the basis of principle of proportional representation. Some of the key legislations safeguarding the rights of the women are:

- The Constitution of Nepal: Fundamental Rights - citizenship rights, women rights, social justice rights, social security rights, etc.
- The National Civil (Code) Act 2074
- Human Trafficking and Transportation (Control) Act 2064
- Civil Service Act, 2049
- The Human Rights Commission Act, 2053
- Domestic Violence Act, 2063
- Electronic Transactions Act, 2063
- The Sexual Harassment at Workplace (Elimination) Act, 2071
- The National Criminal Procedure (Code) Act, 2017
- National Women Commission Act, 2074
- National Gender Equality Policy, 2077

Women's participation in energy sector

Women are related to water for livelihoods in various and now they are also involved in hydropower projects. Their engagement in the hydro sector can be discussed in three categories:

1. Women as electricity consumers, and water users

Women in Nepal have strong relationship with water sources in every ways possible. Among women's relationship with other natural resources, women's everyday social, economic and cultural life is associated in water and river in many ways.

More recent migration trends suggest that a majority of males in many households have traveled abroad or to urban areas for work, trade, and services. Therefore, women are faced with more responsibilities to operate and manage household affairs. Women's relation to water and hydroelectricity can be summarized as follows:

- 100% women are consumers of electricity for light, cooking, and household appliances.
- Fresh drinking water accessibility is a major challenge in many parts of the country. Women spend hours every day to collect water from nearby sources (well, swallow well, taps and rivers) for the family and cattle.
- Rivers are used for washing clothes and bathing.
- Rivers are considered holy places to worship and perform religious rituals.
- Women celebrate various festivals with holy bath in the nearby rivers. ***Rishi Panchami, Maghe Sankranti***, etc. are some examples.
- Fishing is one economic activity on which many families depend for income.
- Boating to cross rivers for travel is one economic activity in the riverbank settlements.
- Water is used for irrigation and is crucial for the largely agriculture-based economy of Nepal.

Women are affected in different ways by electricity generation, distribution, and availability. Availability of reliable energy can benefit them from multiple ways. However, construction of energy projects in their neighborhood affects their natural resources resulting in multiple impacts on their lives. Some of these impacts are,

- Whenever hydropower generation project is constructed near settlements, women comprise the largest population affected by the new development and construction activities.
- Whenever rivers are utilized by power producers, their routine use is compromised. For example, they might have to explore alternative sources for drinking water and water for other purposes.
- Further there is a presence of outsiders involved in construction that can have social impacts, particularly in culturally sensitive areas. Presence of male workers in the projects can also affect their privacy and safety. Taking bath in river in everyday and specific festival seasons can be difficult in presence of outside community workers and people.
- Women visit rivers every day to fetch water for family and cattle; this can be compromised because of river diversion and presence of various people in river side areas and also due to contamination of water rendering it unpotable.

To address the changes in everyday lifestyle and possible adverse effects to their lifestyle, culture, safety threats,

etc. It requires regular consultations with project affected women. Existing social norms, household responsibilities, mobility, and social acceptance are some factors that hinder women's participation in public meetings. Generally, they are discouraged from participating community meetings as men are considered as household heads and own most land. As household heads, men are considered to be decision makers, which is why women are generally excluded in such consultations.

One benefit of increased access to hydroelectricity is using energy for cooking. This can benefit women in terms of reducing risks of respiratory diseases caused by use of traditional fuels. Also there will be saving of time due to faster cooking in electricity and avoidance of transit time of collecting firewood. That time can be utilized for economic activities.

2. Women engaged in energy generation

Accessibility has been major hurdle for women. If we compare participation of women in energy generation/ distribution using a gender lens, it is obvious that female participation is significantly low. Female participation as workers is very limited. Since women get less opportunities to study technical subjects like engineering and project management, there is a shortage of skilled women experts. For unskilled work, there are social and geographical barriers that constrict access of women in project development. Culturally they are discouraged to get involved in economic activities and are limited to childcare and home management. As a result there are only a few women workers in construction works. Males, in contrast, can travel to places for exploring opportunities and engage in economic activities. Further, the large number of male workers in projects site is another barrier that prevents women from seeking work space in hydro-projects. Their presence as developers and in company boards and management levels is also minimal, even though there has been a tendency to register some businesses in the name of women for tax purposes.

As hydropower projects are located in rural and least developed areas: ensuring safety of women, health and wellbeing are big concerns. Gender inequality remains the biggest problem in Nepal where girls are always treated as support system to men. The situation in rural areas is worse than urban areas. As compared to men, women are also paid less for similar jobs. The gender gap in Nepal's hydropower sector is reflected in the following diagram:

The data shows that women engineers are underrepresented in Nepal's Hydropower sector. In terms of labor force also, women employment is mostly concentrated as unskilled laborers. There have been various constraints like stereotypes, gendered norms, safety issues etc.

If we analyze the existing women presence in the hydro power sector, the picture is miserable but improving. Women are least welcomed in all levels of engagement. Gender neutral workplace with merit-based selection, engagements and promotions remain a dream. Positive gender discrimination policy of the government has also not been successful in changing the energy sector.

The data above explains the minimal presence of women talent in decision making levels. Women participation in executive and board level are limited to single digit percentile.

3. Women in policy making and governance role

Women participation in mainstream politics is increasing in Nepal due to promulgation of constitution in 2015 AD which mandates minimum 33 % of representation in parliament of Nepal. Also, rules on corporate governance has been encouraging investors to have more women as board members. However, since the overall women participation of women is low in every government agency, policy making and leadership positions, the issues affecting them, opportunities and challenges are also least discussed. When the policy making platforms are completely composed of male members only, there will be a lack of gender sensitivity and promotion of equity. Promoting women in leadership roles and ensuring a respectful workplace environment can help in narrowing down the gender gap. The following practices can help to bring about some positive change.

- Having more women director in company boards.
- Increasing the representation of women in company unions to amplify the voices of women employees.
- Establishing an inclusive hiring panel with at least one woman as member for inclusive recruitment.
- Encouraging female applications in all new recruitments and disclosing the provision in advertisements.
- Revising personnel manual and policies for ensuring gender equality and include clauses for discouraging bullying and sexual harassment.
- Appointing a female employee as a Grievance Handling Officer to address and respond to gender-based violence in the workplace.
- Orienting employees on the grievance mechanism and gender-related violence prevention.
- Recruiting a female employee in a senior technical position in a non-traditional role.
- Continuing trainings for regular changes and improvements.

The Sustainable Development Goal five on gender equality and women's empowerment advocates women's effective participation and equal opportunity for the empowerment of women at all levels and ending all forms of discrimination. Attaining this requires elimination of all gender-based discrimination at all levels of decision-making including access to information and opportunities. A study undertaken by Asian Development Bank (ADB-

2018) reports that representation and participation of women in decision-making positions, especially in energy project and institutions are very limited. Women and excluded groups are facing various structural barriers preventing them to participate in energy production and benefiting from energy sector. At Nepal Electricity Authority (NEA), a state owned organization responsible for generation, transmission and distribution of energy, the presence of women at mid and lower level of professional is limited to about 10% in against of about 89% men. In the case of Alternative Energy Promotion Center (AEPC), another institution working for clean energy sector, the situation seems slightly better. In the total human capital base, 72% are men and the participation of women is about 28% in mid and lower level professions. Independent Power Procedures Association of Nepal (IPPAN) – one umbrella organization of private power producers has tried to ensure participation of women in executive committee but only constant concerns raised by various stakeholders, after the amendment of its constitution in 2018.

A study undertaken with the support of the International Finance Company (IFC, 2020) pointed out gender stereotyping, lack of gender sensitive policies and practices, and remoteness of hydropower project sites as major challenges hindering the participation of women in hydro power generation/distribution projects. The participation of women and reflecting their voices in project design and its development therefore remains a critical issue. The low number of male workers available means that women are associated with everyday use and protection of natural resources. Contrary to their absence of participation in project development and implementation phase, women are the largest user groups of hydroelectricity. Due to male dominated foreign migration for employment, women have sheer number of population in rural areas where majority of project development and expansion take place. In male member's absence, women are using natural resources and such end products to support elder members, children and cattle. This is why women's participation and their engagement in hydropower projects are critical.

Barriers in participation and decision making

Literacy is a major constraint that hinders women participation in public meetings. Men are in an advantageous position for this, because they receive more exposure and opportunities in education and participation compared to women. Difficult topography is one factor that create obstacles to women's participation in consultations and decision-making process. Due to the difficult topography, there is a tendency of organizing consultations at market centers and accessible locations. Such centers are generally far from project-affected communities in the case of hydropower projects.

The Hydropower Environment Assessment Manual, 2018 requires developers to acquire gender disaggregated data during the Environment Impact Assessment (EIA). It demands information on gender related impacts such as employment, marginalization and sexual harassment, impact due to influx of migrant workers, crime, trafficking, and loss of livelihood opportunities. The Environment Protection Act, 2076 and its Regulation 2077 has provisioned for public hearings and notification of impact assessment in national newspapers. However, it is silent on inclusive and mandatory women's participation in consultations. In case of projects financed by international financing institutions (IFIs), due to their mandatory policy for inclusive consultations some developers try to comply with the requirements. In the case of projects promoted by private developers and the electricity utility the participation of women and vulnerable communities is significantly ignored. Considering the significance and impact of infrastructure projects on women and vulnerable populations it is essential to prepare a clear policy for ensuring women's participation in such developments. However, many donors' guidelines still do not provide positive discrimination towards women in employments though in theory, they are the most vocal in gender equality and inclusion.

Conclusion

As in other sectors, the energy sector is largely male dominated. Therefore, it is opportune to purposively promote principles of diversity, equity, and inclusion in the hydro sector. There are laws that seek to safeguard the rights of the women but their implementation is not encouraging. Nepal needs to strengthen the capacity of women in leadership roles. Creating networking opportunities and providing them learning platforms can assist women to be confident to compete for appointment in leadership roles. Since the women make up almost over 50 percent of population, the government need to make conscious efforts to boost their contribution in infrastructure development, particularly the hydropower sector. Focusing on STEM (Science, Technology, Engineering and Math) education and providing more access and opportunities from grants/ scholarships to women would lead to more participation in the future.

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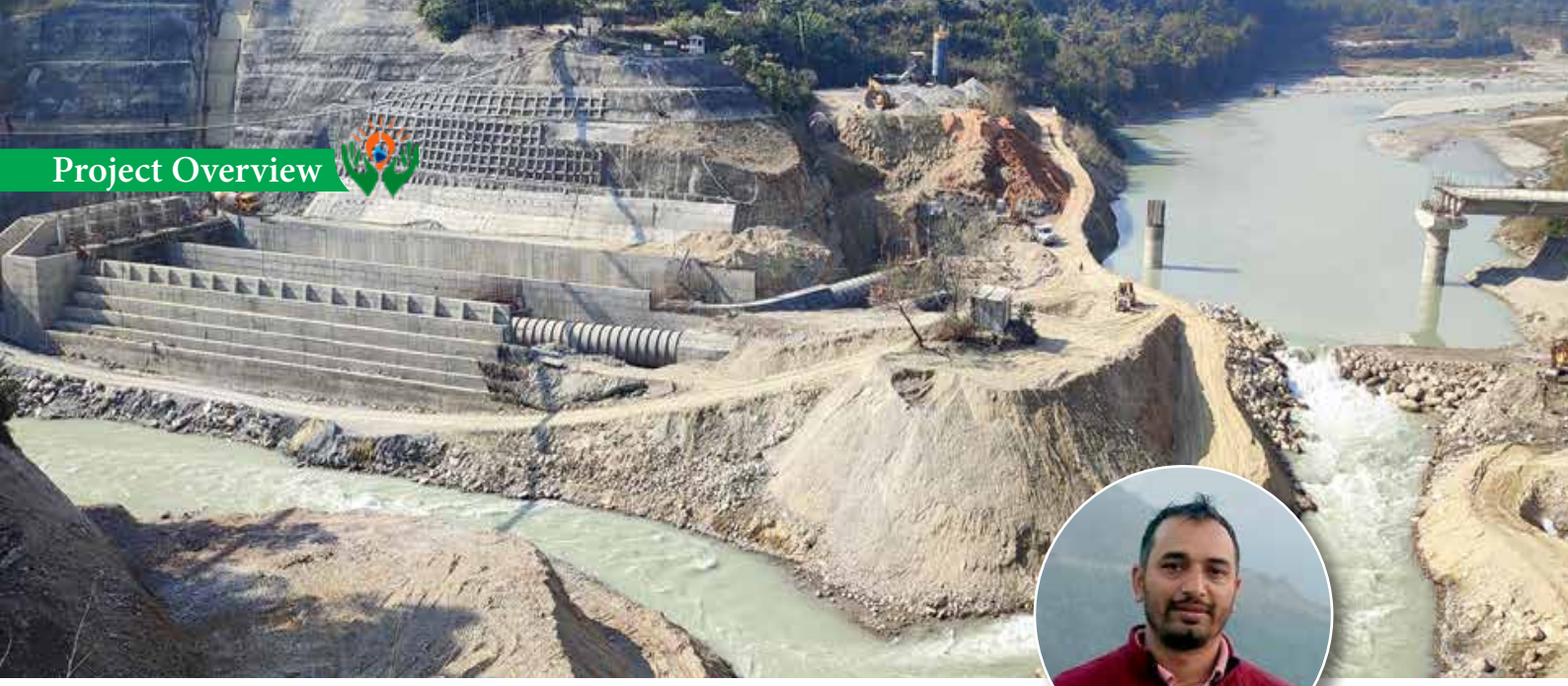


Seti Khola:Progressing towards Sustainable Power Generation

Ujjal Regmi

The Seti Khola Hydropower Project, a remarkable 22 MW initiative situated against the stunning backdrop of Pokhara, is not only a testament to engineering ingenuity but also a beacon of commitment to international standards in environmental and social responsibility. As construction speeds forward, Seti Hydro Power Pvt Ltd is unwavering in its dedication to aligning with the Environment, Social and Governance (ESG) and Environmental, Health, and Safety (EHS) guidelines.

Nestled in the heart of Pokhara, the Seti Khola Hydropower Project not only seeks to harness the raw power of nature but also to do so with utmost respect for the environment and the communities it impacts. The city, known for its serene lakes and breathtaking mountain views, provides the perfect backdrop for a project that marries beauty and brains.

Er. Ujjal Regmi, Project Manager of the Seti Khola Hydropower Project, proudly attests to the project's strict adherence to International Finance Corporation (IFC) Performance Standards. These standards, established by the International Finance Corporation, set the global benchmark for sustainable and socially responsible business practices. The project aims not just to generate clean energy but to do so in a manner that ensures the well-being of the environment and the communities in which it operates.

The commitment to EHS guidelines is a cornerstone of the project's ethos. Regmi elaborated on the progress, indicating that 50 percent of the construction work has been completed without any serious injury or fatality. Recently, they achieved and celebrated 1 million safe man hours in the month of November 2023.

Dolma Impact Fund plays a pivotal role in monitoring and capacity building for the Seti Khola Hydropower Project providing guidance and direction towards implementation of ESG and EHS at site level. Their involvement signifies a commitment to ensuring that the project not only meets current standards but also has the capacity for sustained excellence over time.

Furthermore, Project ESG consulting is in the capable hands of Alpage SARL, a French consulting company led by Pierre Bierdermann, an esteemed expert with a global track record in various projects. Bierdermann's expertise brings an additional layer of assurance regarding the project's adherence to Environmental, Social, and Governance (ESG) principles. His experience in worldwide projects adds an international perspective, ensuring that the Seti Khola Hydropower Project stands as a benchmark for responsible development, not just in Nepal but on a global scale.

As the project continues to take shape, it symbolizes a greater future where development harmonizes with nature. Beyond being a source for clean energy, the project exemplifies how infrastructural development can coexist with environmental conservation. Once completed, it promises not just electricity but a model for responsible and sustainable development that can serve as a guide for future projects in Nepal and beyond.

The author is the Project chief of Seti Khola hydropower project

Nepal's Transition towards 100%

Renewable Energy

Despite being one of the least contributors to climate change, Nepal has been disproportionately affected by its adverse impacts.

The latest United Nations (UN) Climate Change Conference in Dubai (COP28) has endorsed a decision calling for accelerated and immediate action for deep emission cuts, while adopting a transition away from fossil fuels– the first ever COP addressing the issue of 'fossil fuels' in its decision. At COP28, countries countries pledged to triple renewable energy capacity and double the rate of energy efficiency by 2030 in order to achieve the goal set by the Paris Agreement which talks to limit the global average temperature rise to 1.5 degree celsius by the end of this century.

"We must accelerate a just, equitable transition to renewables," said the UN Secretary-General at the opening session of the COP28, who also visited Nepal and underscored the plight of the Himalayan country. "The science is clear: the 1.5-degree limit is possible only if we ultimately stop burning all fossil fuels. Not reduce. Not abate. Phaseout – with a clear timeframe aligned with 1.5 degrees."

Climate change has become a global challenge and the biggest threat to the future of mankind. The frequency and intensity of climate induced disasters and risky weather incidents occurring worldwide have affected lives, infrastructures, and economy of almost all the countries around the globe. Despite being one of the least contributors to climate change, Nepal has been disproportionately affected by its adverse impacts. Nepal's average temperature is rising at a higher rate than the global temperature. The country is experiencing increasing climate-related disasters, retreating glaciers, erratic rainfall patterns, and fast

spreading communicable diseases. Changing climate and increasing climate-related disasters have forced people to migrate from their original locations.

Traditional biomass-based energy still dominates Nepal's total energy share. While the proportion of traditional biomass in total energy consumption is declining, the share of fossil fuels has increased significantly in the recent decades, with nearly one-quarter of its share in the total energy consumption. Only about 3 percent of total energy comes from clean and renewable energy sources. This dominance of biomass-based energy and increasing consumption of fossil fuels also contributes to air pollution, making Nepal one of the most polluted countries in the world. Increasing reliance on fossil fuel is contributing to a widened trade deficit affecting the nation's economic progress. In the fiscal year 2022/23, Nepal imported about Rs. 300 billion worth of petroleum products—the largest imported item in terms of the value.

At the COP26 held in Glasgow in 2021, Nepal had pledged to achieve net zero carbon emissions by 2045. In 2020, under the Paris Agreement, Nepal prepared National Determined Contributions and communicated to the UNFCCC committing to reduce its emissions. Nepal targets to expand clean energy generation from approximately 1,400 MW to 15,000 MW, of which 5-10 percent will be generated from renewable sources by 2030. The NDC's target also includes ensuring 15 percent of the total energy demand to be supplied from clean energy sources, while 25 percent of households to be using electric stoves as their primary mode of cooking by 2030. It aims to install 500,000 improved cookstoves and additional 200,000 household biogas plants and 500 large scale biogas plans by 2025. The transport targets include increasing sales of e-vehicles to cover up to 90 percent

Raju Pandit Chhetri
Executive Director; Prakriti Resources Centre

Raju Pandit Chhetri

1. Under the '100 per cent renewable and accessible energy program,' what kind of work has been done by Prakriti Resources Center (PRC) regarding energy transition and 100 per cent Renewable Energy (RE)?

Under the auspices of the '100% RE MAP (Multi-Actor Partnerships for 100% Renewable Energy)' initiative, Prakriti Resources Centre (PRC) has undertaken comprehensive efforts in the realm of energy transition and the realization of 100% Renewable Energy (RE). PRC has successfully convened diverse stakeholders, including representatives from government bodies, non-government organizations, private sector entities, academia, and individual experts/practitioners. This collaborative platform has facilitated the formulation of a collective vision for a just energy transition and the attainment of 100% RE within the country.

This endeavor has significantly broadened the national discourse on energy policy, shifting the focus from a hydro-centric approach to embracing the significance of a diversified energy mix and resilient energy systems. PRC's activities have extended to capacity-building initiatives at all levels of government (federal, provincial, and local), addressing crucial issues such as electric cooking, transport decarbonization, and energy efficiency. Moreover, the organization has played a pivotal role in introducing international experiences and best practices to Nepal through the organization of the 'International Conference on 100% Renewable Energy,' featuring participation from 18 countries and 121 delegates. PRC has also produced impactful research on energy scenarios and RE roadmaps for Nepal, contributing to the effective implementation of the Nationally Determined Contribution (NDC).

2. What are the outcomes of PRC's programs for renewable and energy mix, including electric vehicles and e-cooking?

In collaboration with WWF Nepal, PRC's programs have successfully informed and capacitated federal, provincial, and local government bodies, particularly in Bagmati and Gandaki Province, on energy transition, 100% RE, and sectoral policy actions. Dialogues, workshops, knowledge-sharing sessions, and policy briefs have been instrumental in the formulation of the 'Provincial Energy Strategy and Action Plan' for Bagmati and Gandaki provinces, aligning with national objectives. At the federal level, PRC has contributed to the

preparation and submission of a 'Policy Roadmap for Nepal to Transition to 100% RE by 2050' to the Government of Nepal.

3. The Government of Nepal has determined sectoral policies and set climate change and renewable energy targets through various programs. How is the PRC working to fulfil those goals as an executor?

While PRC primarily focuses on research, policy design, and knowledge-sharing, it closely collaborates with the Alternative Energy Promotion Center (AEPC) to promote renewable energy in Nepal. PRC has played a crucial role in informing federal and national climate visions, designing policy roadmaps, and building momentum for the execution of climate and energy targets from a bottom-up approach. By fostering collaboration among stakeholders, PRC addresses sectoral challenges, policy barriers, and opportunities to support the government's climate and RE goals.

4. How will the PRC contribute to the government's goal of achieving net-zero emissions by 2045 through the 100% renewable energy programme?

PRC commits to ongoing engagement with government and stakeholders to contribute to policy actions for achieving the 100% RE goal. Through research, knowledge-sharing, platform building, and capacity-building programs, PRC aims to support Nepal's transition by promoting the right enabling environment for RE-related investment, showcasing pilot projects, and collaborating with implementing organizations and development partners. PRC emphasizes the potential of green, clean, sustainable, and resilient renewable energy systems in reversing Nepal's dependence on imported fossil fuels, aligning with the goal of achieving net-zero emissions by 2045. We will continue to focus on this area. This helps our socio-economic development and also tackles climate change.

5. Nowadays, climate change has become a major challenge. How is the PRC working with the government and the public to reduce this challenge and improve the climate?

Recognizing climate change as a significant challenge, PRC collaborates with government and the public to address its impacts. By convening multi-stakeholder collaborations, PRC contributes to effective policy formulation and implementation. The organization actively promotes adaptation actions while aligning low-carbon development with national plans, thereby addressing both climate mitigation and adaptation needs. 100% RE is one of the focuses where we hope to help our government adopt low-carbon development pathways by integrating it into the development plans and also address climate mitigation at the same time.

6. What are the upcoming agendas of the PRC for decarbonization and 100% RE, mitigation of climate change and promotion of clean energy?

We believe that the participation of all stakeholders and cross-pollination of ideas will only help to achieve the just energy transition and net-zero emissions targets by 2045. PRC will continue to engage with the Government of Nepal and stakeholders to design the right policy actions, to support accessing international climate finance and to push for mobilizing public funding to implement climate actions, to bring international experiences, and to build the capacity of stakeholders, which are essential elements to achieve 100%RE goals and NDC targets set by the government.

of all private passenger vehicle sales, which includes two-wheelers and 60 percent of all four-wheeler public passenger vehicles, and to build 200 km of electric railways by 2030.

Pathways toward cent percent RE

"Nepal announced to achieve net-zero emissions by 2045 and only very few countries have the target by 2045," said Ram Manahor Shrestha, a professor at Asian Institute of Technology (AIT). "But Nepal is not doing enough work to meet the set targets."

For the energy security and resilient energy system, Nepal should embrace energy mix along with exploring and harnessing diverse renewable energy sources. Nepal has a great potential in solar but we are putting excessive focus only on hydropower. Nepal's energy policy and institutional structure is hydropower or water resource-bias says Prof. Shrestha. "Hydropower and its investment are at risk because of climate change, which has posed a threat to our energy security. Therefore, Nepal should focus on diversification of energy sources and increase investment on solar, wind and other renewable energy sources to address energy security and create a resilient energy system," says Arati Khadgi, head of the Climate and Energy Program in WWF Nepal.

Prof Shrestha stressed on the need that the government should accelerate investment in solar energy as well. The cost of solar generation is already cheaper than hydropower generation, while it is further declining globally. He said that the solar, wind, battery and hydro sectors can supply 100 percent clean energy by 2050 and green hydrogen has potential in future, with an expected minimal cost of generation.

More than five percent of Nepal's population still doesn't have access to electricity. Many of those who have access to grid or off-grid don't get reliable and adequate electricity.

Access to adequate and reliable electricity is a prerequisite to achieve the NDC targets of electrification of the cooking and transport sector, and to move toward energy transition. "Nepal should focus on a decentralized energy system to provide rural communities an access to energy," suggests Ram Prasad Dhital, energy expert and former Board of Director of the Energy Regulatory Commission.

RE can also provide quick and cost-effective solutions to energy access in rural communities. Nepal has several good examples and stories to share. Dinesh Ghising, a Drinking Water User Committee Representative from Marin Rural Municipality, Sindhuli, said the solar drinking water lifting project in his village has not only provided access to drinking water but also provided economic opportunities to the villagers. "Before the villagers used to buy vegetables owing to the water scarcity but now people have started growing vegetables to receive commercial benefits," he added. According to him, a hybrid water lifting system with solar and grid electricity has now come into operation after grid electricity penetrates his locality in the village.

Similarly, the solar drinking water project in Devghat Municipality in Tanahun has provided access to drinking water to the 41 households located at an elevation of 1,200 meters. This has respited villagers, especially women, from walking a couple of hours to fetch the water. "Solar project has changed the face of our village," says Om Bahadur Bhujel, a local person from the village.

Managing financial resources is one of the major challenges in achieving the climate goals. The NDC implemented plan has estimated about USD 33 billion to meet all the targets. "Policies and planning are worthless if financing remains as an issue. Nepal's annual budget alone won't be able to fund them,

thus we need to work on attracting international finance, mobilize private investment and look for innovative financing," says Mukti Ram Acharya, under-secretary at the Ministry of Finance.

It has been apparent that public funding alone is not enough to achieve climate goals. The government should facilitate and bring policies to provide an enabling environment for the private sectors to invest. In addition, the country should be proactive in developing bankable projects and access international climate financing. "There is a potential to bring in huge investment in repayable projects such as energy generation as well as some other public service sectors including public transportation, so the government has to invest," says Acharya.

To support the national climate commitment: net-zero emission goal and NDC targets, the 'Multi-Actor Partnership (MAP) Platform for 100% RE initiative has prepared a Policy Roadmap to complement policy pathways for Nepal towards 100% RE by 2050, while obtaining green and inclusive low carbon economic development. This is based on a study that provides a technical scenario in achieving 100%RE by 2050. The initiative was led by Prakriti Resources Centre (PRC) and WWF Nepal.

"The Policy Roadmap has emphasized the need to integrate energy policies into transport, manufacturing, household and agriculture to allow reinforcing RE development for widespread energy access," says Dhital, who also supports devising the roadmap. It also recommends providing an enabling environment for the private sector to invest in RE technologies.

"The government alone cannot achieve the NDC and net-zero emissions targets. It requires strong partnership and collaboration between diverse stakeholders– all three levels of governments, research institutions, civil societies, financial institutions, private sector and development partners," says Raju Pandit Chhetri, executive director of the Prakriti Resources Center.

Nepal needs to transition away from traditional biomass and fossil-fuel-based energy systems to modern renewable energy systems. But the transition has to be done in a just manner – with maximizing energy equity and addressing gender and social inclusion.

Building Climate Resilient Power System for Nepal

Saroj Koirala

less than average rainfall has led to reduction in electricity output in certain years, thereby diminishing ability of financial institutions to recoup loans in time and decreasing overall profitability of electricity generators and most importantly, threating the energy security of the nation.

It's well known that Nepal has been placing high hopes on hydropower as a medium to bring about prosperity in the country. With Indian cabinet deciding to import 10,000 MW from Nepal over 10 years, the target pertaining to power export set by the Whitepaper on Present Condition and Future Roadmap of Energy, Water Resource and Irrigation, 2018 doesn't seem like an impossible dream anymore. While the electricity trade so far had been based on bilateral agreement with India, Nepal will be participating in a trilateral framework to export 40 MW to Bangladesh. All these facts point out towards the obvious conclusion that cross-border electricity trade of Nepal shall further intensify in the coming days.

But, there are challenges to attaining this "hydropower dream". Most significant of them is the insufficiency of financial resources for construction of such large power plants. Adding thousands of megawatts of installed capacity shall require billions of dollars in investment. Secondly, hydropower generation so far has been constrained by bottlenecks in our transmission networks. So, augmentation of transmission infrastructures shall also become essential. Basing on the trend of international cooperation in electricity in the region, it has slowly become apparent that access to market will not be a problem. But, how much Nepal can actually benefit from cross-border trade of electricity depends upon the efficiency in policy, regulatory and management aspects of electricity sector.

Now that we are on the track to harnessing our available hydropower potential, early effects of climate change have already manifested in the Himalayan countries. The glaciers are melting at an accelerated rate. Snowy peaks have lost their pearly glow and the rainfall pattern has become erratic and unpredictable. The scientific community is of the opinion that these are mere precursors to far sinister events. It is almost unanimous that certain countries like Nepal, Bhutan, Maldives, etc., which have the least contribution to climate change are the foremost victims. These developing countries, which have to battle their way up to prosperity because of modern standards of development are posed with another set of hindrance because of the ensuing impacts of climate change.

Because of erratic rainfall, the hydrological patterns have changed leading to inability of power plants to forecast their electricity output accurately causing problem in system planning and power management. Also, less than average rainfall has led to reduction in electricity output in certain years, thereby diminishing

ability of financial institutions to recoup loans in time and decreasing overall profitability of electricity generators and most importantly, threating the energy security of the nation.

Loss of revenue and problems with power system management are surprisingly the least of the worries. In the previous 3-4 years, erratic rainfall patterns have led to flood in major river basins and sub basins causing massive damage to hydropower projects, both in terms of lives and property. Flood in Dordi and Madi rivers in monsoon of 2021, devastated the hydropower projects in the area, both under construction and under operation. Because the natural river flows have been obstructed by multiple weirs and impoundment of multiple hydropower plants, the flushing of sediments and debris has been hindered. When the rainfall is massive, the amount of sediments and debris is also high. Evidently, this has led to raising of the river bed level in some cases, causing water to break loose inside under-operation powerhouses causing loss of generation and obviously, incurring massive capital expenditure in middle of generation. Additionally, rivers flowing into under-construction civil structure was also found to cause flood damage, deposition of huge amount of sediments and debris, and loss of structural integrity in projects. These events adds to the cost of under-construction projects and increases cost of business for operating projects thereby increasing the probability of the hydropower plants to become sick, financially.

In transmission side also, similar perils exist. Because Nepal is full of hills and slopes, location of all transmission infrastructures may not always be ideal. When there are multiple transmission lines of multiple power plants passing in the basin, the possibility of each towers of each transmission lines finding a suitable location diminishes. When an unusually high rainfall occurs, transmission lines also are in risk of landslides. Since transmission line is basically a link made of various towers, structural failure of one tower interrupts the evacuation of power from the entire power plant. For example, in 2021 the sweeping away of the tower number 9 of Middle Marsyangdi Hydropower Plant by a flood had led to shut down of the the 70 Megawatts plant.

Because of inherent risk of disasters posed by climate change, reinsurance of Nepalese hydropower plants has reportedly become more difficult. Because our power system is hydropower dominated, these risks shall accentuate in the future as the impacts of climate change worsens. Consequently, impact on hydrology of rivers may either diminish generation of power plants or make forecast of electricity generation harder, which exposes Nepal to energy insecurity. Additionally, as the rainfall becomes more erratic, there will be times when all hydropower plants in a basin will have to be deliberately shut down to prevent water with high sediment and debris during flood enter into power plant as a protective measure. This will reduce the damage, but again, since the power plants will have to be shut for self-preservation, their reliability will decrease. In a different way, it brings up the same old issue of electricity insecurity.

In the recent years, particularly after commissioning of the 400 kV Dhalkebar-Muzaffarpur Transmission Line, Nepal has made a remarkable stride in term of cross-border electricity exchange with Nepal exporting a massive share of its generation in the monsoon and importing large quantity in the winter. Undoubtedly, this has not only alleviated Nepal's energy poverty, but has also provided certain degree of energy security for Nepal. When our hydropower plants fail, we can still import electricity to meet Nepal's need. However, purchasing power through short term market arrangements can often be more expensive compared to long-term contracts. So, while energy availability might not be hindered as much, there may arise issue of increasing cost of electricity. And let's not forget that even importing electricity is not without transmission system constraints. So, building resilience of Nepalese power system to withstand impacts of climate change shall be important for both power security and protection of capital invested.

So, the first step towards mitigating the impacts of climate change in our power system is to diversify the energy mix. We may continue to primarily focus on and harness Nepal's bountiful hydropower resources but at the same time, we must also develop a healthy blend of other sources of energy, primarily utility scale solar and distributed solar systems. Unlike a hydropower plant, solar PV's performance doesn't fluctuate season to season, so it presents more certainty in terms of generation. Additionally, allowing a certain percentage of distributed energy resources such as rooftop solar PV systems shall waive the necessity of long transmission lines, which may often be deemed as the weakest chains in the link. However, this shall not be sufficient. For a country with such large potential for hydropower generation, sustained focus on hydropower development shall be necessary. However, we shall have to reconsider how we develop hydropower.

Nepal has been developing hydropower for over 100 years. Even though the initial pace of hydropower development in Nepal was glacial, in the recent decades, the generation capacity has shown a significant growth. So, developers and also contractors of Nepalese power plants have gained many such lessons which may be worthy of dissemination with each other to encourage climate resilient design and construction of hydropower plant. Although openly talking about

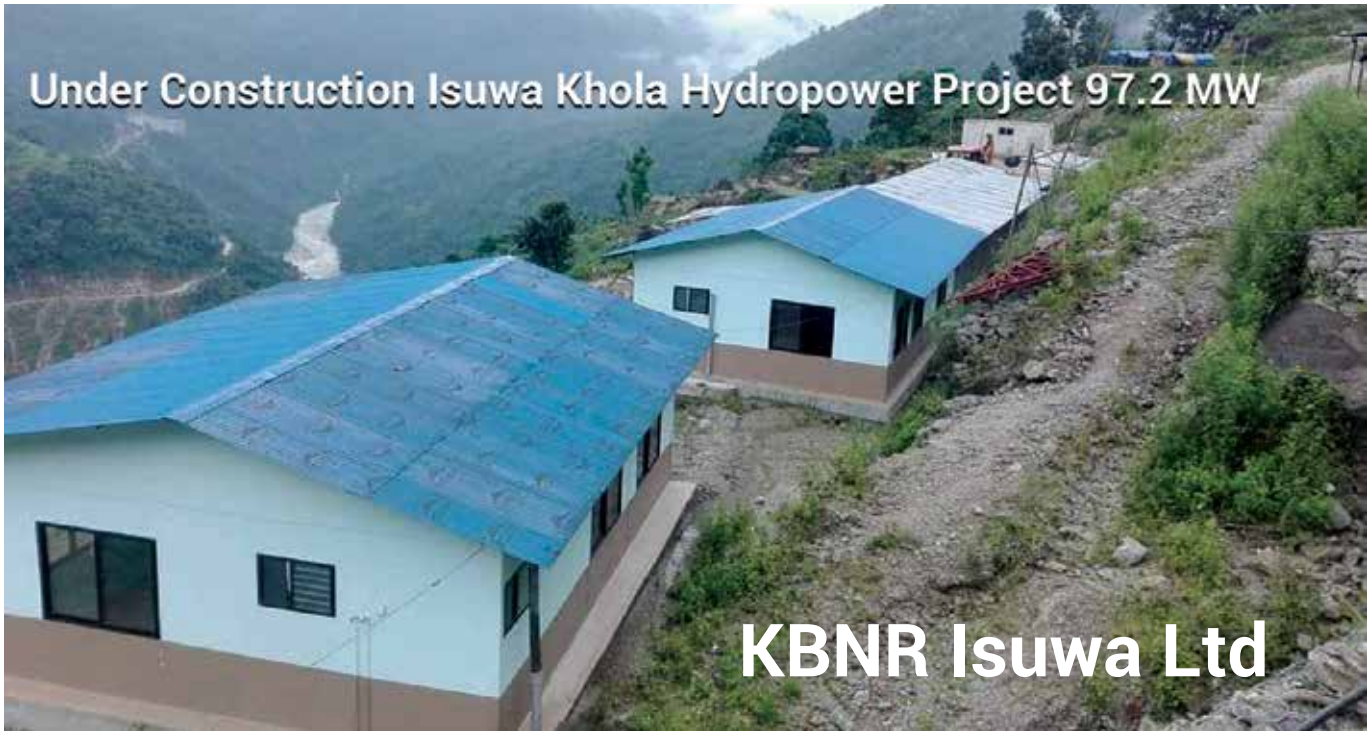
own failures doesn't win anyone any awards but they may act as a cautionary tale for other developers on what to do and what not to do in the future. Therefore, a platform may be created to discuss about such inadequacies of past and determine best course of action for the future. Primarily, technical consultants have a higher responsibility in this regard to incorporate ways by which hydropower plants can be made more resilient to increased risk borne of climate change. This may include but not be limited to updating design parameters for hydropower, providing pertinent suggestions to developers and consulting community developing and agreeing on a set of design standards.

Another method shall be a game changer but shall require policy intervention and high degree of commitment from government. For this, government of Nepal should incentivize clubbing of licenses and pooling of investments to encourage bigger hydropower plants that are more resilient to impacts of climate change. Larger hydropower plants not only offer the economies of scale but since their budget is large, they can afford more competent human resources and a better design. Also, since their project budget is large, they will have a larger fund for environmental mitigation and corporate-social responsibility. In the past, preference used to be placed on smaller plants as larger projects were considered relatively unsustainable because of their impact on surrounding ecosystem. Now, since the climate change has accelerated, we need to cut down emissions even if it means building larger hydropower plants which previously were not deemed so environment-friendly. Additionally, because of lower number of hydropower plants in a river corridor, lesser number of transmission lines will suffice thereby making it possible to have better choices for the location for transmission line towers.

Last but not the least, improved project management practices and involvement of competent and experienced human resource in development and construction of power plant is important in building climate resilient power plants. The current exodus of Nepalese youths outside of Nepal is a major issue in every industry, and the technical community is also not left untouched. Given that work in hydropower, particularly in construction, is neither pretty nor lucrative, the brain drain of trained engineers and technicians with expertise in hydropower has also occurred. Therefore, retention of experienced human resource shall also be key in order to make hydropower more resilient.

We must not lose sight of the fact that harnessing of hydropower resources in Nepal shall be crucial in advancing economic growth in Nepal and accelerating clean energy transition in South Asian region. So, hydropower development must continue. However, considering the immediate and long term impacts of climate change, how we design, build and operate hydropower projects must be changed. It's difficult to pin point what exactly shall be the magnitude of impact of climate change in our power system. But given the early warnings, it is certain that we must begin including climate resilience aspect in our power system.

Saroj Koirala is an electrical engineer with LL.B. and MBA, passionate about working at the intersection of electricity, management, and law.



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Energy Efficiency for betterment

Anurag Pokharel

In the prevailing discourse on Nepal's energy sector, the idea of energy efficiency seems to be overlooked. While we are expecting an electricity surplus in the country and the main agenda now has become electricity demand stimulation and cross-border power trade, we must not disregard the significance of concepts like energy efficiency. These concepts are crucial for the well-rounded development of our nation.

The Nepal Electricity Authority (NEA) in 2021 announced that there is already a surplus power supply in the wet season in Nepal. "As more generation projects with a combined capacity of thousands of megawatts are being constructed or planned, it is expected that the country will achieve a surplus throughout the year as early as 2029/30." Unless stored, the generated electricity must be consumed or it will be wasted, and the electricity network will also be unstable. Thus, to prevent the supply from far exceeding the demand for electricity in the near future, consumption would need to grow at a much higher rate than what it is currently. The government wants to address this issue through stimulation of demand by expanding the cross-border electricity trade market and supporting the uptake of electric vehicles, e-cookstoves, and other end-uses within the country.

While the target is to increase demand as much as possible, the existing electricity network cannot carry all the generated power to areas where the demands are. This can be clearly seen in the industrial sector where several industries are not operating as per their full capacity. Arghakhachi Cement, one of the largest cement factories in Nepal, was not able to run one of its two units even in this monsoon season, therefore losing production of around 1,400 tons of cement per day. Such situations are mainly the result of constraints with transmission lines the construction of which has not taken faster pace compared to that of the generation infrastructure due to reasons such as the lack of funds with the government and right-of-way issues. Congestion, therefore, is prevalent which causes disturbances in the power supply, loss of energy, and resulted cases where the demand is not fulfilled.

In such a situation, prioritizing an improvement in national-level energy efficiency could help. Being energy efficient can reduce losses and better manage the load on the demand side and the saved energy could be channeled to cater to unmet demands. This means that we will get more output with the available resources. Take the popular example of light bulbs. We have transitioned from energy-hungry incandescent lamps to highly efficient LED lamps. One incandescent lamp consumes roughly as much energy as equally powerful five LED lamps. On a larger scale, this would mean if the power grid can support, for instance, one lakh incandescent lamps lighting up at once, then that same infrastructure can instead light five lakh LED lights. Therefore, wide-scale energy efficiency improvements can help the existing grid to support more end uses.

Considering that the transmission congestion would be relieved, and the electricity network would soon be ready to convey all the generated electricity, the demand would need to grow swiftly. The question then would be whether investing in energy efficiency improvements still makes sense. To assess that, getting an answer to question why we are pursuing a growth of electricity generation and consumption in the first place could help. Looking at the larger picture, this is tied to economic growth. Nations have been harnessing various sources of

energy to generate electricity that can cater to needs of household levels from cooking to the large-scale industrial applications. Vaclav Smil, a renowned energy expert, writes in *Energy and Civilization: A History*[1] that economic activities are fundamentally conversion of energy from one form to another, for instance, converting electricity to other usable forms of energy. Therefore, if we're basically using energy for economic growth, why not achieve the same level of growth by lesser amount of energy? This would mean less degradation of resources to produce energy and cheaper costs. Smil mentions in the book that efficiency improvements over the long term have been the most significant contributors to substantial reductions in energy costs. Therefore, the country's goal should not only look after increasing demand but also improving energy efficiency so that productive use is prioritized.

Furthermore, the benefits of energy efficiency are not limited to the electricity sector alone. Electricity as a fuel is still in the minority when looking at total energy consumption scenario of Nepal. As of 2023, only around 5 percent of energy consumed in Nepal is electricity, while biomass accounts for 60 percent, and fossil fuels like petrol, diesel, and LPG contribute over 27 percent[2]. Reduction in the use of biomass and fossil fuels will be crucial as these fuels are major causes of air pollution. Furthermore, fossil fuels contribute to massive GHG emissions, and they increase the trade deficit for the country as they are exclusively imported. Reduction through switching to cleaner sources such as electricity, however, won't happen instantly. Biomass and fossil fuels would, therefore, be consumed for next several years, and due to the reason, improving the efficiency of these fuels will be vital.

Making it a reality

While improving energy efficiency ensures several benefits, there might be concerns about the costs and whether it is even realistic for Nepal. Implementing it is not necessarily a luxury, whereas it can be potentially even more cost-effective than generating energy. For instance, studies have shown that the investment to save electricity through energy efficiency measures could be cheaper than investing in power generation plants to supply the same electricity provided it had not been saved[3]. Making interventions on the ground, however, is not very straightforward. In order to improve energy efficiency across different sectors or technologies, there will be a need for behavior change and the availability of dependable and affordable technologies in the market, both of which are not in place currently. To make this happen, it is pertinent that policies like the Act on Energy Efficiency come into force first.

A bill for the Energy Efficiency and Conservation Act was first drafted in 2019. It was created on the basis of the Energy Efficiency and Conservation Strategy prepared by the Ministry of Energy, Water Resources and Irrigation (MoEWRI), which is a comprehensive document that aims to promote energy efficiency in Nepal. An updated version of this bill was again drafted and is currently awaiting approval, but there seems to be uncertainty about its fate. This law will come online only when the government take the ownership and approves the bill, which however has not happened until now. Speculations say that one of the reasons for all this is that the government has failed to realize the importance of energy efficiency and has assumed that it might only hinder the demand stimulation targets. One of the key agendas of the Act would be to form an authority to implement energy efficiency tasks, without which there will be negligible ownership from the government and a lack of incentive for the market to bring energy-efficient technologies.

Despite the roadblock, concerned government bodies are already making efforts at their respective ends. Alternative Energy Promotion Center (AEPC) is the authority with the temporary mandate to handle energy efficiency activities of the government and it has been taking on various initiatives such as standards development, energy auditing, and so forth. The initiative of the MoEWRI is noteworthy, as without its leadership, the Energy Efficiency and Conservation Strategy and the bill would not have existed. Other institutions such as the Nepal Electricity Authority (NEA) and the Town Development Fund (TDF) are also making interventions in their own capacities. To upscale the current efforts by the government and other stakeholders, the Act however, will ultimately have to be in place. It is pertinent as energy efficiency plays a crucial role in advancing the energy sector, with the objective being sustainable development rather than solely increasing energy consumption. Misconceptions should be avoided and there should be more priority given to wide-scale programs and the formation of actionable policies. Let us agree that energy efficiency is a step forward, not a step back.

The author currently works in the energy and electric mobility sector.

1 https://www.jstor.org/stable/j.ctt1pwt6jj
2 https://wecs.gov.np/source/Energy%20Sector%20Synopsis%20Report%2C%202022.pdf
3 American Council for an Energy-Efficient Economy. How Much Does Energy Efficiency Cost? https://www.aceee.org/sites/default/files/cost-of-ee.pdf

Reverse Auction in Power Sector

Unnati Amatya

Energy reverse auctions can contribute to cost efficiency by encouraging competition among potential suppliers, resulting in competitive tariff for energy services.

For the reverse auction of the solar projects, the NEA has adopted hybrid bidding which is also a reverse bidding process.

In the present context, energy procurement is evolving continuously and in this situation, businesses and utilities are consistently exploring creative methods to procure energy solutions that are economical, competitive and sustainable. One of the prominent methods is the method of competitive procurement through reverse auction. This method of procurement turns the traditional auction model upside down, encouraging competition among suppliers, reducing costs, and offering a clear and effective platform for obtaining energy services. Reverse auction involves a competitive bidding procedure where energy suppliers compete for a contract to supply energy to a buyer. This type of auction is commonly used in the energy industry, especially for procuring electricity, renewable energy or related services.

Reverse auctions are often used for competitive bidding when awarding contracts for renewable energy projects. Developers bid for project capacities and the tariffs quoted during these auctions, which will determine the rates at which the government or utilities purchase the energy. Energy reverse auctions can contribute to cost efficiency by encouraging competition among potential suppliers, resulting in competitive tariff for energy services. The transparent nature of reverse auctions ensures fairness and openness in the procurement process.

The businesses and utilities are inclined towards energy reverse auction as it fosters competition which helps in reducing the tariff rate and as a result energy is procured at a competitive price. Auction and competitiveness automatically bring out the transparency in the process, which allows participants to see the lowest bid and adjust the tariff accordingly. Further, reverse auctions streamline the procurement process, reducing the time and effort required compared to traditional negotiation methods. The openness encourages innovation and allows buyers to explore various offerings. Not just being limited to the low tariff rate, buyers can evaluate other factors such as the reliability of the energy source, environmental sustainability, and contractual terms. Buyers can prioritize environmentally friendly energy sources, promoting the procurement of renewable energy and supporting sustainability goals.

The process of energy reverse auction varies from entity to entity; however, the process begins with the buyer outlining their energy needs, and mentioning the required services. This includes specifics like energy quantity, type, and contract terms. The buyer extends invitations to potential suppliers, initiating a competitive bidding process. This can be done through specialized online platforms designed for reverse auctions. Interested suppliers register for the auction, providing essential information about their capabilities and past performance. Some auctions may involve a pre-qualification process to ensure that the participating suppliers meet specific criteria. Suppliers submit initial bids, indicating the tariff rate at which they are willing to provide the required energy. Unlike traditional auctions, the goal of this method is to decrease tariff rate as suppliers compete for the bid. If an auction platform is deployed, it will facilitate real-time competition, allowing suppliers to adjust their bids based on the current lowest tariff offer. This dynamic process continues until certain conditions, like a specified time limit or target tariffs are met. After selecting a supplier, the buyer engages in negotiations to finalize the provision of the contract. This involves discussions on delivery schedules,

payment terms, performance guarantees, and other critical aspects of the contract. After negotiations are successfully completed, the buyer awards the contract to the selected supplier, marking the conclusion of the reverse auction process.

India has been actively promoting the adoption of renewable energy sources, such as solar and wind power. Reverse auctions have been widely utilized for procuring renewable energy capacity in India. The Government of India, through agencies like the Ministry of New and Renewable Energy (MNRE) and state electricity regulatory commissions, has been setting targets and policies to encourage the use of renewable energy. Reverse auctions lineup with these initiatives. Reverse auctions provide transparency in the procurement process, and the competitive nature helps in achieving cost-efficient prices for renewable energy, benefiting both the government/utility and consumers. Solar and wind energy projects, in particular, have seen significant participation through reverse auctions in India. Auctions for solar photovoltaic (PV) and wind energy projects have played a crucial role in India's renewable energy capacity expansion. States in India often conduct their own reverse auctions for renewable energy projects, aligning with national goals while addressing specific regional energy needs.

Recently, Nepal has also started using reverse auction for procuring electricity. Nepal is more inclined towards procurement of solar power through reverse auctions. Nepal enjoys more than 300 days of sunlight each year on an average. The national average of the sunshine hours is 6.8 per day. From this, we can say that Nepal is a country which has reasonably high solar potential. As Nepal has a potential in solar power and because competition to procure hydropower is challenging due to the site specific issues, in recent years, the Government of Nepal has introduced various programs and policies in order to procure solar power through competition and mixing of multiple types of renewable energy into the national grid. In 2016, the Government of Nepal had published the 'National Energy Crisis Prevention and Electricity Development Decade' policy paper, in which the government had announced a plan to include solar and wind energy from 5-10% of the generation mix by 2026. That plan also included Nepal Electricity Authority (NEA) conducting tariff-based competitive bidding for solar projects at various locations of the country. Based on the commitment and for the enrichment of the solar projects, NEA has recently published a Request for Proposal for the procurement of solar projects having the total capacity of 100 MW through reverse auction. Under these bids, the developers are required to set up grid-connected Solar PV power projects in Nepal for sale of power generated from solar PV plants to the NEA through tariff-based competitive bidding process.

For the reverse auction of the solar projects, the NEA has adopted hybrid bidding which is also a reverse bidding process. In this reverse auction bidding, the ceiling price is determined in the initial round and then tariff-based bidding to discover the lowest price and eligible bidder in the second round. In the published request for proposal, it has been mentioned that the NEA will directly purchase power generated from solar PV plants by concluding the power purchase agreement with the selected developers. The selected developers would be allowed to sell the electricity generated for 25 years through the tariff determined by the tariff-based competitive bidding process. Even though the total capacity of the bid was 100 MW, the request for proposal allowed developers to submit the bid to the minimum capacity of 1 MW. In the evaluation criteria, the developer who has bid the lowest tariff was given the highest rank. However, in case if two developers have bid same tariff rate for the same project then, the rank would be provided in four steps:

1. Highest rank would be provided to the developer who holds the 'Grid connection Agreement' with the NEA for the proposed site.
2. If the developers have the 'Grid connection agreement' then the developer whose proposed substation is in Lumbini Province/Karnali Province/ Sudurpaschim Province.
3. If the developers tie in the aforementioned criteria, then the developer holding the 'Generation License' would be provided higher rank.
4. In case if there is still a tie, then the developer with the highest net worth would be ranked higher.

In this way, the NEA had successfully conducted the reverse auction bidding process and awarded the bid to the selected developers. As this bidding process is competitive in nature, it encourages the bidders to offer the most cost-effective tariffs, resulting in potential cost savings to the procuring entity. This tariff-based competitive bidding has promoted the development of the solar projects, contributing to the growth of the sustainable energy sources in the overall energy mix in Nepal.

Hence, many countries, including Nepal, are increasingly focusing on developing renewable energy sources. Government policies and initiatives play a crucial role in shaping energy procurement strategies. Nepal has recently completed the tariff-based bidding for solar projects, however, in order to promote renewable energy or discover advanced procurement methods, energy reverse auctions through online platforms can be considered, where competition and transparency will be going together. Reverse auctions can possibly attract investors in energy sector development which can directly support the growth of the energy sector in Nepal.

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Alleviating the 'Boiling Earth' through Hydropower Development

Laxman Biyogi

In mid-October, Bapak Joko Widodo, the president of Indonesia while announcing the commencement of the World Hydropower Conference (WHC), 2023 delivered a significant message.

Widodo's words:

I believe that in the naturally beautiful Bali, this conference will advocate for the world's development in the context of long-term environmental sustainability. Currently, the Earth is in distress. Even though the United Nations has declared the end of the 'era of the world moving forward,' the era of the 'world being enlightened' has now been announced.

The United Nations has made a statement that the era of global warming has ended but the era of global boiling has arrived. If global temperature rises to more than 1.5 degrees Celsius, disaster is inevitable. Around 210 million people are predicted to experience water scarcity; 14 million will be exposed to heat wave, and 290 million houses will sink due to coastal flooding, and 600 million will suffer from malnutrition as an impact of crop failure. These are serious threats for us.

These statistics are quite alarming and very dangerous. They suggest that the Earth, the abode of all living beings, is becoming inhospitable. Bringing the world together in one courtyard may not be an immediate solution. Even though it is stated that 'Now, uniting the world in one courtyard is not an option,' it underscores the urgent need for collective action.

Boiling Earth

Imagine a huge bowl of boiling water over a fierce flames of fire. If any living being or object immerses in such water, what would happen? Surely, an immediate death. Presently, inhabitants of Earth are passing through such moments filled with the fear of imminent death. The root cause of this is the boiling Earth and climate change, either provoked or induced.

When humans, development, progress, prosperity, and sustainability, sought to conquer the Earth like a fairy, its pressure increases. The equilibrium of the five elements—Land, Water, Air, Fire, and Sun (Sky)—is disturbed as a result. According to the Hindu mythological scripture **Yajurveda**, these five elements are particularly the sources of energy.

Without the balanced management and proper utilization of these, all living beings on Earth suffer. Although efforts have been made to strike balance among these five elements, the extraction and selfish use of resources within the Earth is still going on. Humans are treating the Earth as their personal property. Perhaps, the idea of 'wise use, conservation, and prosperity' for the Earth has rarely crossed their minds.

When greed and negligence crossed the limits, Earth responded with anger, giving rise to disasters such as earthquakes, famines, floods, droughts, and unprecedented calamities. The atmosphere became polluted. The Himalayas trembled. Glaciers began to melt. Ultimately, this upheaval didn't spare just humans; it unleashed its wrath upon the entire existence of Earth—on land, water, air, and the beings dwelling within. Faced with the crisis of its own existence, humanity has now awakened, realizing the Earth's vulnerability. Presently, there is a growing awareness of the need to preserve harmony with Earth while safeguarding one's own existence.

The impact of climate change mitigation, the transition to clean and green industrialization, and the utilization of renewable energy have been widely discussed and addressed at global level since 1990s. Numerous conferences, meetings, discussions, and debates have taken place in this dynamic field. The crisis due to the imbalance among Earth, the environment, and clean energy was first acknowledged in the Rio Conference of 1992 in Brazil. The fundamental **Mantra** of that conference was 'Nature Conservation.' However, some scholars argue that the core principle should be 'Nature Service' rather than 'Nature Conservation.'

The issue of human existence being pushed towards crisis due to Earth's deterioration is actively discussed on the international stage through the United Nations Framework Convention on Climate Change (UNFCCC). This framework involves conferences of the parties where countries come together to address climate change issues. Currently, 198 countries, including Nepal, are members of this framework. The first conference under this framework took place in Berlin, Germany, in 1995. Subsequently, the Kyoto Protocol in 1997, the Paris Agreement in 2015, and the 28th COP (Conference of the Parties) on December 12, 2023, in Dubai, have played significant roles in this ongoing global discourse.

This all-encompassing concern and urgency for the preservation of Earth, where the inhabitants are grappling with the fear of destruction, are echoed in these meetings. In the pursuit of sustainable Earth care, efforts are being made to reduce the consumption of living matter as fuel for the treatment of the boiling Earth, coupled with the clean and renewable energy production and usage. Consequently, conferences on hydroelectricity and renewable energy, as well as discussions on climate change mitigation, are happening regularly, either annually or monthly. This issue is not confined within geographical boundaries; it has become global. From political debates to discussions at the national and international levels, involving politicians, leaders, and ministers, the concern for environmental conservation has permeated every facet of society.

All of these meetings reflect the growing concern and anxiety about the Earth's well-being, and the inhabitants are participating with a sense of urgency. In order to treat the boing Earth sustainably, efforts are being made to reduce the consumption of fossil fuels and promote the production and usage of clean, green, and renewable energy. As a result, conferences on hydroelectricity, renewable energy, and discussions on climate change mitigation are being held regularly, either annually or monthly. This issue transcends geographical boundaries; it has become a global concern. It has reached the forefront of political discussions, involving leaders, ministers, and political entities at both national and international levels, making it a global issue.

Elected lawmakers, experts, researchers, leaders, and policy-makers, participate in deliberations and discussions. Many countries have established 'Climate Parliament,' to address environmental concerns, raise awareness, and promote the increased use of clean energy. This initiative gained prominence following the Paris Agreement.

Depletion of fossil fuels

Post 1880, the Earth's temperature has been increasing at a rate of 0.08 degrees Celsius every decade. This rate, doubling after the 1880s, is evident in international statistics. Subsequently, the Earth's warming trend has continued. Moreover, after 1990, with the rapid growth of industrial development, the Earth's warming trend has become even more pronounced.

Up to the year 2022, recorded global temperature measurements indicate it as the sixth warmest year on record. According to the 'Global Climate Report 2022,' the temperature is 0.13 degrees Celsius lower than the record set in 2016 and 0.02 degrees Celsius lower than the previous year (2021). This marks the seventh-highest annual temperature in recorded history. Out of the 143 years of recorded data, 10 of the warmest years have recorded since 2010. In the last nine years (2014–2022), we have witnessed consistent growth in temperature. Additionally, the United Nations reports that over 2 billion people worldwide still lack access to clean drinking water. Furthermore, it is estimated that by 2030, approximately 660 million

people will be without access to electricity.

Similarly, according to the American Climate Science Special Report, 2017, annual temperatures have been consistently rising with intensity since 2000. Based on this trend, it is projected that the Earth's average temperature will increase by approximately 5 degrees Fahrenheit by the end of the century. The estimate suggests that if the pace of carbon emissions continues to decrease, the temperature rise could be limited, and we might see a slower increase by 2.4 degrees Fahrenheit, with a global average temperature remaining around 5.9 degrees Fahrenheit in the mid-20th century compared to the pre-industrial levels.

The mentioned conditions have evolved behind the scenes since the late 19th century, driven by industrialization, the use of dirty energy, and the reckless destruction of the Earth's environment as major causes. It is not possible to reverse the damage done to the Earth's ancient structures in the past couple of decades, but mitigation is certainly possible. The latest effort in this series is the 'Bali Conference.' Held every two years, this conference aims to find sustainable and clean energy sources for global electricity, promote the proper use of renewable resources, and ensure economic prosperity in the present 'era of challenge.'

Bali Conference

The conference concluded with the issuance of the Bali Declaration, where representatives from the majority of countries emphasized the need for long-term national strategies for sustainable hydropower development. The conference, themed 'Powering Sustainable Growth,' took place from 31 October–2 November, 2023, and saw active participation from over 1,000 delegates representing nations across Asia, South East Asia, Europe, America, China, and more. The declaration

Remarks by key persons at the conference

Bapak Joko Widodo

President: Indonesia

The Head of State also affirmed Indonesia's full commitment to speed up energy transition through the development of new and renewable energy on a large scale since Indonesia is rich in green energy potential. Indonesia's green energy potential reaches 3,600 GW from solar energy, wind power, geothermal, wave power, bioenergy, and hydropower.

Regarding hydropower, Indonesia has more than 4,400 rivers including Mamberamo River in Papua province that has potential of 24,000 MW and Kayan River in North Kalimantan province that has potential of 13,000 MW which will become a source of energy in Kalimantan's Green Industrial Park.

Indonesia is facing some challenges. One is hydropower sources that are located far from the demand areas. The Government of Indonesia thus has made a blueprint of the acceleration of transmission line to connect electricity from hydropower sources to economic center and industrial areas. Other challenges are funding and technology transfer which require quite huge investment and collaborations with all hydropower ecosystem in the world. Indonesia has formulated a special plan for the construction of transmission lines to facilitate the distribution of electricity up to that region. This initiative aims not only to support our goal of reducing net-zero carbon emissions but also to contribute to lowering the global carbon.

Malcolm Turnbull

President: International Hydropower Association (IHA)

I don't mean to stop the world to achieve net zero. There is no need to halt business as economic growth and zero carbon emissions can go side by side. Hydroelectric power must be the backbone of future energy as long-term energy development is not possible without transformation from fossil fuels to renewable energy. We are working towards empowering long-term development through long-term hydropower.

Nani Hendiarti

Minister of Maritime Affairs and Investment Coordination, Indonesia

This conference will assist in achieving the country's national goals. Although we have the potential for 95,000 megawatts of hydroelectric power production, so far only a small portion has been utilized. The Bali Declaration expresses our confidence in developing a low-carbon emission-focused economy through hydropower development. We are committed to supporting Indonesia in reaching its ambitious target of net-zero carbon emissions by 2060.

Prabal Adhikari

Former DMD: NEA

The conference has conveyed a message highlighting Nepal as an attractive destination for foreign investment in hydropower. The discussions with representatives and developers from various nations during the conference have instilled enthusiasm to invest in Nepal. This demonstrates that Nepal's journey towards transitioning to clean and green energy can be facilitated with global trust. Participation in such conferences also contribute to internationalizing the status of Nepal's hydropower development and enhancing its capabilities. Moreover, it emphasizes the need to mitigate domestic and regional risks associated with hydropower development in the current context. Therefore, fostering regional and sub-regional cooperation becomes crucial for addressing these challenges.

Sharbini Suhaili

Chief Executive Officer: Sarawak Energy, Malaysia

The Bali Declaration is highly commendable for prioritizing renewable energy and making hydropower a key factor in sustainable economic development. This provides a clear-cut roadmap for the type of energy needed for the future. Therefore, each government and financial sector of every nation needs to incorporate long-term perspectives on hydropower development into their plans and regulations. Additionally, encouraging continuous investment in renewable energy is relevant in this context.

Dr. Ashok Khosla

Chairman: Hydropower Sustainability Alliance (HSA)

Hydropower can play a crucial role in achieving sustainable development goals and addressing the impacts of climate change by mitigating its effects. The HSA is committed to inspiring exemplary project development with a focus on global standards. It aims to ensure that communities, governments, and investors benefit appropriately. Additionally, the HSA plays a role in managing the local environmental impacts and minimizing them as much as possible.

Hydropower Capacity and generation by Continent by 2022 (GW)

S.N	Continent	Capacity	Generation
1	East Asia and Pacific Area	1100	464
2	South And Central–Asia	600	157
3	Africa	630	37
4	North and Central–America	620	184
5	South America	500	179
6	Europe	350	202
	Total	**3800**	**1223**

Note: Pump-storage capacity is not included in these estimated figures.

underscored the commitment to robust, inclusive, and low-carbon economies through the extensive development of hydropower and renewable energy. It emphasized the role of clean and sustainable energy in building prosperous and low-carbon economies.

The mention of the world's largest source of hydropower as a reference for energy production and storage was made in the context of advancing global economic prosperity through enhanced industrial development. The conclusion emphasized the pivotal role of proper utilization and management of hydropower resources. For the countries that are yet to fully harness their hydropower capacity, the Bali Declaration urged to expand investments in this sector.

The declaration affirms that in the current era of industrial revolution, sustainable development can also be achieved through water, air, and solar-generated electricity. This highlights the potential for transformation using resources like water, air, and solar power to drive ongoing global development. The declaration expresses confidence in uniting policymakers and developers globally in a common space to support this cause.

10 ways hydropower enables sustainable growth

1. Long-lasting, low-carbon electricity generation.
2. Management of water resources.
3. Grid balance through flexibility, dispatchability, frequency regulation and storage
4. Synergy with other renewables
5. Decarbonization of hard-to-abate industries
6. Climate mitigation and resilience
7. Affordability
8. Sustainability
9. Green job
10. Economic development in local/rural communities

Net-zero Carbon Emission

In the end, energy from hydropower was recognized as a primary source to mitigate the effects of climate change. Bhutan and Suriname have achieved their targets for net-zero carbon emissions. According to the Paris Agreement, 137 nations have set goals for zero carbon emissions. Among them, 90%, or 124 countries, aim to achieve zero carbon emissions by the year 2050.

Key countries aiming for net-zero carbon emissions

S.N	Country	Target
1	Nepal	2045
2	Bangladesh	2050
3	India	2070
4	Sri–Lanka	2050
5	Maldives	2050
6	Pakistan	2050
7	Afghanistan	2050
8	China	2060
9	Japan	2050
10	Indonesia	3060
11	Sweden	2045
12	Finland	2035
13	Austria	2040
14	Argentina	2050
15	Uruguay	2030
16	Barbados	2050
17	Belgium	2050
18	Brazil	2050
19	Bulgaria	2050
20	Cambodia	2050
21	Canada	2050
22	Germany	2045
23	Ukraine	2060
24	Kazakhstan	2060
25	America	2050
26	Mauritius	2050
27	Myanmar	2050
28	Malaysia	2050
29	UAE	2050
30	Australia	2050

Recently, the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA) have highlighted the need to double global hydropower production by the year 2050 to achieve the goal of worldwide carbon neutrality. Currently, the world has around 2500 to 3000 GW of electricity production, including pump-storage hydropower projects.

Currently, global hydropower production is only 4408 TWh of electricity, accounting for 3.7% increase as of the year 2021. Out of the total installed capacity of approximately 1397 GW of hydropower in 2021, the contribution of pumped-storage hydropower is around 160 GW.

World's Hydropower Achievements by 2022

According to International Hydropower Association (IHA), a total of 34 GW of hydropower, including 10.50 GW of pumped-storage, have been added worldwide in the year 2022.

East Asia and the Pacific: During this period, China added 24 GW of electricity, including 8 GW generated through pumped-storage. China has plans to achieve a total production of 270 GW by 2030.

Central and South Asia: In the same timeframe, this region added 2 GW of electricity, with Pakistan's Karot Project contributing 720 MW.

North and South America: In this region, electricity generation was less than 1 GW during this period. According to the international statistics, Canada and Colombia contributed 618 MW, and Chile contributed 477 MW to hydropower production.

Africa: In this region, less than 2 GW of hydropower was added. Countries like Ethiopia, Guinea, Gambia, Madagascar, Uganda, Rwanda, among others, contributed 50 megawatts each.

Europe: In this region including Turkey, a total of 3 GW of electricity was added. Switzerland and Portugal contributed 1 GW. The demand and production of electricity is expected to remain significant until 2030, with a forecasted gap of 230 MW when the demand is 420 MW.

In recent years, electricity generation using Floating Photovoltaic (FPV) technology over water has been increasing. In 2015, 70 MW of electricity was generated using this technology, and by 2020, it had reached 1300 MW. In the Asia-Pacific region alone, 1342 MW of electricity is being produced using this technology, while in Africa, it is 600 MW, in Europe, it is 26 MW, and in Latin America, it is 381.1 MW. Despite the cost savings from factors like land acquisition, the use of high-end technology has made solar projects based on water more expensive than land-based solar installations.

Achievements of Asian Countries by 2022

Bhutan: Bhutan has added 2.9 GW of electricity production. Its hydropower production has been rapidly increasing in recent times.

India: India has added 434 MW to its total production this year. The Bajoli Holi ROR project in Himachal Pradesh alone has contributed 180 MW. Additionally, Nathpa Jhakri has set a new record by adding more than 1.5 GW in 2022. The Gandhi-Sagar Pumped-Storage Project in India aims to produce 10 GW of additional electricity.

Nepal: Nepal's total installed capacity has reached 2,868 MW by 2023, with hydropower contributing approximately 95%. Both grid and off-grid systems are included.

Pakistan: Pakistan has added 720 MW of hydropower through investment from China Three Gorges Corporation. Pakistan aims to add 10 GW of electricity by 2030.

Thailand: Thailand has recently achieved 1.53 GW of hydropower production. The future goal is to generate 900 MW from the Bajiraolongkang Pumped-Storage Project in Kanchanaburi Province. An estimated 1,285 MW will be generated from the Baleh Hydroelectric Project in 2027.

Vietnam: Vietnam aims to achieve additional 30 GW of hydropower production by 2030, with the current total production standing at 40 GW.

Upcoming scenario of Hydropower

The global target is to achieve net-zero carbon emissions by the year 2050, with a contribution of 70% from wind and solar energy. During this period, it is expected that the annual production of energy from coal, oil, and gas will be reduced by a rate of 100 GW per year. Additionally, an ambitious goal has been set to achieve 100% carbon reduction that is reaching a total of 2700GW from current capacity of 1300GW.

According to the International Energy Agency (IEA), the contribution of hydropower to the global energy system has been only 15% so far. However, it is estimated that by 2050, hydropower will account for 40% of the total installed capacity, which amounts to 22,700 TWh. According to the IHA, there are currently 590 GW of hydropower projects in the pipeline globally. Among them, 131 GW are under construction, 163 GW are in the approved phase, and the rest are in various stages of development.

As per the pathway outlined by the IRENA, the contribution of hydropower to the global energy mix is expected to double by 2050. The total capacity is projected to reach 2,900 GW, with 420 GW from pumped-storage. This is in line with the global efforts to limit the temperature increase to 1.5 degrees Celsius. In conclusion, the future of hydropower looks promising, with significant growth expected to contribute substantially to the global transition towards renewable and sustainable energy sources. The construction and development of various hydropower projects globally indicate a commitment to harnessing the potential of hydropower for a cleaner and greener future.

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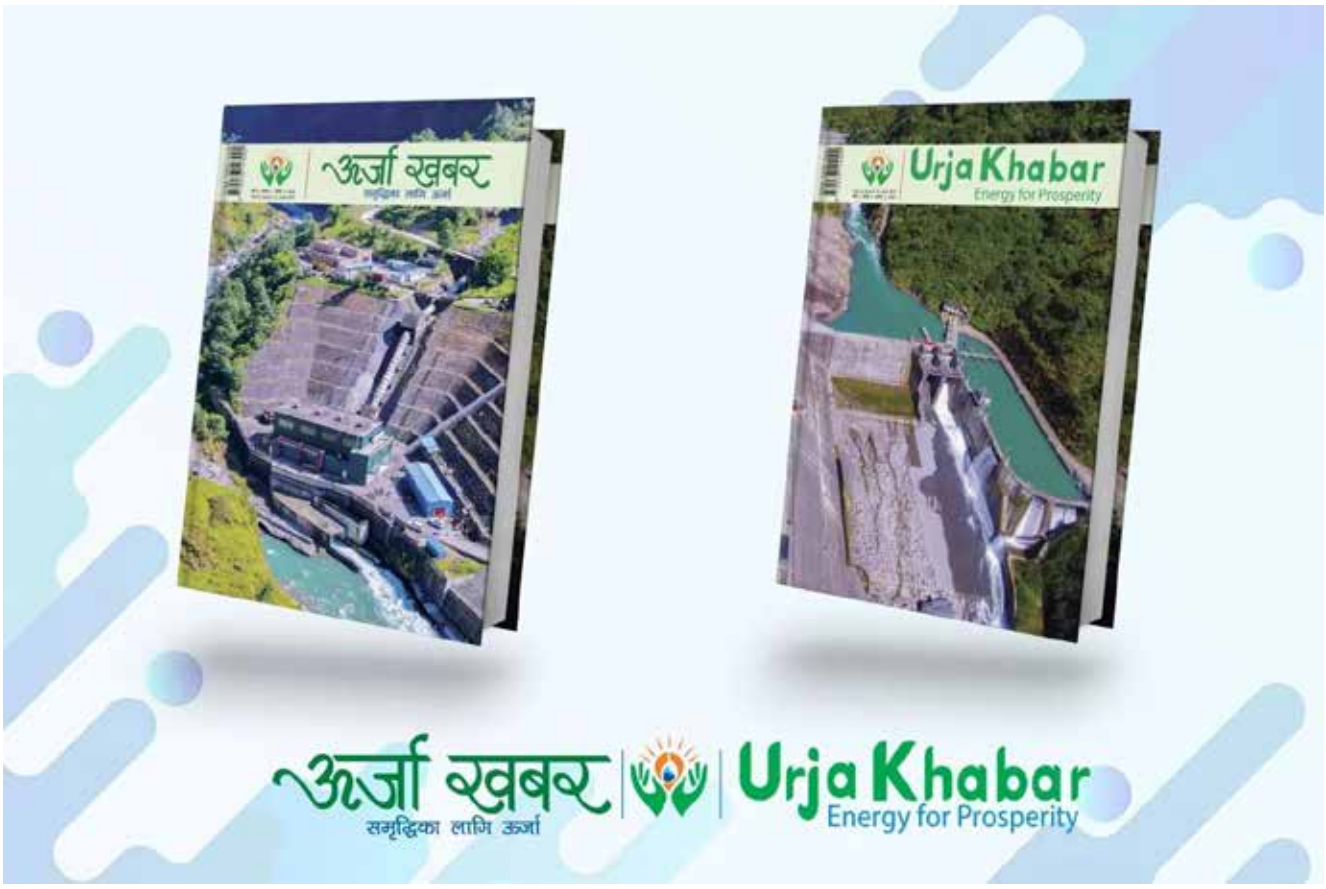

Cross-Border Green Ammonia Trade between India and Nepal: A Concept Note

Dr. Biraj Singh Thapa

The conventional approach to ammonia production, the Haber-Bosch process, when coupled with electrolysis, has the potential to eliminate coal usage entirely and significantly produce green ammonia using hydrogen energy.

1. Background

1.1. Approximately 2% (8.6 EJ) of the world's ultimate energy consumption is used to produce ammonia, which emits about 620 million metric tons (MMT) of CO_2 per year. With an annual production of 235.34 MMT in 2019, Ammonia is the second-largest chemical commodity produced in the global market. The global ammonia market size was USD 202 billion in 2022 and is projected to surpass around USD 353.3 billion by 2032, growing at a CAGR of 5.8% during the forecast period 2023 to 2032. Ammonia is of great significance to the global economy for food security and as a prominent fuel for energy security.

1.2. The ammonia production capacity of India accounts for about 10% of the global production. Furthermore, India is the largest importer of ammonia in the world with a value of USD 1577 million in the year 2021. This has subsequently advanced large-scale production and utilization of ammonia-based products such as urea and ammonium carbonate fertilizers in the Indian sub-continent.

1.3. India has announced its commitment to reach carbon neutrality before 2070 adopting vigorous measures to achieve a 45% reduction in carbon intensity by 2030. Currently, Ammonia produced and imported to India is largely from coal and gas and shares about 3% of the total country's CO_2 emissions. Energy Transition's goals and Energy Independence Mission by 2047 will cause the demand for Green Ammonia in India to rise exponentially.

1.4. The hydropower in Nepal has immense development potential. Nepal government's Electricity Authority forecasts of 3500 MW surplus hydroelectricity by 2028 pave the way for the exploration of substantial green hydrogen production opportunities. The conventional approach to ammonia production, the Haber-Bosch process, when coupled with electrolysis, has the potential to eliminate coal usage entirely and significantly produce green ammonia using hydrogen energy.

1.5. The technological maturity of ammonia production in India, along with the vast potential for green hydrogen production in Nepal, presents an opportunity to bridge the energy deficit in both nations and facilitate the emergence of cooperation to strengthen cross-border clean energy trade.

2. Objectives:

2.1. Implement targeted measures and initiatives to facilitate the gradual shift from coal-based ammonia production processes in India and encourage the adoption of hydrogen energy for green ammonia production. Kathmandu University, Nepal, has conducted an initial feasibility study on green ammonia production, demonstrating a significant technical capacity in this domain. The University is currently engaged in a government-funded project aimed at developing

a comprehensive system specification for a demonstrative 5 TPD (Tons Per Day) ammonia production facility. Leveraging the institution's robust technical expertise, the project seeks to implement crucial measures and offer strategic research recommendations to ensure the safe and sustainable advancement of the ammonia industries.

2.2. Establishing green hydrogen and ammonia production infrastructure in Nepal complements the country's targets in hydropower generation. This will be a major step to unlock the potential of Nepal's hydroelectricity to meet India's green energy transition targets.

2.3. Capitalize India's technological expertise in ammonia production and increasing demand for green ammonia consumption with Nepal's green hydrogen production capabilities and foster cross-border green energy trade. Such cooperation at the government level will fortify regional energy security and contribute significantly to global climate change mitigation efforts.

3. Opportunities and Challenges

The project seeks the following opportunities:

- Complementary Resources: India possesses a well-established ammonia production capacity, while Nepal has significant potential for green hydrogen and green ammonia production through surplus hydroelectricity. Nepal also has a very high potential for green ammonia consumption in fertilizer industries. This complementarity offers a unique opportunity for both countries to leverage their strengths and create a symbiotic partnership for hydropower to green ammonia business.
- Climate Commitments: Both India and Nepal have made substantial commitments to combat climate change. Establishing a green ammonia trade can support these climate goals by reducing carbon-intensive ammonia production in India and promoting green energy utilization in Nepal.
- Regional Energy Security: The cross-border trade of green ammonia can enhance energy security in the region. Nepal, with its renewable energy sources, can ensure a stable supply of green hydrogen-based ammonia, while India can diversify its ammonia sourcing, reducing dependence on traditional coal-based production.

Along with the opportunities, some challenges need to be addressed:

- Infrastructural Investment: Developing the necessary infrastructure for green ammonia production and transportation requires substantial investment. Both countries will need to invest in upgrading existing facilities and establishing dedicated logistics for handling and transporting green ammonia.
- Policy and Regulatory Framework: Establishing cross-border trade requires a robust policy and regulatory framework that addresses legal and technical aspects, such as standards for green ammonia production, certification, tariffs, and environmental regulations. Harmonizing these frameworks between the two nations can be a complex task.
- Capacity Building: Building local expertise and human capital in green ammonia production, handling, and utilization is vital. Both countries need to invest in training and skill development programs to support the sustainable growth of this sector.

The concept of cross-border clean ammonia trade between India and Nepal represents a transformative initiative with far-reaching implications for both nations. Though the challenges of infrastructural investment, policy alignment, technology transfer, market dynamics, international collaboration, and capacity building lie ahead, the political dialogue between the government can offer an opportunity to address these obstacles and explore viable solutions. With a firm commitment to sustainability and a collaborative spirit, both countries can set a precedent for cross-border clean energy trade and contribute significantly to the global effort to combat climate change and build a more prosperous and sustainable world.

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Odd Hoftun: a Nepali Hero

Kumar Pandey

As a young electrical engineer, his first assignment in Nepal was to build the United Mission to Nepal (UMN) operated Tansen Hospital in Palpa District.

Nepal Electricity Authority, the institution responsible for electricity distribution in the country relies on 11,000 Volt lines, which would be transformed to 400/230 Volts to make the household connections.

Odd Hoftun was born in a family with engineering professionals, in Norway, in the late 1920s. He grew up around a power plant which his father operated. He had early exposure to power plants and was aware of the multiple positive impacts they could have on rural communities. Norway was a poor and devastated country in the aftermath of the Second World War. Odd was witness to how broken economies could bounce back, with proper policies, infrastructure and skilled people. It was in these early years of his life that Odd internalized the importance of hard work, frugality, self-reliance, work ethics, etc.

After completing his engineering degree in his mid-20s, Hoftun and his wife Tullis decided to volunteer, and provide service to poor communities around the world. Although Odd wanted to go to Tibet, he found his way to Nepal. As a young electrical engineer, his first assignment in Nepal was to build the United Mission to Nepal (UMN) operated Tansen Hospital in Palpa District. When Odd came to Tansen in 1958, there were no road connections. He had to walk from the Nepal-India Border to Tansen, through Butwal, up and down the high hills. When he started working in Tansen, he quickly realized the lack of people with even basic technical skills, as well as lack of construction tools and equipment to carry out even the simplest tasks such as metal welding or carpentry. Odd found ways to teach the locals, learned to improvise, and learnt local methods that were workable.

After completing his work at Tansen, Odd and Tulis decided to remain in Nepal, and went on to establish the Butwal Technical Institute (BTI) with the aim of training local youths in technical trades to make them electricians, welders, carpenters, mechanics etc. He set up a system where the trainees would contribute to the market needs of the day, as part of their training. After there were abundant local skilled human resources, Odd went on to establish numerous companies and institutions. He pioneered the construction of hydropower projects through Nepali companies as well as foreign direct investments. One could write volumes on each of these initiatives. All of Odd's successes and failures as well as his trials and tribulations have been well documented in numerous books which have been written on his behalf or in which he provided invaluable insights to his works and accomplishments. In this article, however I would like to recount my memories of Odd as my boss and my mentor.

Unconventional Missionary: Odd Hoftun was often at odds with his fellow Christian missionaries at the United Mission to Nepal (UMN). Most foreign missionaries

that then worked at UMN, then, believed that their mission should be to help the underprivileged and disadvantaged people of Nepal. Most of them wanted to limit their scope of activities to meeting those goals. They believed that this service should be provided in the form of charity through non-governmental organizations. Odd however was of the belief that the downtrodden and the economically backward could be helped in the long run through skills training and making good jobs and other economic opportunities available. Contrary to his colleagues who believed in doing charity work in favor of the poor, Odd set up training institutions, and private companies to start industries and provide service to other industries and businesses. The trainees in the training institute were made to contribute paid labor in local businesses as part of their trainings. The concept of helping the economically backward people through profit making companies and institutions was a revolution of a sort within UMN as well as in the development sector of Nepal. Odd championed the concept of making the private sector involved in the generation and distribution of electricity, which even today is not commonly accepted by many international donors and people in governmental agencies in Nepal. In this regard Odd was truly an unconventional missionary who brought about meaningful change in thinking about sustainable development delivery and providing service to the poor.

Simple and frugal: During his early adulthood, in the difficult days following the Second World War Odd saw firsthand how the Norwegian communities had to cope with poverty and hardships, much like what he saw in Nepal upon his arrival. Having lived through this situation in his youth, Odd developed a keen sense of simplicity and frugality, as well as sense of service to the society. In Nepal, he maintained a hermit like lifestyle. He dressed simply and was always seen with a Nepali Topi. He could be seen moving around Kathmandu on his rusty bicycle, with one of his pant-cuffs pinned so it would not be caught in the chain of the bicycle.

I remember one time when we furnished his office in Butwal, which he frequented only several times a year, he kept on referring it to as his 'luxurious' office, when in fact the other staff were still complaining over the lack of work place amenities. Until then, Odd was used to sharing the open space under a staircase for office. After the upgrade he was given a room of his own, which he thought to be too luxurious.

He also deeply believed that too much money was a b*ad thing. In the book, Power for Nepal,* (a biography of Od Hoftun written by Peter Svalheim) *he* says "money should be treated like poison. The ideal is to have too little money. The pinch triggers the imagination, and brings local resources an inventiveness into play." He used to say we should have about 10 percent less money than what we really need. That way we could get the work done but it would keep us disciplined about our expenses.

He was a strong proponent of simple living. When travelling with him within Nepal, when we had to stop for lunch at local bus stops he always refused the meat dish. He said the meat dish was a rip off.

This principle of frugality also had its downside. When it came to allocating staff salaries, he was adamant about setting salaries at minimum levels. This did not go unnoticed by the employees. Often times this became a cause for some, including some of his most trusted employees, to quit working for him. Yet, many of us respected Odd's views because Odd himself practiced this principle of frugality and he himself maintained a low cost life style.

Belief in institutions and people: In the book *Power for Nepal,* Odd says "Human capacity won't happen automatically as a result of a strategy. It cannot be accomplished by pouring in money. What is needed is people who have strong faith that something is important – people who are willing to go out and start a process, and have the patience needed to see the ship into port. For it is all about people." (*'Power for Nepal').* Odd spent all his life in the process of capacity building in Nepal. Ever since he got to Tansen in the late 50s and until his retirement and even in his post retirement years, he sought ways to build local capacity in Nepal. In his early days in Nepal he built the Butwal Technical Institute to develop local skills in people. He progressively incorporated companies to carry out design works for hydro projects, he built companies to build tunnels and other companies to fabricate steel parts for power plants etc. He also set up companies to construct wooden furniture, build bio-gas plants and manufacture plywood in Butwal. With all these activities Butwal turned into an industrial hub within a few decades after Odd started his activities there.

Presently there are 100s of hydro power companies that are either operating or building projects in Nepal. Almost all of those projects have someone that directly or indirectly got his/her preliminary training or exposure to the industry through one of Odd's initiatives. Without Odd's vision for developing human resources and institutions for small hydro development in Nepal, in no way could there be a robust hydropower industry in the country, as there is now.

Capacity building through technology transfer: Odd set up

most of the institutions under the aegis of the UMN. But he had friends and acquaintances in Norway, US and Europe that he could call upon to provide the technical expertise and support when required. He had connections with old power plant owners in Norway that were willing to donate their old machines to Nepal, he was able to mobilize Norwegian volunteers that would collect and pack those machines and equipment to ship to Nepal. He had connections in the Christian community through the UMN where he could seek experts for technical assistance when he required it. Most of these people shared Odd's vision and mission and were available as volunteers. Odd also had connections within NORAD, the Norwegian Development Agency that financially supported many of his initiatives. These resources and experts were critical for supporting many of the activities Odd had undertaken, may they be running the technical institute, or installing a power plant or obtaining grants for rural electrification. The people trained in Butwal or engineers that Odd hired in his companies learned from these foreigners. Many of the locally trained technical personnel today are experts capable of providing similar expertise to clients internationally.

Hard working and dedicated: Odd believed in hard work. One would hear again and again how Odd put in long hours every day. When I first went to Butwal to be interviewed by Odd, I got to know firsthand of his long work hours. I was put up at the UMN guest house the night before the interview. As I went to my small room (these rooms were hardly a few inches larger than the bed that was placed in them), for the night, I heard someone typing till about 11 p.m. when I dozed off. I was again awakened by the sound of typewriter at around 4 a.m. Later I came to know that the person residing in the next room to mine was Mr. Hoftun and this was his normal routine. He was said to work 16 hours a day on a regular basis. Odd's thinking was rooted in "…the period before, during and after the war, when austerity and hard work was the recipe for dealing with harsh environment", (Power for Nepal).

Even after his retirement from Nepal, he kept on working on a regular basis for the development of Nepal. He had many plans. He worked hard to get BPC privatized and to secure Norwegian participation in the privatized company. He formulated a scheme to build the Melamchi Drinking Water Scheme with a Hydropower component attached to it. This was later caught up in politics within the funding agency and the Melamchi drinking water scheme was built without the hydropower component.

Odd was dedicated to his mission of capacity building as well as construction of hydro projects in Nepal. He travelled frequently to and from Norway to secure resources, (plant, equipment, experts, and money) in order to enable him to implement those plans. In the summer of 1992 I was in Oslo, as part of a training program. One night we got the sad news that the plane that was carrying Martin Hoftun, Odd's son, had gone missing and it was feared that all the passengers were killed. The next morning, we went to the office to express our sadness, only to learn that Odd had come in earlier than all of us. And he had gone to a meeting at some government agency to discuss the development of the Khimti Project. It was just another working day for Odd. We were in shock!!! This was the kind of dedication he had for his job.

Believer in small is beautiful, appropriate technology

Odd was a great practitioner of appropriate technology. He would adopt technology to match the needs of the local people and community. The rural electrification program he initiated around the Andhikhola Hydro Project in Syangja district demonstrated how appropriate technology could deliver development to people, who had been denied such privilege because the mainstream technology was not feasible for them. Nepal Electricity Authority, the institution responsible for electricity distribution in the country relies on 11,000 Volt lines, which would be transformed to 400/230 Volts to make the household connections. But the problem with this was that the oil-filled transformers used to transform the Voltage were too heavy and could not be transported to villages far from the road-heads. Odd and his team then designed a system with dry transformers that could be carried along the trails on the hills that would transform 1000 Volts to 230 Volts that could be connected directly to the households. Normal insulated cables could be used to carry 1000 Volts, thus eliminating the need to cut trees to extend the transmission lines. This way the connections became cheaper and feasible, enabling thousands of consumers in the area to have electricity, who without this technical intervention would have received electricity decades later!!

Similarly, as the engineer responsible for building the hospital in Tansen he redesigned the tin roofs so that they could collect water in a plastic lined cisterns under the floor of the Hospital. This way the hospital could have water available in the dry season, in water starved hill of Tansen.

There were numerous such schemes he designed he championed to enrich the lives of the rural poor of Nepal.

Odd also believed in taking small steps towards development

prior to taking on the big challenges. For example, when he stared building the Tinau Hydro project, he first installed a temporary 50 kW scheme (1971). Later he extended the tunnel and installed 450 kW turbines (1976). Finally, as demand for power increased and the ability of his staff also increased, the project was fully optimized at 1050 kW (1978). It had taken 12 years to complete the project since work started, and 15 years, since the planning began, to fully complete the job!!!

With the workforce and equipment that were developed and secured from the Tinau Project, Odd ventured to develop the Andhi Khola Project (5.1 MW). He relied on manual labor and cost effective technology to build this project. It took over 10 years to commission this project, from its start. But in those 10 years, companies like Himal Hydro, Nepal Hydro & Electric, and Butwal Power Company had gained tremendous amount of experience and developed huge pool of human assets to design, build and operate hydro projects. After the completion of Andhi Khola Project (1991), these same companies were engaged to build the 12 MW Jhimruk Hydro Project in Pyuthan (1989-1994). Following its completion Odd was able to get international partners to develop the 60 MW Khimti MW hydro Project (1995-2000), with the involvement of the same Nepali companies that had built Tinau, Andhi Khola and Jhimruk. So the team that started by building a 50 kW scheme, within three decades, had successfully participated in the construction of a 60,000 kW power plant. In every step of this growth Odd schemed to involve Nepali individuals and companies to the greatest extent possible.

Development oriented: Odd was worried about Nepal' development. In the book **Power for Nepal**, Odd talks about how he worried about the social injustice in rural Nepal, especially relating to caste. He thought this would bring undesired rift in the society. He also believed Nepal's development would have to be done through Nepali professionals and institutions. As said earlier he believed it was good to be cash strapped rather than to have excessive cash. He was not fond of donor money for development.

Although he initiated the Khimti Project, Odd was not happy with the way it ended. The project was funded in big part by the Asian Development Bank, and Norwegian multinationals were the major owners. Along with their funds, came their conditions and international standards on financing, technology etc., which Odd thought was inappropriate for Nepal. These conditions and standards were too expensive which would result in electricity being too expensive for consumption. So he concluded that hydropower projects in Nepal would have to be built by Nepali professionals and institutions, and through Nepali banks, to enable the Nepali people and industries to benefit from them. But he was open to the idea of foreign investors building projects in Nepal and exporting that electricity to India to reduce Nepal's trade deficit, after expanding its industrial base in Nepal and consuming as much as possible in Nepal (Nepali Times. 16 March 2023)

Open discussions and social research: Odd initiated a lot of activities for industrial and technical development in Nepal. However, he was also cognizant of the need to promote open discussions and develop research in the social sphere as well. After his son Martin died, he helped establish Martin Chautari as a discussion forum, for people of different backgrounds to come together and share their views on development. Later, in the year 2002, the institution was registered as a separate NGO by a group of young Nepali academics and development practitioners. The organization now carries out research on social and media related issues, publishes its research papers, and mentors young university students so that they can be competent researchers. Martin Chautari has continued the tradition of weekly discussions, affectionately called Mangalbarey Discussions, for over three decades. After all, industrial and technical development efforts require rigorous social vetting to ensure that we are getting the kind of development our society requires. Today Martin Chautari is a well-established research institute in Nepal, with over 110 books published in the last two decades, and an impressive library of over 25,000 volumes of books to aid research works.

Finally,

It was an honor to work with one of the greatest minds and intellect in this sector. He was a tough boss, who worked harder than any of us. He was always thinking far ahead than most of his colleagues. He had a lot on his mind. It was not just one project or one company. He had a vision for the entire sector and even the country. Odd was truly a pioneer of Nepal's small hydro power sector. The most important lesson I learnt from him was that one needs to keep on moving ahead with one's belief and passion even when success is not guaranteed or certain. As one that espoused his views and passion, I hope to be able to push his dreams a little further and achieve a little more, riding up from the strong foundations he has laid, and the wisdom he has imparted. Rest in Peace Mr. Hoftun. You will be long remembered for all you have done for Nepal!!!

The writer is an energy expert and Independent power producer.

Panauti Power Plant to promote Green Hydrogen Technology in Nepal

Prof. Dr. Rajesh Saiju Dr. Biraj Singh Thapa Dr. Mandira Shrestha Saiju Mohamad Quadri

Abstract

With an enormous hydropower potential, it is possible to transform Nepal into CO2-free energy generation and consumption country in the coming decades, particularly by 2040. It can be mentioned here that Nepal has a hydropower potential of around 83,000 MW, while around 43000 MW is economically feasible. At the pace of today's development of hydropower projects, Nepal could generate around 38,000 MW of hydropower within 2040. The best way to utilize this enormous hydropower, which is much more than its necessity, is to generate hydrogen and apply it in different sectors of energy demands. To boost this hydrogen technology in Nepal, in the first step, it is necessary to develop suitable manpower from leading universities like Kathmandu University [KU]. In this context, the Flensburg University of Applied Sciences [FUAS] has signed a memorandum of understanding with the KU. Both universities have chosen hydrogen technology development as their key issue, that's why the existing Panauti hydropower plant has been selected as a location to develop a real hybrid power system laboratory in which around 500 kW of PV plant will be integrated. The generated constant electrical power of 500 kW will be utilized in different fields of hydrogen applications like fertilizer production, H_2 mobility, and electricity generation through the fuel cell. This real effort will be able to provide places for practical works, research and technology-understanding tours for people from different walks of life. Besides, this sustainable renewable energy park will sustain itself economically through the hydrogen economy.

Introduction

Nepal started its hydropower technology early in the beginning of 1911 with its first hydropower Pharping (500 KW), which was installed before the hydropower introduced in China in 1912. However, there was no continuous progress which could be observed with the power plants installation capacities in different years up to 2015. The second hydropower plant (640 KW) was established at Sundarijal in 1936 and the third one was established after a long gap in 1965 in Panauti with a capacity of 2,400 KW in the cooperation of the former Soviet Union. In the last five years, the development of hydropower plants has rapidly progressed at good rate by the Independent Private Producers (IPP) as well as the Nepal Electricity Authority (NEA). The Panauti hydropower plant has a historical

meaning in the development of hydropower in Nepal and it is running and producing power till today. Out of three generation units which used to produce a total power of 2,400 KW, now just one unit is running a producing power of around 500 KW which is being supplied to the national grid. This power plant has a reservoir which is used to regulate the water and helps to produce constant power. The inside and outside views of this power plant are shown below:

Panauti Hydro Electricity Project

Name : Panauti Bijuli Ghar
Built-in: 2022 B.S.
Made by: Russia
Location: Khopasi, Balthali (20 minutes Bus ride from Panauti Bus Park to Khopasi Bus Stop and 5 minutes walking down the road)
Installed Capacity: 2400 KW (3 units(turbine) 800 KW each)
Daily Pondage Capacity: 50000 Cu. Meters
Canal Discharge: 3.2 Cubic meters/sec
Length of canal (Basen To Barrage): 3721 meters
Effective head:60 meters
Maximum head: 66 meters
Length of Penstock: 370 meters
Internal Diameter of Penstock: 1400 mm
Turbine Capacity: 850 KW
Type of wheel(turbine): Francis
Discharge of each unit: 1.61 cu.m/sec
Generation voltage: 6300 Volts
Transmission voltage: 33000 volts up to Bkt Sub, 11000 volts up to Sangha
Step-up transformers: 6300/33000 Volts (2*1500 KVA), 6300/11000 Volts (2*650 kVA) [1]

As the declared national target is to utilize the power generation from hydropower for maximum benefit to the nation, new technologies are to be implemented in different levels of power system infrastructure. One of the future-oriented technologies is definitely the direct utilization of electrical power in different fields like industry, mobility, household etc. Because of the Problems like energy storage, short life cycle and recycling of the batteries, other technology might be the most significant in the future and that is the hydrogen technology. As a pilot project, the Panauti Hydropower Plant is very suitable because of its location, power production, reservoir, investment and utilization. The electrolyzer is the main component of hydrogen generation and its lifetime is dependent on the available power fluctuation. The higher the power fluctuation, the shorter the lifespan of the electrolyzer. A hybrid power system consisting of a hydropower plant, reservoir and PV system provides the best condition for the electrolyzer because constant power generation will be guaranteed during day and at nights. The power can be regulated and the extra power can be transmitted to the national grid.

Hybrid Power System: Energy Systems

The basic layout of the proposed hybrid power system is shown below in the figure.

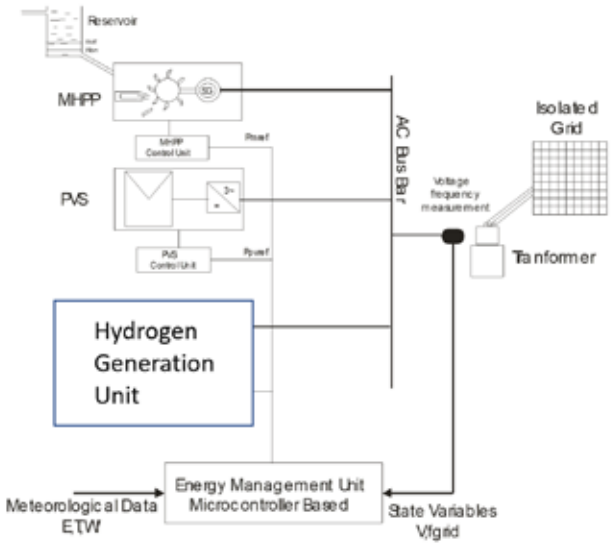


Figure 2: Schematic representation of hydropower and PV system based on hybrid power system [2]

The energy management system regulates power production based on available primary energy. The control strategies of the energy management system are shown below in the table 1.

Condition	Action	Hydrogen Generation	Uses
Ppv > 500 KW	Reduce Ppv to 500 kW Store water in the reservoir	Generate hydrogen from 500 KW	Utilization in different field
Ppv = 500 KW	No action in the PV system Store water in the reservoir	Generate hydrogen from 500 KW	Utilization in different field
Ppv < 500 KW	Generate the power (500 KW – Ppv) from the hydropower	Generate hydrogen from 500 KW	Utilization in different field

Table 1: Control strategies of Energy Management System

Hydrogen Utilization System

"Water is the coal of the future. Tomorrow's energy is water that has been decomposed by electric current. The elements of water thus decomposed, hydrogen and oxygen, will secure the earth's energy supply for the unforeseeable future." (Jules Verne, 1875)

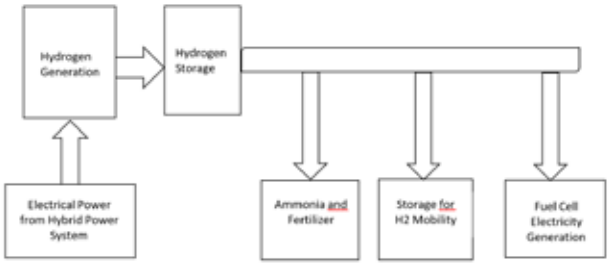


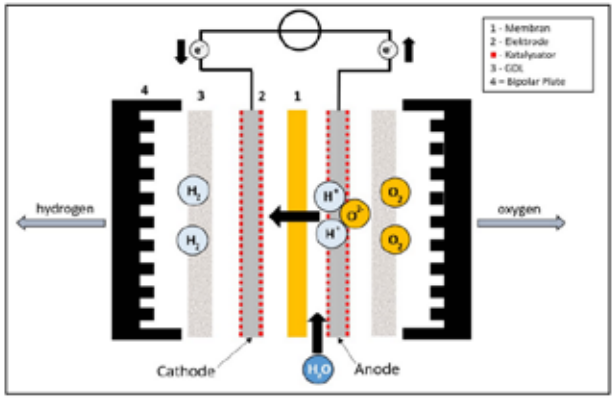
Figure 3: Generation of green hydrogen and its applications

The heart of this proposed renewable energy park is the hydrogen generation unit, which will generate green hydrogen from available renewable energy and supplies hydrogen to different application units.

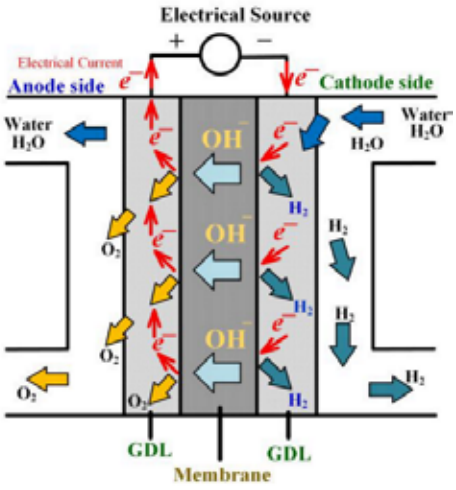
Different types of electrolyzers are available in the market. On the other hand, many research institutes and companies are working towards making efficient, secured and cost effective electrolyzers. Three types of electrolyzers are shown below:

1. Conventional alkaline electrolyzer

Direct current (DC) voltage is applied between two electrodes --anode and cathode-- which are separated by a permeable membrane well known as the diaphragm and the electrodes and the diaphragm are immersed in an alkaline solution made from potassium hydroxide solution. Because of the electrical voltage, oxygen is produced at the anode and hydrogen at the cathode. Because of low investment costs and high long-term stability conventional alkaline electrolyzers are quite popular and widely used for hydrogen generation. The efficiency of alkaline electrolysis is currently around 65 percent and up to 90,000 operating hours can be achieved [2].



PEM Electrolyzer



Alkaline Electrolyzer

Figure 4: Working principle of alkaline electrolyzer [3] and PEM electrolyzer [4]

2. Proton-conducting polymeric membrane electrolyzer / Proton Exchange Membrane (PEM)

PEM electrolyzer consists of an electrolytic cell in which two electrodes (cathode and anode) are spatially separated by a semipermeable membrane. The electrodes are noble metals like platinum or iridium. The semipermeable membrane which allows only the protons to pass through are made up of Nafion Ruthenium oxide and iridium oxide are used as catalyst which will be applied on both sides of the membrane to enhance the reaction. As the reaction takes place in a harsh condition, the outer envelope of the electrolytic cell is formed by corrosion-resistant bipolar plates like titanium or stainless steel.

3. Solid state electrolyzer / Solid Oxide electrolyzer (SOE)

This type of electrolyzer is recently available in industrial applications just after passing through the research. In this electrolyzer, consisting of a solid ceramic (solid oxide), gaseous water is fed into the reaction chamber. The solid oxide separates the electrolyzer into two half-cells.

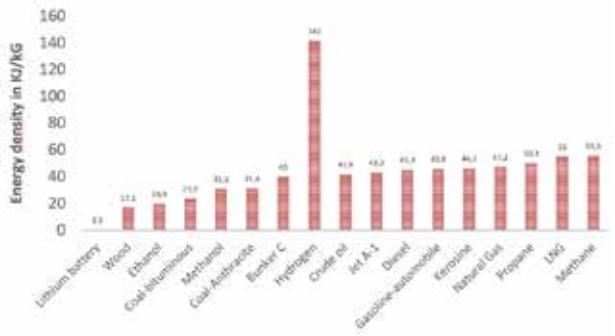
This technology, with a very high efficiency of over 80 percent, is operated at a very high temperature of 600-900 °C. The largest SOE is operated by the company Sunfire GmbH. The investment cost resembles the PEM electrolyzer.

From the above short introduction of different electrolyzers, this project can use either a conventional alkaline electrolyzer, which is well developed and easily available in the market and cost-effective or the PEM electrolyzer, which is more suitable than the former, because of its dynamic characteristic to resist the fluctuating power. As

a real lab, during the lab experiments, research projects and educational visits, a fluctuation in power flow to the electrolyzer is necessary to be demonstrated.

Storage and Transportation

The generation of hydrogen from locally available renewable energy plays a significant role in the sustainable CO2-free energy system transition. At the same time, it is also clear that the generated hydrogen at the suitable site cannot be directly used, so the storage and transportation is another important issue of the hydrogen-based energy systems.



Within the real lab, hydrogen generated from the hydrogen generation unit has to be stored and transported to the different application units. How it can be stored and transported is shown in schematic way below:

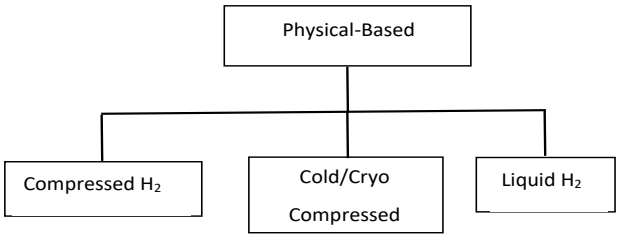


Figure 6: The energy density of hydrogen compared to other fuels [5]

Hydrogen has the highest energy per mass compared to any fuel; however, its low ambient temperature density results in a low energy per unit volume. To gain higher energy density, hydrogen can be stored in different physical-based and material-based methods. In the beginning, the focus of this project was the generation and utilization of hydrogen in different fields, so physical-based storage was chosen as a suitable solution for its storage.

Hydrogen Storage

Figure 6: Physical storage of hydrogen

Compressed hydrogen

Hydrogen can be stored in high-pressure vessels to increase the density. Such vessels can withstand pressure from 300 to 700 bar and can be used in different applications like in vehicles or stationary storage etc. Many vessels can be mechanically connected to store large amounts of H_2 as shown in the figure below:

Cryo-compressed hydrogen storage (CcH_2): CcH2 refers to the hydrogen which is stored at cryogenic temperatures with pressure of 253 to 354 bar.

Figure 7: Single piece of hydrogen tank and combination of tanks

PRODUCT: HYDROGEN TANK 500BAR – 160L TO 300L

This tank comes in several sizes, from 160L to 300L and can be arranged in the form of bundle with several tanks. This 300-liters internal volume tank can store about 10kg hydrogen at 500bar. This Type 4 tank is the perfect match for hydrogen refilling stations or for gas transportation.

Indeed they have a double certification: PED for stationary application and TPED for gas transportation.

SERVICE CONDITIONS	
MASS OF HYDROGEN STORED AT 500BAR (15°C)	9.5kg
TEMPERATURE OF USE	From -40°C to 65°C
MAXIMUM WORKING PRESSURE	500bar
MAXIMUM REFILLING PRESSURE	500bar
POSITION OF USE	Vertical or horizontal
DIMENSIONS	
INNER VOLUME	300L
MASS OF EMPTY TANK	260kg
EXTERNAL DIMENSIONS (CM) (WITHOUT SUPPORT)	Ø49cm x 307
MATERIALS	
HYDROGEN TANK	Type IV – Polymer liner reinforced with composite material
NOZZLE STAINLESS STEEL	x2
REGULATION TEST	
SERVICE LIFE	10 years / 5,000 cycles
HYDRAULIC PRESSURE TEST	750bar
APPROVED ACCORDING TO	EN12245 - PED 2014/68/EU & TPED 2010/35/EU

Figure 8: Technical description of 500 bar – 160L to 300L tank [7]

Liquid hydrogen (LH_2):

Storage of hydrogen as a liquid requires cryogenic temperatures (typically around -300°F / -184°C, or as low as −190 °C (−310 °F)) because the boiling point of hydrogen at one atmosphere pressure is −252.8°C.

Components requirement

Table 2: Components requirement to build a real lab

Sl. No.	Components	Unit	Company	Available
1	Hydropower plant	1	NEA	Yes
2	PV Panels (ca. 500 KW)	1	NEA	Will be provided by NEA
3	Energy management system	1	Still to find out	No
4	Eletrolyzer 500 KW	1	Still to find out	No
5	Compressed gas tank	24	Still to find out	No
6	Hydrogen Tank Station	1	Still to find out	No
7	Fuel Cell	1	Still to find out	No

Calculation of hydrogen storage size

In case of mass storage of hydrogen at 500 bar, a total volume of 6,000 liter tank is required as calculated below:

Available power (Pav) = 500 KW

Electrical energy per day (Een) = 500 KW x 24 H = 12000 kWh/day

Energy requirement for 1 kg hydrogen = 50 kWh

Production of Hydrogen/day (H2day) = 12000 kWh/50 kWh = 240 kg/day

Compressed gas tank size (500 bar)

Density of hydrogen at 500 bar (Dhy) = 33 kg/m3 = 33 kg / 1000 liter

Size of tank for 9.5 kg of hydrogen = 300 liter

Size of tank for 240 kg of hydrogen = (300 liter /9.5 kg) x 240 kg = 7579 liter

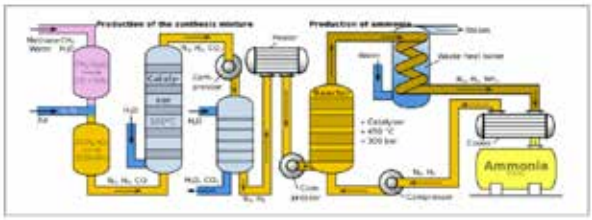
Number of above mentioned tank (Tn) = 7579 liter / 300 liter = ca. 26

Hydrogen utilization

The green hydrogen generated from hydropower and PV systems can be utilized in different application fields. In the case of a developing country like Nepal, the important fields are the production of fertilizer, H2 mobility, cooking in the household, heating systems in industries, E-Fuels and the generation of electricity.

Production of fertilizer

The production of artificial fertilizer is based on ammonia, which will be green only if the green hydrogen is used. The process of ammonia production is shown below in the figure. The production of ammonia is the most energy-intensive process in which a reaction between H2 and N2 takes place under high pressure between 150 and 300 bar and high temperature between 300 and 550 °C.



Ammonia production using Haber-Bosch process:

Figure 9: Schematic diagram of ammonia production based on the Haber-Bosch process [8]

Green ammonia can be used to produce three types of fertilizers, plant nutrition. The most common one is urea [1 kg urea ($CO(NH_2)_2$.) = 0.46 kg N2 + 0.067 kg H2 + 0.2 kg C+ 0.26 kg O2] or UAN. For this type of fertilizer green hydrogen is required as shown in the above figure 10. The green hydrogen is mixed with N2 available in the air to form ammonia. Ammonia is converted into nitric acid which is mixed with ammonia itself to form ammonium nitrate (AN). When ammonia is treated with liquid CO_2, urea fertilizer is made. Ammonium nitrate and urea can be mixed in water to prepare urea ammonium nitrate (UAN).

N_2 (g) + $3H_2$ (g) → $2NH_3$ (g)
Ammonia

$2NH_3$ (g) + CO_2 (g) → $H_2N\text{-}CO_2^-$ NH_4^+ (s)
[Ammonium carbamate]

↓

$(NH_2)_2CO$ (s) + H_2O (l)
Urea

$4NH_3$ (g) + $7O_2$ (g)→ $4NO_2$ (g) + $6H_2O$ (l)

$4NO_2$ (g) + $2H_2O$ (l) + O_2 (g) → $4HNO_3$ (aq)
Nitric Acid

HNO_3 (aq) + NH_3 (g) → NH_4NO_3 (aq)
Ammonium Nitrate

NH_4NO_3 (aq) + $(NH_2)_2CO$ (aq)→ $NH_2NHCONH_3^+NO_3^-$ (aq)
Urea

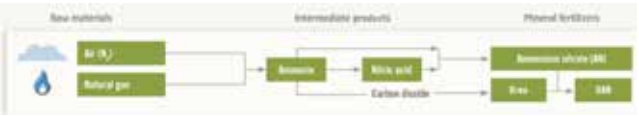
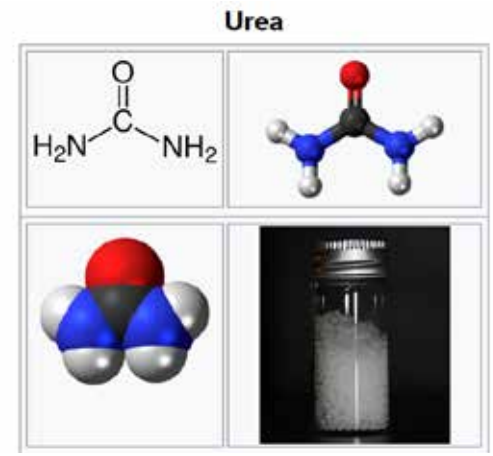


Figure 10: Schematic diagram of urea production [9]



Some part of the energy produced from the hybrid power system is to be used in the process of fertilizer production. The fertilizer plant will be a small one only as a demonstration.

Figure 11: Chemical bonding of urea fertilizer [10]

Calculation of electrical energy for production of 1 kg urea [10]

Production of 1kg H2	Production of 1kg Ammonia	Production of Urea	Total energy production per day 12000 kWh
50 kWh	8.3 kWh	10.55 kWh	

The total electrical energy of 12,000 kWh can be generated from a constant 500 kW hybrid power system, from that 200 kg hydrogen (=10000 kWh) will be produced and the rest of the energy 2,000 kWh is used to produce urea fertilizer (= 181 kg). As a demonstrative purpose, a small fertilizer production unit can be installed.

Hydrogen mobility

Another purpose of this sustainable renewable park is to conduct H_2 busses between Kathmandu University and Kathmandu City. At the moment, a lot of bus transports take place between Kathmandu University and Kathmandu, which brings the students from Kathmandu to the university and back. The hydrogen required to operate the busses is generated in this proposed park and at the same time, this project serves as an example to complete transportation sector in Nepal. As an example, Urbino 12 hydrogen bus from Solar Company is considered below:

Urbino 12 hydrogen		
Antrieb	Standard	
Motor	Standard	Electrical Portalachse ZF AVE130 2x110 kW
Fuel Cell	Standard	70 kW
Traktion batteries	Standard	Lithium-Ionen
Hydrogen Tank	Standard	Gastank aus Verbundwerkstoff 5x312 L
Charging System	Standard	Plug-in

The tank set of the Solaris Urbino hydrogen, made of type 4 composite materials and placed longitudinally above the vehicle's first axle, reaches a total volume of 1560 l and guarantees a storage capacity equal to 37.5 kg of hydrogen. Thanks to the advanced technology used, the buses will be able to travel at least 350 km on a single charge.

Figure 12: Urbino 12 hydrogen bus [11]

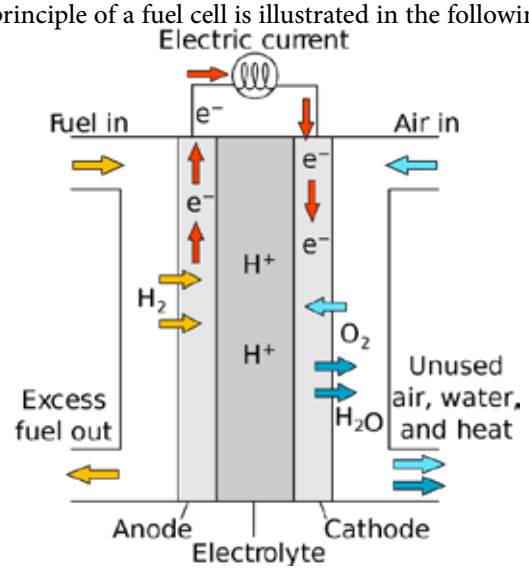
From 200 kg of hydrogen produced per day, 150 kg will be used in H2 mobility. The Urbino 12 hydrogen bus can travel 1400 km with 150 kg/day of hydrogen generated in the sustainable renewable park. 20 hydrogen buses between Kathmandu and KU (ca. 30 km) travel 1200 km, which requires only 128 kg of hydrogen. It indicates that

one-day production of hydrogen in this park is sufficient to operate 20 hydrogen buses. The cost of one Urbino 12 hydrogen bus is ca. 625.000,00 €.

Fuel Cell

With the help of a fuel cell, electrical energy can be produced back from the splitted H_2 and O_2 from water. A fuel cell is similar to the electrolyzer in its construction. The main difference is the input and output of the fuel cell. The process is exactly opposite to the above one. The fuel cell produces electrical current from hydrogen and oxygen reactions inside the cell as shown below. The output of the cell is free electrons, which flow through the electrical load connected between two electrodes (Anode and Cathode) and pure water (H_2O). It is an important component in an H2 vehicle that produces electrical power to drive the electrical motor of the H_2 vehicle. The basic input/output flow inside the fuel cell is shown in figure 13.

There are different types of fuel cells available in the market based on the material used inside them for electrodes. The main electrode types are alkali, molten carbonate, phosphoric acid, proton exchange membrane and solid oxide. Among different types of fuel cells, for this project, PEM fuel cell can be chosen to demonstrate the electricity production from H_2 with the help of O_2 in the air. Two electrodes are separated with polymer electrolyte in the form of a thin, permeable sheet. The fuel cell output ranges from 50 to 250 kW and the efficiency is between 40 to 50%. Because of the low-temperature operation PEM fuel cells are suitable for home and H_2 transport use. One kg of hydrogen can produce 33.33 kWh energy, which means 33.33 kWh/kg x 50 kg = 1,666 kWh of the electrical energy will be produced and supplied to the hybrid power system or grid. The fuel cell size required to produce the above-mentioned electrical energy is 70 kW. The working principle of a fuel cell is illustrated in the following figure:



(a) (b)

Figure 13: Basic working principle of PEM fuel cell (a) [12] and 50 kW fuel cell (b) from Loop Energy Inc.

Conclusion

The existing Panauti hydropower plant (1965) can be integrated with a 500 kW PV system to form a hybrid power system, which will produce a constant power of 500 kW to generate 240 kg of green hydrogen per day. As a real lab, this hybrid power system will be used to demonstrate the various fields of application of thus produced green hydrogen. At the same time, it will promote the hydrogen technology in Nepal. In the coming years, a huge amount of H2 can be generated from the available renewable energy sources mainly hydro-, solar- and wind power. Different fields of application of green hydrogen such as H2 mobility, fertilizer production and fuel cells will be realized in practical life. This Panauti Sustainable Renewable Energy Park will be a milestone for Nepal to move towards CO2-free nation.

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Automation is a boon or bane for Hydropower projects in Nepal

G Naik

The plant data like Generation, speed, temperature, pressure, flow, status of various equipment in the plant, electrical and mechanical parameters are displayed which can also be viewed from remote location.

The present era of technology has made the life simple and easy with access to information and data processing with very minimum human interference and this has made people more dependable on technology.

Similar is the case with industries, every process which were manually done is replaced by machines and further these machines are programmed to perform specific task with no intervention or minimum intervention of humans. This has improved the efficiency, quality and time which is more appropriate for a process industry.

Nepal as a county has huge natural resource for Hydro power projects which is helping the country with economic boost by Exporting clean power to various countries. These projects run 24 hours a day and 365 days' year. The continuous operation of plant is key since most of the projects are run of river type and we need to utilise the flowing water effectively without any downtime.

In this context, it is appropriate to use the technology effectively for smooth and continuous operation of hydro projects. Present automation system PLC - SCADA has features of sequence of operation, PID, gird synchronising, Load monitoring, remote monitoring & diagnostics, predictive maintenance alarms, event recording, trend monitoring of data etc. This information is helping the user to understand health and performance of machines with advance planning for spares and maintenance.

Most of South East Asian countries are with dense population and are deprived of employment opportunities, the Automation of projects comes with some additional cost and to make automation more reliable we need to make more redundant system which again add the cost of the project where as these countries has lower labour cost and it may not be worth investing on automation for every size of projects. Also, the automation is spoiling the skill of engineers in developing countries and for every trivial issue expert engineers are contacted, this is also increasing the down time, the lack of infrastructure like power and internet which are key for remote diagnostics is also a concern.

The above picture is actual running SCADA screen from 2 x 34.5MW project with Vertical 6 jet Pelton turbine in Vietnam, Dakre HPP. The complete Design, Engineering, supply & commissioning done by BFL. The plant data like Generation, speed, temperature, pressure, flow, status of various equipment in the plant, electrical and mechanical parameters are displayed which can also be viewed from remote location. These data will be recorded periodically and stored with a time stamp. The recorded will help the manufacturer & operators of project to understand the healthiness of the system and also in diagnostics.

The author is associate with BFL for over 20 years and total experience of 30+ years is power industry.

gnaik@bflhydro.com

Image: SCADA SCREEN

ANDRITZ and Nepal
a synergy since decades

ANDRITZ being one of the global leaders in the field of operation and maintenance services (O&M) for hydro power plants has also recently tied-up with Chilime Engineering and Services Company Ltd.

ANDRITZ HYDRO has till date supplied equipment consisting of over 43 units with an installed capacity of 1100 MW in Nepal.

ANDRITZ HYDRO is a fully owned subsidiary of international technology group ANDRITZ Austria. ANDRITZ HYDRO is one of the leading global suppliers of hydro mechanical (HM), electromechanical (E&M) equipment and operation and maintenance for hydropower plants. ANDRITZ HYDRO's "Water to Wire" concept ensures long term sustainable solutions on green-field and rehabilitation projects for its esteemed clients. As one of the global manufacturing bases, ANDRITZ Hydro has a large locational manufacturing set-up in South Asia at India. This location has supplied equipment of over 19 GW capacity to Nepal and the global markets since its inception.

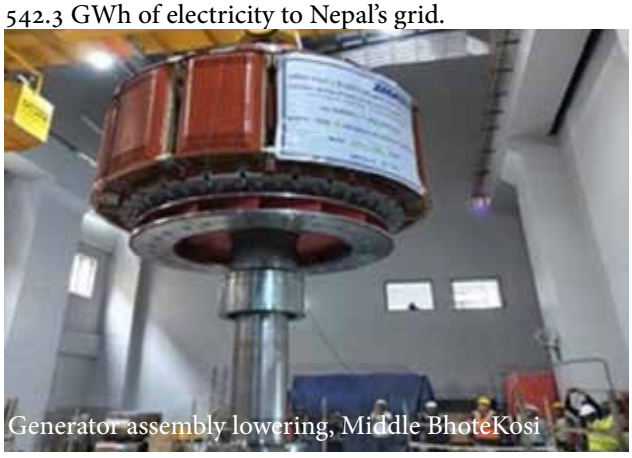
Kalanga Gad powerhouse, Nepal

It order to maintain a close proximity to its clients, ANDRITZ HYDRO has established an office in Kathmandu for almost a decade, and been a part of Nepal's growth story for several years now. ANDRITZ HYDRO has been proud to be part of a country such as Nepal, with its grand legacy and will continue to remain an important part of the country's growth towards self-reliance.

One of Nepal's role model projects namely Chilime hydro project (22.1 MW) has been performing consistently and won accolades by the Nepalese media for outstanding generation. The equipment was supplied by ANDRITZ HYDRO in 1998. Further, earlier in 1993, when a natural disaster struck the Kulekhani-1 project destroying the penstock, ANDRITZ HYDRO was instrumental in the restoration works of the penstock in the shortest possible time, whereby air transport were used to bring penstock ferrules to the project site. A 129-meter penstock line was restored in a record 57 days! This prompted Nepal Electricity Authority to issue ANDRITZ a letter of appreciation.

Middle BhoteKosi stator lowering

ANDRITZ has commissioned Nepal's largest state-owned Upper TamaKosi project (456 MW) for which it was felicitated by the Prime Minister of Nepal for our execution excellence in March 2022. ANDRITZ is also commissioning various other large hydro projects in the Himalayan country currently, namely the Middle BhoteKosi project and Upper Trishuli-1 hydro project. Middle BhoteKosi (102 MW) is expected to be commissioned this year in 2023 and will supply about 542.3 GWh of electricity to Nepal's grid.



Generator assembly lowering, Middle BhoteKosi

ANDRITZ is supplying the hydromechanical works along with the electromechanical equipment for the Upper Trishuli-1 hydro project (216 MW) with the client being Doosan Heavy Engineering. Once this project is commissioned, it will aid in increasing Nepal's electricity generation by approximately 20%.

ANDRITZ HYDRO has till date supplied equipment consisting of over 43 units with an installed capacity of 1100 MW in Nepal. These supplies have been for large hydro as well as for small hydro projects. Some of these projects are Likhu Cluster projects, Upper Kalanga Gad, Mailun Khola, Midim-1, Chilime, Gandak, Morang III, Upper Sanigad, Upper Modi, Madkyu Khola amongst others.

10-meter-long ferrules of Likhu 1, Nepal

ANDRITZ HYDRO has also been one of the leading global players in hydro-mechanical works and is also involved in various projects in Nepal where it is supplying the hydro-mechanical structures for projects like Likhu 1, Likhu 2, Likhu A, Nilgiri 1, Nilgiri 2 and Upper Trishuli 1. In these projects, the scope of supplies ranges from supply and commissioning of penstocks and gates. It has taken innovative steps to optimise and reduce project downtime in some of these projects thereby aiding its esteemed customers to a great extent.

Upper TamaKosi post commissioning

In August 2022, ANDRITZ commissioned Nepal's prestigious Upper TamaKosi project (456 MW) after it took over the hydromechanical works from the original contractor M/s. Texmaco. The work involved very arduous tasks of installing vertical shafts up to a length of 370 meters along with 6 bifurcations in the horizontal portion measuring a length of 280 meters.

In 2023, we have received a contract from NEA for the plant control and protection system upgradation of the Kulekhani I & II project. Further, due to our stupendous support, NEA has issued an appreciation certificate to ANDRITZ for our extended cooperation during the restoration of unit no. 1 of Kaligandaki "A" hydro power station.

Contract signing of Kulekhani 1&2 AT works, Nepal

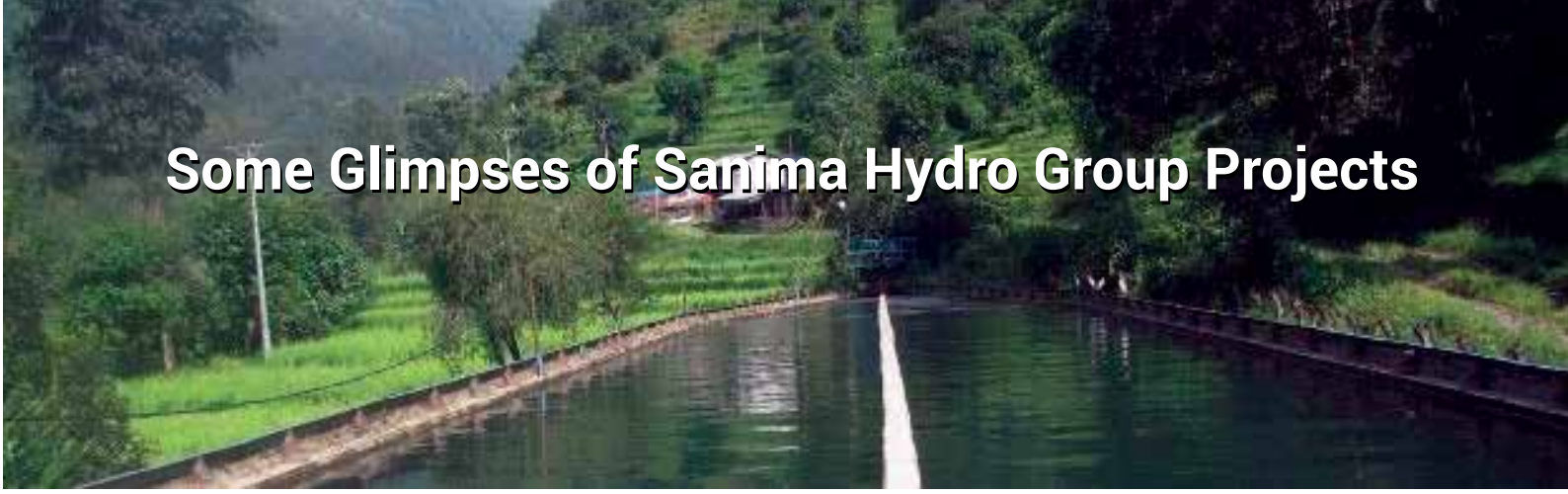
ANDRITZ being one of the global leaders in the field of operation and maintenance services (O&M) for hydro power plants has also recently tied-up with Chilime Engineering and Services Company Ltd. (ChesCo) to explore opportunities in the field of O&M and related works in Nepal.

In April 2015, when the tragic earthquake hit Nepal with devastating effect, ANDRITZ HYDRO was at the helm of affairs and made speedy decisions to come to the aid of the people by shipping 230 tents and 15 UPVC bio-toilets to the Samakushi and Parsa regions in Nepal.

ANDRITZ HYDRO's relationship with Nepal has been one filled with bonhomie and camaraderie. And we would like to foster and sustain this deep-rooted relationship for years to come; for we care!

ANDRITZ commissioning team at Upper TamaKosi site, Nepal

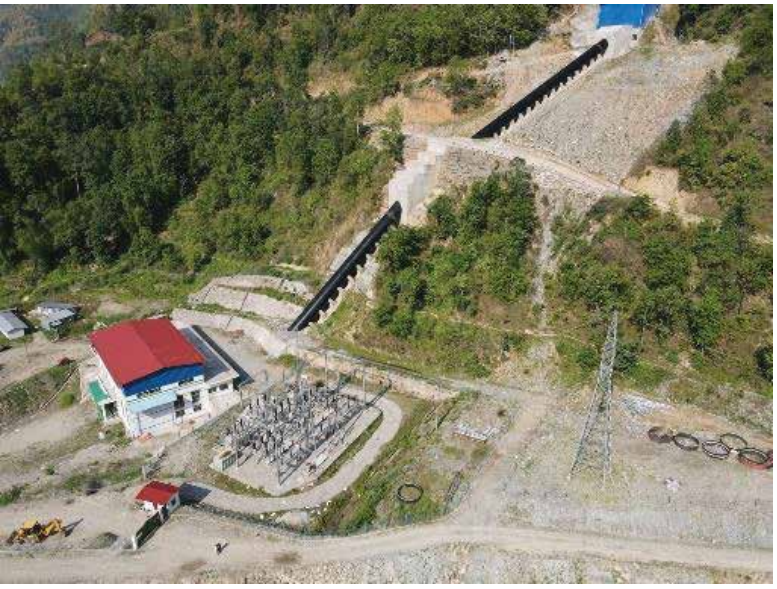
Some Glimpses of Sanima Hydro Group Projects



Sunkashi Small Hydropower Project (2.6 MW, Average Annual Energy 14.38 GWh)

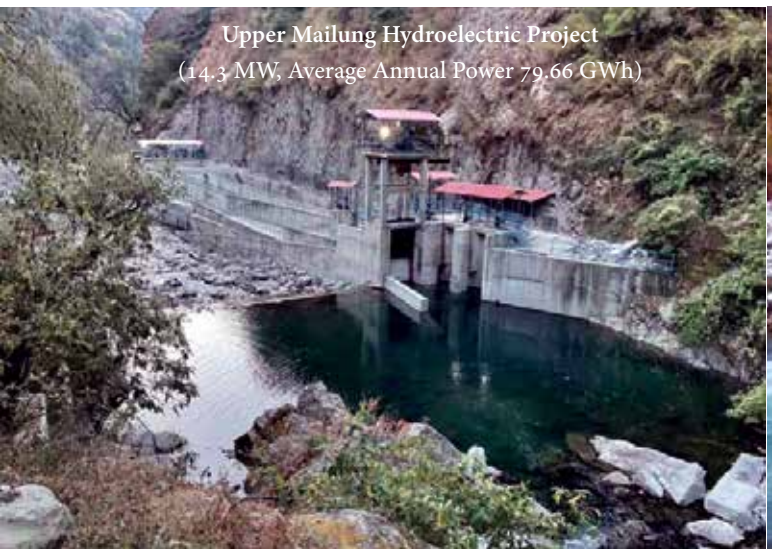
Mai Hydroelectric Project (22 MW, Average Annual Energy 128.30 GWh)

Mai Cascade Hydroelectric Project
(7 MW, Average Annual Power 38.42 GWh)

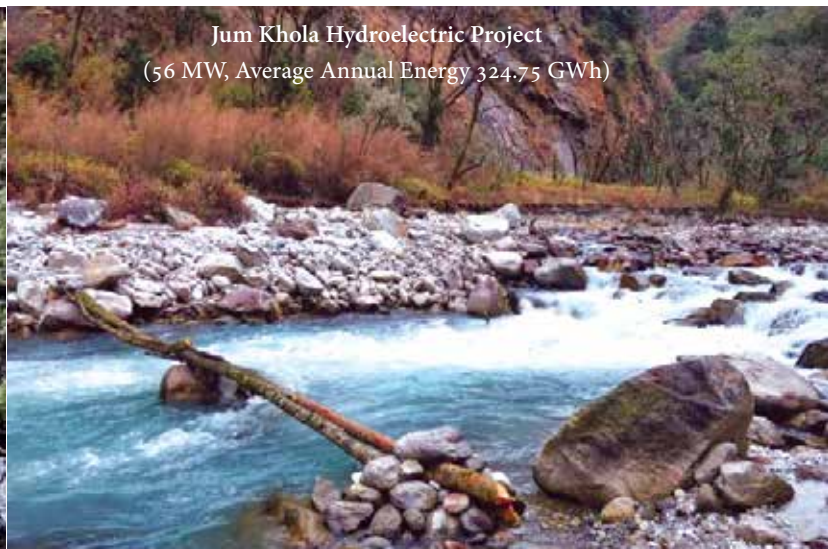


Lower Likhu Hydroelectric Project
(28.1 MW and Average Annual Energy 170.84 GWh)

Middle Tamor Hydroelectric Project
(73 MW, Average Annual Power 429.41 GWh)



Upper Mailung Hydroelectric Project
(14.3 MW, Average Annual Power 79.66 GWh)



Jum Khola Hydroelectric Project
(56 MW, Average Annual Energy 324.75 GWh)

CORPORATE ICON

SUMAN JOSHI

Views on Energy Sector:

I am optimistic about the future of the energy sector in Nepal. By improving cross-border and domestic electricity trade, Nepal can achieve the goal of ensuring the happiness of its citizens and building a prosperous nation. However, there is a need for greater clarity in policies related to electricity development, and the government should focus on creating an easily understandable framework for project development.

Despite the potential in the energy sector, developers and promoters face numerous challenges in project development, leading to disappointment in the private sector's contribution. To address these issues, the government should establish a streamlined, one-window system dedicated to resolving problems related to project development. This would foster a more favorable environment for private investment in the sector.

As industrial demand is much more, the current energy generation has fallen short. To bridge this gap, the Nepalese government must increase its investment in the energy sector. It is crucial for the government to ensure the provision of high-quality, high-capacity energy to meet the needs of all industrial sectors. To attract foreign investors, the government should create an investment-friendly environment, giving priority to foreign, private, public, and public-private partnership models.

Ensuring project security and investment security is essential in addressing challenges faced by investors and promoters, particularly those related to local issues. Infrastructure development is a key area where the government can enhance its capacity to support projects. Investing in infrastructure development, especially in the hydropower sector, can significantly improve security and attractiveness. Guaranteeing investment security, coupled with robust infrastructure development, will undoubtedly shape the future of the hydropower sector. In conclusion, Nepal's energy sector has immense potential, and with strategic policies, streamlined processes, and targeted investments, the country can pave the way for a prosperous and sustainable future.

Academic Details:

Masters in Business Administration (MBA) K.U | Masters in Economics (MA)

Associated Companies:

Former Director NCC Bank Limited | Manager-Energy Sector, NMB Bank Oct 2016-2018 Feb | Relationship Manager, Prime Commercial Bank Oct 2008-Oct 2016 | Relationship Manager Machhapuchre Bank July 2008-Oct 2008.

Area of Interest:

Financial Market
Energy Market
Project Management
Bank and Insurance

Area of Interest:

Financial Market
Energy Market
Project Management
Bank and Insurance

Experience:

Over a decade experience in Banking sector, Corporate and Infrastructure Financing, Corporate Credit, Energy Market, Consortium Financing and related business on energy sector.

SUSHIL POKHAREL

Views on Energy Sector:

Harnessing clean energy from the Himalayan rivers isn't just about generating electricity for me – it's about sparking a nation's sustainable future. As a clean energy entrepreneur, I would like to dedicate my life to building a bridge between hydropower potential and international investment. From the foothills of Dolakha district now to the various countries around the world, my journey began with a broadcast company. Now, I am mainly focused on clean energy industry. Along with my team members, we aim to stand as tall as our mighty mountains by building over 1000 MW of renewable energy by 2035 – each MW a testament to our unwavering commitment to responsible practices. In order to build 1000 MW, we have already started working on Upper Chuwa (110 MW), Chuwa Cascade (98 MW), Myagdi Khola (65 MW), Kunban Khola (20 MW), Myagdi Khola-B (12 MW).

I also wear another hat – that of Vice Chair at the International Hydropower Association (IHA). It's a privilege to champion responsible hydropower policies on a global stage, representing 28 South and Central Asian nations. I am committed to bring every stakeholder engaged in order to follow every standard of hydropower sustainability. In a landmark moment for Nepal's energy sector, two hydropower projects which l am currently leading, received the Hydropower Sustainability Standard (HSS) certificate at Hydropower Congress 2023 in Bali. Pioneering this recognition in Nepal, the projects set an exemplary standard for sustainable hydropower development which is crucial to attract international investment.

Driven by a passion for giving back to society, I've dedicated myself to empowering the next generation of clean energy leaders. Besides, my others responsibilities include, advisor at Independent Power Producers' Association of Nepal (IPPAN) where I leverage my experience to attract international investment and accelerate Nepal's transition to sustainable future. Nepal possesses vast hydropower potential, but we must look beyond our domestic market to truly unlock its value. India and Bangladesh represent promising opportunities, and Nepal can play a key role in driving regional energy transition. To expand our hydropower market, active participation from the private sector in energy trading with India and Bangladesh is important. Government intervention through effective policies and clear strategies is needed bring private sector onboard.

Recognizing the urgent global challenges of climate change, I am committed to leave lasting impact on the energy industry. By harnessing the transformative potential of clean energy solutions, I aim to drive economic growth, address poverty and unemployment.

Academic Details: Master's Degree in Business Studies, Tribhuvan University

Business Status:

Founder Bizbell Private Limited 2014-Present | Managing Director Bizbell Energy 2023 April-Present | Managing Director Nepal Portfolio Energy | Director Hydro Village Private Limited 2023 January-Present | Chairman, Sushmit Energy Private Limited 29 June 2016-Present | Director Bidhee Pvt. 2014-2016 | Co-Founder/Chief Executive Officer, Sushmit International Pvt. Ltd, 2007-2014

Associated Companies:

Vice-Chair International Hydropower Association (IHA, for 2023-2025) | Executive Committee Member Energy Council 2017-Present | Advisor IPPAN Oct 2023-Present | Advisor Nepal Hydropower Association (NHA) | President Rotary International- Rotary Club of Kathmandu Northeast

Awards/Medals:

Presidential Medal (Suprabal Jana Sewa Shree Padak- 2020), Asia Honesty Entrepreneur Awards (2015), MARS Award (2015)

Views on Energy Sector:

Experience:

Over a decade experience on energy sector and project development

Butwal Power Company

Established in 1966, Butwal Power Company (BPC) stands as a stalwart in Nepal's hydropower sector, boasting a rich history spanning over five decades. Since its inception, BPC has played a pivotal role in hydropower generation, transmission, and distribution, emerging as a prominent name in the country's energy landscape.

Our Core Activities

Beyond its primary focus on electricity generation and distribution, BPC actively engages in the development, operation, and maintenance of hydropower plants. The company also excels in engineering and design consultancy for hydropower and infrastructure projects, as well as the manufacturing and repair of hydro-mechanical (HM) and electro-mechanical (EM) equipment through its subsidiary companies.

Founder's Vision

Founded by the visionary Norwegian engineer Odd Haftun, BPC was conceived with the mission of cultivating technical expertise to explore Nepal's hydropower potential. Mr. Haftun, a driving force behind the construction of the Tinau Hydropower Plant, aimed to empower the youth of Nepal with the necessary skills to harness the country's river resources, creating opportunities for small businesses. In 1964, he successfully garnered support from Norway and imported essential equipment to Butwal.

Pioneering Excellence

BPC has been at the forefront of developing self-competency across various facets of the hydropower industry, encompassing engineering, construction, operation, maintenance, and the manufacturing of hydroelectric equipment. The company's commitment to excellence led to the establishment of the Butwal Technical Institute (BTI), in collaboration with the United Mission to Nepal (UMN) and the Government of Nepal, providing opportunities for skilled human resources.

International Collaborations

In a strategic move, BPC entered into a joint venture named SCIG International Nepal Hydro Joint Development Investment Company Pvt. Ltd. with three Chinese companies from Chengdu, Sichuan Province, People's Republic of China.

Privatization Milestone

BPC transitioned into a public company in 1993 and underwent privatization in 2001. After nearly three decades of collaboration with the government and UMN, the privatization process culminated in October 2001, with the government inviting bids for the purchase of 75 percent of the company's shares. A pivotal moment arrived on January 3, 2003, when an agreement was reached with Norwegian company representatives, marking the successful sale of 75 percent of the shares.



Leaders in Electrification

BPC takes pride in being the sole private sector company involved in electricity production and distribution. The company distributes electricity from Tinahun, Jhimruk, Andihola, and Khudi, serving four districts. Furthermore, BPC extends its electrification efforts to approximately 62,000 customers in Syangja, Palpa, Pyuthan, and Arghakhanchi districts through its dedicated distribution network.

At Butwal Power Company, our journey is marked by innovation, collaboration, and a steadfast commitment to powering the future of Nepal.

Power Generation

BPC, a formidable force in power development, currently manages four projects with a combined capacity of 56.6 MW.

SN	Project	Capacity (MW)	Stage
1	Tinau	1	Generation
2	Andhi Khola	9.4	Generation
3	Jhimruk	12	Generation
4	Nyagi khola	30	Generation
5	Kabeli A	37.6	Under construction
6	Manag Maryangdi	135	Prepare for financial closure
7	Lower Manag Maryangdi	139.2	Approved Construction License
8	Upper Marsyangdi 2	327	Process for PPA
9	Chino khola	7.9	Process for PPA
10	Mugu karnali	160	Applied for construction License

A company that owns shares of BPC

Company	Share (%)
BPC services limited	100
Himal Power Limited	16.88
Hydro Consult Engineering Limited	80
Hydro Lap Pvt.Ltd	16.64
Gurash Energy Limited	40
Kabeli Energy Limited	27.24
Khudi Hydropower Limited	60
Nyadi Hydropower Limited	97.20
SCIG International Nepal Hydropower JV Develoment Company Pvt Ltd	20
Manag Marsyangdi Hydropower Company Pvt.	100
Himtal Hydropower Company Pvt.Ltd	19.40
Marsyagdi Transmission Company Pvt.Ltd	19.40
Nepal Hydro and Electric Limited	51.30

Subsidiary Companies

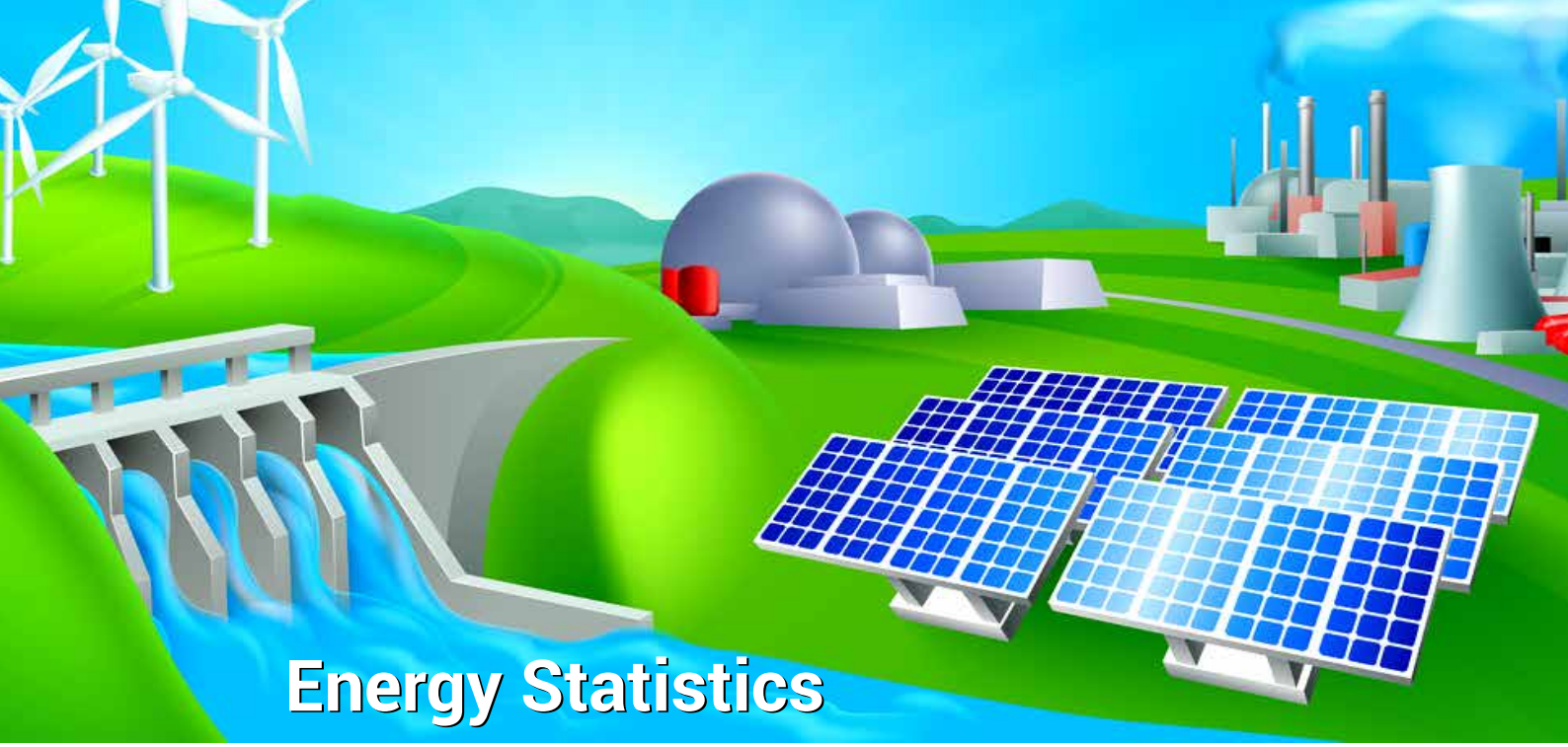
Nyadi Hydropower Limited
Nepal Hydro and Electric Limited
Khudi Hydropower Limited
Kabeli Energy Limited
Hydro Consult Engineering Limited
Bpc Services Limited

'Award': BPC has received recognition as the best-managed company in hydropower sector. It has received national best presented annual report (BPA) awards several times. The company was also rewarded with 'International Blue Planet Award 2005' from International Hydropower Association, UK.

Vision: To be a leading enterprise in Power Sector with excellence in providing innovative and quality products and services to meet the growing demand for efficient and clean energy.

Mission: BPC is dedicated to operational excellence and believes in good governance, corporate, citizens, and creating value for stakeholders.

- To be a competitive hydropower developer and an electric utility
- To be secure sustainable performance of investments
- To be committed to product the environment
- To practice corporate social responsibility by serving the communities where we do business
- To provide a safe, healthy and fulfilling work environment for employees
- To maximize value for all stakeholders



Energy Statistics

Potential of Power Generation from different sources

Source	Capacity (MW)
Hydropower (WECS Study)	72,000 (Technical and Economic)
Hydropower(Dr. Hariman shrestha)	83,000
Micro Hydropower	1000
Solar PV	–
Wind Power	3000

Power Generation Scenerio

Source	Capacity (MW)
Hydropower	2690.80
Hydropower (Isolated)	4.536
Thermal	53.41
Grid Connected solar	86.90
Co-generation	6
Off Grid (Micro hydro, solar)	83
Total Generation	2924.64

Electricity Access in South Asian Country

Country	Percentage
Afghanistan	98
Bangladesh	99
India	99.57
Bhutan	100
Nepal	98
Sri Lanka	100
Maldives	100
Pakistan	94.92
China	100

Per Capita Energy Consumption (Kwh)

Country	Quantity
Afghanistan	152
Bangladesh	484
India	1327
Bhutan	5550
Nepal	384
Sri Lanka	631
Maldives	1125
Pakistan	560
China	5728

South Asia Energy Scenario (MW)

S.N	Country	Installed Power	Potential Power (Hydro)	Installed (Hydro)
1	Afghanistan	1285	23,000	600
2	Nepal	2924.64	100,000	2690.8
3	India	4,26,140	1,50,000	51,861
4	Sri Lanka	5024	2000	1727
5	Bhutan	2500	36,900	2500
6	Maldives	290	–	
7	Bangladesh	28,159	–	230
8	Pakistan	45,000	60,000	10,852
9	China	2649 (GWh)	6,00,000	4,16,000

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