ISSN 2976-1433
9 772976 143005

वर्ष ४, अङ्क ६ असार २०८१
Year 4, Issue 6, 15 July 2024

Urja Khabar

Energy for Prosperity

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KTM Reg. No.: 494
(Year 4, Issue 6, 15 July, 2024)
Published by
Energy Information Center Pvt. Ltd.

ऊर्जा खबर | Urja Khabar
Energy for Prosperity
Half Yearly

ISSN No.: 2976-1441

Price
Individual:1000, Organization : 3000

Babarmahal, Kathmandu, Nepal
Tel.: 01-5321303
info@urjakhabar.com | www.urjakhabar.com

Printing: B.L. Printing Press
Bagbazar, Kathmandu

ADVISORY COMMITTEE

Khanikhola-1 Hydropower Project is a run of the river project located in Marbu Village Development Committee, Dolakha District with the hydropower intake located at the highest elevation of 3338 m in Nepal. The construction was initiated in 2011. Greenlife Hydropower Ltd. and manages the overall construction of the project. The civil, hydro-mechanical and electromechanical work is 90 % complete and is in the last phase of completion with installation of EM and final concreting. During the last 11 years natural disasters including the frequent flood and April 2015 earthquake as well as political instability in the country has caused a major impact which consequently led to the delay in project execution. These unexpected calls were dealt cautiously and carried further.

- Civil and Hydro-mechanical work complete.
- Electro-mechanical work 90% complete.
- One of the highest head project in Nepal.

Salient features

Project : Khani Khola 1 Hydropower Project
River : Khani Khola
Type of Scheme : Run-of-River
Location : Dolakha District
Catchment Area : 76 sq. km.
Design Discharge : (40 percentile flow) 5.1 cubic m per sec
DESANDER
Support Type : Shotcrete and Concrete Lined
Length : 1950 m
Size : 2.2 m x 2.2 m D-Shaped
Type : Pressure Flow
POWERHOUSE
Type : Underground
Size : 46(L) x 12(W) x 16(H)
Turbine Centre Line Elevation : 2425 m
Switchyard : Outdoor
MAIN ACCESS TUNNEL
Turbine : Pelton
No. of Units : 3
POWER AND ENERGY
Installed Capacity : 40 MW
Gross Head : 963 m
Net Head : 940 m
Annual Energy Generation : 229.50 GWh
Annual Dry Energy : 33.53 GWh
Annual Wet Energy : 195.97 GWh
Plant Factor : 65%

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EDITORIAL

Commercialization of Green Hydrogen

Today, the primary sources of fuel available in the world are mostly derived from the Earth's minerals. As the Earth ages and its structures change, these mineral resources will soon be depleted with their enhanced use. Many of these resources, which come from fossilized remains of animals and plants, are at risk of becoming scarce in the future. Some countries may also face situations when they cannot sustain such mineral production.

Therefore, new sources that can be utilized for human life are being sought. One such invention is hydrogen, which is abundantly available on Earth and in the atmosphere. The simplest method to produce hydrogen is by splitting water through a process called electrolysis, which uses electricity to separate water into hydrogen and oxygen gases.

With the dynamic pace of human development, energy has become an essential element in daily life. Various energy sources have been discovered on Earth. Apart from coal, natural gas, and fossil fuels to hydropower, solar, wind, and nuclear power, hydrogen can be considered reliable alternative source of energy. Various studies have shown that the initial use of hydrogen gas started about 200 years ago. In recent decades, it has emerged not hydrogen gas as such, but as 'green hydrogen.' Due to rapid climate change, there is a global campaign to cap the Earth's temperature rise to 1.5 degrees Celsius. Green hydrogen is considered a sustainable and reliable energy source to support this campaign.

Hydrogen can be used to produce ammonia for chemical fertilizers, vanaspati ghee from vegetable oils through hydrogenation, highly useful chemicals like methanol and hydrogen chloride. Hydrogen can also be produced and stored to be used as energy. Such energy can also be utilized in kitchens and transportation, among others. Hydrogen being used in industrial sector is produced by using electricity generated by using fossil fuels.

Accordingly, hydrogen is perceived as potential substance for use (i) in industrial processes like metallurgical extractions, hydrogenation and preparing important chemicals like methanol and hydrogen chloride; (ii) in manufacture of nitrogenous fertilizers and (iii) in transformation of energy to facilitate transportation and storing energy as well as for use as fuel substitute in transportation, industrial field and kitchens.

Using hydrogen as energy source is an emerging concept. To combat the adverse effects of carbon emissions, the world has aggressively moved towards the production of renewable energy. There are plans to gradually reduce the use of polluting energy sources. Renewable energy sources are inherently intermittent, making their storage and usage challenging. However, they are considered essential sources of clean energy for the future.

Today, with the abundance of electricity production worldwide, storage batteries are being used to operate electric vehicles. However, these batteries have limited capacity. Experts have analyzed that battery power and energy capacity may not be effective for heavy duty vehicles like trucks and in the aviation sector. On the other hand, studies have confirmed that hydrogen can be stored and used in maritime ships, aviation, trucks, or railways. Green hydrogen can significantly reduce the large amount of carbon emitted in the transportation sector. The battery storage system also creates another challenge of managing electronic waste, which does not occur in the context of hydrogen fuel.

Hydrogen has been tested reliable not only in transportation but also in kitchen (hydrogen-cooking). As claimed by researchers of the sector, green hydrogen can be considered a fundamental

source to substitute fossil fuels and end carbon emissions from the transportation sector and kitchens. However, the use of hydrogen in the transportation industry and kitchens is still in trial phase.

Nepal is also following the global trend of testing, using, and commercializing green hydrogen. It appears that the discussion on this issue started with professors from Pulchowk Engineering Campus in 2007. Since then, Kathmandu University (KU) has been working on the research, testing, and commercial possibilities of green hydrogen. The establishment of the 'Green Hydrogen Lab' in the university premises confirms its aggressive initiative.

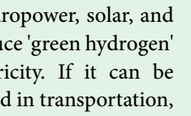
Similarly, the Nepal Energy Foundation (NEF) has taken the lead from the private and non-governmental sectors. With joint efforts from foreign donor agencies and NEF, there has been a successful demonstration of cooking local meals on hydrogen stove using hydrogen as fuel in the premises of Kharbang micro-hydro power center in Badigad Rural Municipality of Baglung District. However, until the challenges of production cost, storage, and utilization are resolved sustainably, it seems that meaningful commercial use of hydrogen for cooking will take more time.

In context of Nepal, there are emerging questions like who will produce green hydrogen or sell it like electricity; who will buy the stored hydrogen; where is the market for 'green cells' produced from hydrogen; where and to whom will it be sold? Even though the government has introduced the 'Green Hydrogen Policy, 2080', it does not seem to provide future pathway clearly. This policy appears to have been introduced to meet formalities under pressure from universities, the private sector, and researchers.

There is no clear stance of the state or the government on 'green hydrogen' or 'hydrogen as energy'. Neither there has been any debate regarding green hydrogen energy at policy level nor it is given importance in the annual budget. Legal and regulatory framework for production, marketing and use of green hydrogen should be given space in related act, regulation and guidelines. Even if all these tasks are completed, provided the cost of hydrogen production is not within affordable range or competitive compared to other fuels, commercial use of hydrogen as substitute energy will not gain pace.

There are no proper storage system of petroleum products inside the country. Every year, billions of rupees are being spent to import such fuels. On the other hand, Nepal has abundant clean natural resources (hydropower, solar, and wind) to produce 'green hydrogen' through electricity. If it can be commercialized in transportation, kitchens, industries, etc., it could be a boon for Nepal. It will prevent the outflow of a significant amount of money to purchase fossil fuel from abroad. Additionally, as discussions are going on about the development of a market worth 13 trillion US dollars for green hydrogen globally, it could open regional market for Nepal as well.

The country is being called for leading the commercialization of 'green hydrogen' as an alternative fuel for the transportation industry and kitchens. For that, appropriate laws, regulatory bodies, and institutional structures are needed to set up. Under such laws, a 'Hydrogen Energy Development and Commercialization Authority' can be formed. This entity can be given authority develop policies, regulations, and guidelines for the development and commercialization of green hydrogen, clearly outlining the production, storage, and market. This work must begin from today.



ऊर्जा खबर समृद्धिका लागि ऊर्जा | Urja Khabar Energy for Prosperity

INSIDE

King Mahendra's visit to Russia and the Panauti Hydropower

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International Law is the Key for Co-ordinating a Mutually Acceptable Balance of Interests in the Energy Sector

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Understanding Carbon Credits: A Key Component of Climate Action

Cover Photo:

Hydropower project promoted by Api Power Company Limited

Jiba Lamichhane

King Mahendra's visit to Russia and the Panauti Hydropower Project

Diplomatic relations between Nepal and the Soviet Union were established on July 20, 1956. Before dissolving the parliament on December 15, 1960, and starting direct rule through a one-party Panchayat system, King Mahendra Bir Bikram Shah undertook state visits to several countries. One of these state visits was to the Soviet Union, which lasted almost a month. After observing the Soviet leadership's autocratic governance, King Mahendra likely developed a similar ambition for absolute rule.

The state visit by the royal couple, invited by Chairman of the Supreme Soviet, Kliment Voroshilov, began on June 4, 1958, and lasted for 28 days. The Soviet leadership placed such importance on the visit that a Russian song called "Koroleva Nepala" (Queen of Nepal) praising Queen Ratna's beauty and grace remained popular for a long time. During the Cold War, which was polarizing the world, even impoverished and powerless countries like Nepal were able to gain recognition and respect from the major power blocs.

The impact of the royal couple's visit to the Soviet Union was felt in Nepal for a long time. During this visit, agreements were made between the Soviet Union and Nepal regarding economic and cultural cooperation. As part of these agreements, the Soviet government constructed the Dhalkebar-Pathlaiya (108 KM) section of the East-West Highway, a project that was highly ambitious for King Mahendra. The Russian jeeps brought in for the highway construction became well-known and continued to drive on Nepali roads for many years.

I have personally seen the "UAZ" jeep, manufactured at the Ulyanovsk factory in Russia, being used for jungle safaris in Chitwan. The massive Belarus tractors were also seen in the fields and farmlands of the Terai and Chure regions. The direct involvement of donor countries in major national construction projects provided unforgettable experiences for Nepali society at that time.

I find it surprising to see such cooperation between the king's regime, which banned communist parties, and the Soviet rulers, who sought to include communist countries in their bloc. This cooperation was generous and wholehearted. By the late 1950s, communist countries had already started to divide into Soviet and Chinese camps. The Soviet Union may have tried to win over non-communist Nepal to keep it from falling under the influence of neighboring China.

During the Cold War era, when Nepal sought to align itself closer to development-oriented nations, it faced a significant moment. King Mahendra recognized opportunities for Nepal to benefit from competition among global superpowers. In 1958, the Soviet government announced the construction of the 'Kanti Bal Hospital' with 50 beds, completed by January 1963 and later handed over. King Mahendra himself inaugurated the hospital. To this day, it remains the only government-funded children's hospital in Nepal. This underscores the critical importance of the hospital's establishment during that time.

On April 24, 1959, an agreement was signed between the Soviet Union

and Nepal for economic cooperation amounting to 30 million rubles. This substantial amount was designated for the expansion of the East-West Highway, the construction of the 'Janakpur Cigarette Factory', the Birgunj Sugar Mill, and a hydropower project. This agreement was a testament to the significant financial support provided by the Soviet Union at the time. In response to King Mahendra's invitation, from February 1 to 5, 1960, Soviet Premier Clement Voroshilov, along with a large delegation, visited Nepal.

King Mahendra's successful foreign diplomacy included receiving support from the Soviet Union, which facilitated the Panauti Hydropower Project. Here's a brief summary:

Construction commenced and completed

On October 22, 1965, King Mahendra inaugurated the Panauti Hydropower Project with the presence of Soviet Energy and Power Supply Minister Pyotr Neprozhny. Engineers who had completed their engineering studies in Russia, including Dr. Hariman Shrestha, were involved in the project construction. He had also researched Nepal's hydropower production potential, estimating it at 83,000 MW.

After diverting water from Roshikhola for local drinking water supply, the electricity generation has decreased. The project, initiated in B.S. 2017 and located in Ward No. 12 of Panauti Municipality at Khopasi, began generating electricity from Asadh 31, 2022. Following Pharping and Sundarijal, this marks the third hydropower plant in the country.

Current situation

Panauti hydropower plant, boasting a history spanning approximately six decades, had three units generating 800 KW of electricity. Due to water scarcity, only one unit, producing 750 KW, operates using a machine. Around 10,000 hectares of land near the Khopasi source are used for potato farming, with irrigation carried out using water diversion. Operations like mining with crushers around the origin of the stream have led to siltation in the stream, which has contributed to a decrease in generation.

In recent years, soil discharged from mining directly into the streambed has caused the reservoir to silt up and fill with sediment within a year. The upper reaches of the hydropower plant are affected by residents who dump garbage into the stream, polluting the lake pound. Genereted electricity from here is linked to transmission lines 20 KM away in Bhaktapur.

Research Center

Panauti has been designated as a center for research, study, and analysis, following a 10-year memorandum signed between Kathmandu University (KU) and the Nepal Electricity Authority (NEA) on Jestha 10, 2075 BS. This agreement allows for a possible extension of the deadline by three months upon mutual consent. KU students can conduct studies in the relevant fields here, while students from other universities need to obtain a recommendation letter to visit.

The agreement between the NEA and the KU outlines that the power plant, owned by the university, will be used for conducting educational programs and training in subjects such as civil, mechanical, electrical, and hydroelectric engineering at undergraduate, graduate, and doctoral levels. Both the authority and the university will jointly use knowledge and expertise for mutual benefit through workshops, conferences, and other educational programs. The authority will receive 10% of the profits generated from such activities if they prove profitable.

The KU has an agreement to utilize the power plant and land owned by the university for conducting educational programs and training in subjects such as civil, mechanical, electrical, and hydropower engineering at undergraduate, graduate, and doctoral levels. Both the NEA and the KU will jointly use knowledge and resources for organizing workshops, conferences, and other programs. If these activities generate profits, the NEA will receive 10% of the proceeds as per the arrangement.

Silent Features

Project Location: Kavrepalanchok

Project Type: Run-of-River (RoR)

Source: Roshikhola

Capacity: 2.4 MW

Annual Energy: 6.97 GWh (6,970,000 units)

Total Cost: NPR 27 million

Gross Head: 66 meters

Net Head: 60 meters

Canal Length: 3.72 kilometers

Penstock Pipe: 1.4 meters diameter, 370 meters length

Turbines: 3 units of Horizontal Francis type

Generators: 1000 kVA each

Power Transformer: 1550 kVA

Voltage: 6.3 kV

Transmission Line: 33 kV Single Circuit (20 KM)

Power Factor: 0.80

Design Discharge: 1.6 cubic meters per second (cumecs)

Annual Average Flow: 3.2 cumecs

Water Storage Capacity: 50,000 cubic meters

Government's Ambiguous Policy on Fossil Fuels and Renewable Energy

Rajesh Khanal

The country has embarked on a journey to achieve zero carbon emissions by 2045, through production and utilization of renewable energy at maximum. One of the state mechanisms, however, has stuck on promoting the use of fossil fuels. The government entity is after making it happen extending the existing petroleum pipeline for this purpose, even when the donor country, India, has announced its withdrawal from the grant. It will likely pressure the Government of Nepal to manage all necessary financial sources, specifically by assuming more loans.

It appears contradictory firstly that the state will have to assume excess financial liabilities to construct the pipeline to use more fossil fuels. Secondly, it will have to subside its aim to use more renewable energy to minimize carbon emissions.

Energy Cooperation & South Asia

Energy cooperation is the collaboration between two or more entities (countries, corporations, non-governmental organizations) aimed at ensuring energy security.

Energy cooperation stands as a pivotal cornerstone for global sustainability, enabling countries to collaborate on the development and sharing of clean, renewable resources. It fosters international partnerships that are essential for tackling climate change, ensuring energy security, and promoting economic growth through innovative technologies.

Cross-border energy cooperation can play a significant role in regional economic development. It is indeed a reality in a number of regions around the world. For instance, the interconnection of electrical grids through high voltage transmission lines across international borders in Europe. Likewise, in the US and Canada as well as in the Nordic countries, cross-border electricity cooperation exists for a long period of time. From a commercial perspective, it is being pointed out that there is considerable scope for expanding regional petroleum trade in South Asia.

There is a wide variation in commercial energy resource endowments and commercial energy demand among the South Asian countries. While India, Pakistan, and Bangladesh account for the major natural gas and coal resources, Bhutan and Nepal have large hydropower resources. All the countries have vast renewable energy potential and the sharing of these resources naturally leads to more optimal energy supply solutions for the entire region.

In case of land-locked nations in particular, cross-border pipelines provide the energy 'lifeline' to some extents. For instance, India-Bangladesh Friendship Pipeline is also under construction.

Prospects of Energy Storage

Energy reserve is one of the aspects of energy security. Energy reserves refer to the estimated quantity of energy sources (e.g. coal, gas, or oil) known to exist with reasonable certainty, and which can be recovered with presently available technology at an economically viable cost.

Energy storage can help enhance reliability and flexibility. Storage of oil and natural gas helps smooth out supply and demand discrepancies.

Energy security is a goal that many countries are pursuing to ensure that their economies function without interruption and that their people have access to adequate, reliable and affordable supplies of modern and clean energy. It is a pressing concern because the demand for energy

is growing rapidly due to robust economic expansion, population growth, new uses of energy and income growth, and yet the supplies of energy resources required to power these needs are finite and, in most cases, non-renewable.

Citing its importance, many countries now adopt strategy to maintain fuel storage to support domestic market demand for at least 90 days. They are investing huge amount of money to construct oil storage system. The global oil storage market size was valued at $12.2 billion in 2020, and is projected to reach $18.4 billion by 2030, growing at a average growth rate of 4.3 percent from 2021 to 2030. The purpose for store fossil fuels is found relevant in the period like spread of COVID 19, trade embargo and economic sanction.

Governments require producers and refineries to carry a larger storage than they would otherwise for security purposes. Although in some countries, private sector and commercial companies stock the fuels, in the countries like the United States, the government stores the oil reserves.

Energy security is multi-dimensional in nature, and many countries regard it as a policy priority. In the short-term, energy security concerns focus on the ability of the energy system to react promptly to sudden changes in the supply–demand balance. In the long-term, energy security concerns have to do with timely investments in energy supply in line with economic developments and environmental needs.

Petroleum Pipelines and Storage Extension in Nepal

South Asia's first cross-border energy pipeline was constructed between India and Nepal. It is a 69-kilometer-long petroleum product pipeline project. Compared to many other international pipeline projects constructed or being developed around the world, the one constructed across Nepal-India border is the modest and small in terms of size and scale.

The new agreement between two countries initially stipulated that the construction of the Amlekhgunj-Chitwan Petroleum Pipeline, Siliguri-Jhapa Petroleum Pipeline, and a Greenfield Terminal at Charali in Jhapa, all to be undertaken by Indian Oil Corporation (IOC) with subsidies. Additionally, plans included the construction of a Greenfield terminal at Lothar in Chitwan, funded by NOC with technical support from IOC.

However, India is reported to have refused to provide a subsidy of approximately Rs 17 billion for the construction of two petroleum pipelines and a fuel storage facility. The agreement reached with the Government of India even involved the government-owned entity the IOC, which has now hesitated to proceed with the project with subsidies.

A joint study conducted by IOC and NOC in 2020 estimated the construction costs of the Amlekhgunj-Chitwan and Siliguri-Jhapa petroleum pipelines at approximately Rs 4.38 billion and Rs 4.6 billion, respectively, with an additional Rs 8.3 billion earmarked for the Greenfield terminal at Charali in Jhapa. These projects were slated for IOC investment, alongside the Greenfield terminal in Lothar, Chitwan, to be funded by NOC at an estimated cost of Rs 9.88 billion.

Additionally, in April 2023, the Nepal-India Joint Working Group on Petroleum and Gas met in Kathmandu and decided to conduct a study for the construction of a gas pipeline from Motihari, India to Amlekhgunj, Nepal. Another proposed gas pipeline will extend from Gorakhpur, India to Bhairahawa. Officials also discussed building a second oil pipeline from Siliguri, India to Charali in Jhapa.

The NOC has stepped up construction of storage depots at different places of the country to increase its storage capacity of petroleum products. It has been constructing fuel storage tanks with capacity of more than 9,000 kiloliters near the Rohini River bank in Rupandehi district of Lumbini Province. The storage facility will sustain petroleum demand of Lumbini Province for 20 days. According to the NOC, It is investing around Rs 3 billion for construction of the infrastructure.

In July 2023, the NOC constructed new diesel storage plant with a capacity of 10,000 kiloliters in Pokhara of Gandaki Province. The state-owned enterprise invested Rs 890 million for this purpose.

Relevance of Promoting Fossil Fuels in New Contexts

While environment groups have been lobbying the government to build charging stations for electric vehicles across the country, the bureaucracy and oil utility want to build a multi-billion-rupee pipeline to transport liquefied petroleum gas.

Petroleum products are Nepal's largest import, accounting for 17.4 percent of its total import bill. Motor vehicles which burn fossil fuels and their spare parts come second, accounting for 6.5 percent of total imports. In this regard, the government must think for minimizing the trade deficit by cutting down the import of petroleum products. This will not only help reduce draining of foreign currencies but also helps the country fulfill its commitment towards minimizing carbon emissions.

While the refusal to carry out the project with a grant element by the Indian side has become an issue lately, there is question on the rationale behind proceeding with the pipeline projects altogether. Nepal in this regard should reconsider its priorities, shifting focus towards promoting electric vehicles (EVs) and developing necessary infrastructure such as charging stations in strategic locations across the country.

Initially, the Indian side committed to funding the project with a grant, responding to Nepal's stance that the project's progression hinged on such financial support. However, the issue has resurfaced with IOC officials now proposing that NOC shoulder the financial burden for the next 10 to 25 years.

It is also worthwhile to note that these costs of billion rupees projects may escalate further. Allocating such substantial funds for pipeline and storage facility construction appears incongruous, given Nepal's commitment to achieving carbon neutrality by 2045, alongside promoting alternative energy sources such as EVs.

Kul Man Ghising, managing director of the Electricity Authority, says if the government plans to invest in fossil fuels and cooking gas despite surplus electricity, it's a flawed policy.

The government reveals dubious policy regarding energy security of the country. On one hand, it talks about promoting use of domestically produced hydroelectricity to minimize the ballooning trade deficit and taking credit for facilitating maximum use of the renewable energy. On the other hand, it plans for constructing pipelines and storage tanks through huge investment, even by taking excessive borrowing at a time when the country already has public debt of over Rs 2.4 trillion, more than double just in a span of few years.

According to energy expert Amrit Nakarmi, Nepal has promised to adopt green energy and reduce the dependency on fossil fuels at different international forums. "But the government is doing just the opposite. This shows that it lacks long-term vision and is abandoning the commitments made at the international forums," he said. "The investment in the import of fuel will be a waste. Instead, the government should invest in increasing the reliability and quality of electricity and invest in infrastructure for electric vehicles."

Reduction in use of petroleum products is also importance from the standpoint of achieving energy security in future. As Nepal is completely dependent on India for the fossil fuels, a halt to fuel shipments by the southern neighbor could lead to an acute shortage in the country. Not limited to whether India's unofficial blockade in 2015 or an embargo in 1989, time and again Nepal has seen fuel shortages when India just made an inch of its policy change towards Nepal.

Amid the surging global warming, there is a growing call for measures to address energy security in new dimensions along with outlining a new range of policy measures that can be used to improve energy security by boosting the uses of renewable energy. These include more investments in energy production and transmission; promotion of energy efficiency in various end-use sectors; modernization of the grid to enable the integration of renewables such as wind, solar and geothermal energy into the energy system; undertaking reforms in energy markets to attract private sector investment in energy production, increase competition, reduce wastage and lower costs to energy users and fostering greater international collaboration on energy issues and regional energy trade.

Conclusion

The country's policies must not be supply driven. Rather it must be judged on the basis of desirability of the outcomes in the line of maximizing welfare of the nation at present and even till future. Nepal must not have to consider obliged whatever be the clauses put forth by the donor side if they are not compatible with the national policies.

The state-owned NOC already operates storage facilities strategically positioned across the country, receiving petroleum products from IOC's depots near the border. Given the efficacy of these existing oil depots in meeting domestic demand through their supply network, investing heavily in new petroleum pipelines and storage facilities seems redundant. Instead, Nepal should pivot towards incentivizing EV adoption and reducing reliance on petroleum products wherever feasible. This shift necessitates investment in EV charging infrastructure nationwide. By doing so, existing infrastructures could readily support domestic petroleum product needs. Both the governments need to reconsider their plans regarding petroleum pipelines and prioritize the development of EV infrastructure to mitigate carbon emissions and foster a green economy.

Furthermore, greenhouse gases which are largely responsible to cause global warming and climate change, are the outcomes of production, transportation and utilization of energy. Therefore, it is an utmost urgency that the right decisions must be made towards meaningful production, transportation and utilization of energy.

Reflecting[1] on Nepal's Inter-basin Water Diversions Vis-a-vis Bheri-Babai and Sunkoshi-Marin Diversion Multipurpose Projects

Santa Bahadur Pun

A. Foreword: Bheri-Babai and Sunkosi-Marin Diversions, Precedent for other Diversions

Four years after Prime Minster Sushil Koirala inaugurated the Bheri-Babai Diversion Multipurpose Project in April 2015 (*Baisakh 2072*), Prime Minister KP Sharma (Oli) inaugurated the breakthrough of the 12.2 Km tunnel on 16th April 2019 (*Baisakh 3, 2076*) that would divert 40 cumecs (*1,437.6 cusecs*) of Bheri River water from Hattikhel through the Chure /Siwalik hills into the Babai River at Chiple. It is reported that the deadline for the tunnel breakthrough was

achieved a year ahead due to the use of the tunnel boring machine for the first time in Nepal.

An American company built and installed the tunnel boring machine for the Project's Chinese contractor. At the inauguration ceremony, Prime Minister KP Sharma (Oli) did not forget to mention the Project '*as a great example of global partnership... synergy between a Chinese construction company, American technology and Nepali manpower.*' The media, however, made no mention whether or not Prime Minister Oli referred to anything about the Bheri-Babai Project's impact on Nepal's agriculture and livelihood of the villagers living in that area. The Bheri-Babai Diversion Multipurpose Project plans to irrigate 51,000 ha of Bardiya and Banke farmlands as well as generate 46.8 MW of hydropower.

1 The writer wishes to acknowledge with thanks the inputs provided by the following: Madhav Belbase (former DG/Irrigation Department, former Secretary Ministry of Water Supply and presently Member Public Service Commission), Shiva Kumar Sharma (former DG/Irrigation Department) and Dr. Hari Prasad Pandit (Professor, Institute of Engineering, Pulchowk, Water Resources Specialist).

Five years after the Bheri-Babai tunnel breakthrough, on 8th May 2024 (*Baisakh 26, 2081*), Prime Minister Pushpa Kamal Dahal with his Ministers and senior officials witnessed the final breakthrough of another diversion project, the 13.3 Km Sunkosi-Marin Diversion Multipurpose Project.

The Project would have a 12 meter high barrage on the Sunkoshi River at Khurkot, a kilometer downstream of the Sunkoshi and Tamakoshi confluence. The barrage would divert 67 cumecs[2] (*2,408 cusecs*) of the Sunkoshi waters through the 7 meter diameter 13.3 kilometer long tunnel to the Marin River, a tributary of Bagmati River, at Kusumtar in Sindhuli district. At the breakthrough ceremony of the tunnel, Prime Minister Dahal said[3] '*This project will provide year-round irrigation to farmlands of five districts of the Madhesh province, and will contribute to the economy and also generate hydropower.*' Beside generating 31 MW of hydropower at the Marin River, the five districts getting year-round irrigation are Bara[4], Rautahat, Sarlahi, Mahottari and Dhanusha of the Madesh Province. Bagmati River already has a barrage, built with Nepal's own meager resources, just upstream of the East-West Mahendra Highway bridge. This Barrage plans to irrigate 122,000 hectares of thirsty farmlands of the five Terai districts on both the left and right bank of Bagmati. Prime Minister Dahal also raised an important but oft-neglected subject of increasing the agricultural production and make the country self-sufficient in food. For the last decade or so our government's top planners and decision makers have been completely enthralled and engrossed[5] with how to produce ten/twenty-five thousand Megawatts of hydropower for export to India. This has, unfortunately, led the nation to unashamedly extend the begging bowl[6] to India not only for rice, paddy, wheat and sugar but also for the humble onions when India banned export of these items in preparation for its upcoming 2024 general elections!

Nepal's 173,000 ha of parched farmlands (*51,000 ha in Bardiya/Banke and 122,000 ha in Bara/Rautahat/Sarlahi/Mahottari/Dhanusha districts*) would receive round-the-year irrigation once the Bheri-Babai and Sunkosi-Marin diversion projects are completed. No doubt, this would, to a large extent, help the food importing nation to mitigate its food deficiency. An attempt, therefore, is made in this article to delve into the story behind the origin of these two inter-basin water diversion projects. Such water diversion projects would, not only, boost Nepal's badly neglected agricultural sector but also hopefully set the precedent for other such diversions to irrigate Nepal's thirsty parched Terai/Madesh. A few such possible key diversion projects[7] are: **Kali Gandaki-Tinau** for Rupandehi/Kapilavastu districts, **Sunkosi-Trijuja** to expand Chandra Nahar's additional networks in Saptari, **Tamor-Chisang** for Morang/Jhapa districts besides, of course, the **Sunkosi-Kamala** for Siraha/Dhanusha that has been skillfully subsumed as

2 This design capacity of 2,408 cusecs is three times the capacity allocated for Parsa/Bara/Rautahat under the Gandak Agreement: Nepal Eastern Canal (Parsa/Bara/Rautahat) gets 850 cusecs and Nepal Western Canal (Nawalparasi) 366 cusecs – amounts Nepal has never received since the handover of canals in June 1976.

3 Kathmandu Post, May 9, 2024 – Sangam Prasai & Raj Kumar Karki

4 The 1959 Gandak Agreement was supposed to supply Gandak waters for 1,03,500 acres for Parsa, Bara and Rautahat through the Nepal Eastern Canal and for Nawalparasi through the Nepal Western Canal. But the 1959 Agreement was shrewdly non-committal on the quantity of Gandak waters Nepal was to get. But for her own requirement, India incorporated the controversial month-wise Schedule of Water Requirements in the treaty. Only when the World Bank came on board for the Birganj Irrigation Project and questioned Nepal's allotment, did Nepal and India agree in October 1971 to 850 cusecs (23.65 cumecs) for Nepal Eastern Canal and 366 cusecs (10.18 cumecs) for Nepal Western Canal. Since the handover of the Gandak canals to Nepal in June 1976, Nepal has never availed the 850 cusecs of Gandak waters. On the other hand, India's Western Canal (*Bihar and UP*) capacity is 18,000 cusecs (500.83 cumecs) and Eastern Canal (*Bihar*) capacity 15,645 cusecs (435.31 cumecs). Thus forcing Nepalese engineers in the Gandak Project to quip '*Nepal ko lagi **Kulo**, Bharatle afno lagi **Nadi***'!

5 The UCPN-Maoist led coalition government with CPN-UML on Mangsir 18, 2065 (*December 3, 2008*) constituted a 15 Member Task Force with Somnath Poudel (*ex-WECS Secretary*) as Coordinator and Lilanath Bhattarai as Member-Secretary to formulate the **10,000 MW in 10 Years Report**. Only nine months later, not to be outdone the next CPN-UML led coalition government with Nepali Congress first truncated (*to share the poor nation's loaves and fishes*) the Water Resources Ministry into that of Energy and Irrigation and then on Bhadra 10, 2066 (*August 26, 2009*) constituted another 12 Member Task Force with by Kishore Thapa (*sitting WECS Secretary*) as Coordinator and Bhojraj Regmi as Member-Secretary to formulate the **25,000 MW in 20 years Report.**

6 Krishana Prasai in Kathmandu Post August 11, 2023 and December 19, 2023

7 As identified to the writer by Madhav Belbaseji.

the Sapta Kosi High Dam Multipurpose Project and Sun Kosi Storage-cum-Diversion Scheme. Nepal's attempts to develop her medium rivers with donors' assistance for irrigating the thirsty Terai/Madesh have the history of subtle diplomatic **'NEYTs'** from India: the 60 MW **Kankai** multipurpose Project, 140 MW **Bagmati** multipurpose project, 107 MW Bhalubang multipurpose project (*62 MW Bhalubang & 45 MW Surai Naka*) on **West Rapti** now subsumed by 280 MW **Naumure** project, **Babai** Irrigation Project, **Sikta** Irrigation project etc.!

B. **Bheri-Babai Diversion Multipurpose Project**

i) **Death of Nepal's Babai (Saryu in India) Irrigation project[8]:**

Though the Bheri-Babai Diversion had been identified early on, it got tied down by the Karnali Chisapani Multipurpose Project since Bheri is an important tributary of Karnali and its diversion would impact the benefits accruing from the Karnali Chisapani Project. However, for the last fifty years or so, the 1,800MW(*1966*)/3,600MW(*1978*)/10,800MW(*1989*) Karnali Chisapani Multipurpose Project also got bogged down with various critical issues: energy sale agreement with India, financial arrangement for implementation, displacement of people in the reservoir area and for India the most important '*arrangements for the **management of construction and operation of the project**.*' Hence, leaving aside the Bheri-Babai Diversion, Nepal in 1980 requested the World Bank for implementation of the Babai Irrigation Project to irrigate a cultivable command area of a mere 13,300 ha in Bardiya on the left bank of the Babai river. A month before negotiations on November 6, 1980, India's Executive Director at the World Bank raised concerns that the implementation of the Babai Irrigation Project would '*adversely affect downstream users[9] in the State of Uttar Pradesh.*' The Bank indicated, as per its Operational Manual Statement OMS 2.32, that the rights of the downstream users would be protected while designing the project. India raised no objection when the Credit 1093-NEP for Nepal was approved.

The Bank's Project Brief of January 17, 1983 mentioned that the proposed Babai Irrigation Project in Nepal would have '***no significant adverse effect on the water flows of the Babai/Sarju** river in India*'. In February 1983, prior to the Bank's appraisal mission, India's Executive Director at the Bank again raised India's concern about the proposed project and argued that the Bank's appraisal mission '***consider building a reservoir on the Babai River***' to provide irrigation water for both the countries. In March 1983 the Bank's appraisal mission after visiting the site was of the opinion that the '***Babai Irrigation Project, even without the storage reservoir, would have no adverse effect on the downstream users in India***'. This finding was repeatedly communicated to India's Executive Director at the Bank who continued to register India's objection to the project.

The Bank in April 1984, despite its own '***no adverse impact***' findings, suggested that Nepal have a dialogue with India on the use of the waters of the Babai River so that the project could be processed. Nepal, well aware of India's diplomatic **'NEYT'**, was not keen on this course of action but agreed that the Bank, to solve the impasse, could provide India with the project's technical parameters. In September 1984 the Bank provided India with the summary of the Appraisal Report and technical discussions were held in February 1985 at New Delhi between the officials of the Bank and the Government of India. India requested additional information on the water flows of Babai River and these were provided in July 1985.

Then in October 29, 1985, the Bank as per its Operational Manual OMS 2.32 informed India that despite her concerns the Bank ***'intended to process the project'*** and gave India six months (*up to April 28, 1985*) to register final comments on the project. **Just three days before the expiry of the dateline on April 25, 1985** India informed the Bank that, based on the information provided, it appeared that the Babai Irrigation Project would be harmful to its interests and **once more recorded her objection.**

As an international multilateral institution, the World Bank had been, so far, playing by the rule of the books.

8 World Bank's *Nepal and International Inland Waterways Issues, September 1987.*

9 Shyam Saran, India's ambassador to Nepal just before completing his Nepal tenure to become Secretary of External Affairs Ministry used the same argument on Nepal's Sikta Irrigation Project to the media on July 9, 2004 '…. *Sikta Irrigation Project in isolation by HMGN would adversely affect the Utraula and Dumeriagunj Canal Project as also the Saryu Canal Projects downstream in India. …… Sikta Irrigation Project could be considered **if the storage at Bhalubang is constructed**…. which would **ensure availability of water** during non-monsoon period **for the Indian operation.** Embassy of India has requested HMGN **not to proceed with the execution of the Sikta Irrigation Project** till both Governments have reached an agreement on the subject.*' – Spotlight July 16, 2004. Such public statements by the would-be Foreign Secretary of India drove away the European Union from Sikta Irrigation Project. Though Nepal funded the Sikta project with her own resources, unfortunately the canal is still inoperative due to Nepal's poor supervision and contractual implementation. However, instead of implementing the Bhalubang Multipurpose Project for providing irrigation to Kapilavastu, Nepal has incorporated, in her latest 2024/025 Budget, **the 280 MW Naumure Storage Project** just upstream of the **Bhalubang Project on West Rapti river**. It should be noted that Prime Minister PK Dahal, during his first Premiership in 2009, had also given his green signal to the 240 MW Naumure Project during his India visit.

After conveying India's objection to Nepal, the Bank then abruptly made an about turn and stopped playing the *'honest broker'* role. Despite its own finding that the Babai Irrigation Project '*would have no adverse effect on the downstream users in India*' and despite the six months' notification to India that the Bank ***'intended to process the project'*, the Bank in June 1986** shamelessly informed Nepal about '***GOI's objection to the Project as well as the Bank's decision to postpone further its processing.***' The Bank's lame excuse was the '*serious budgetary constraints faced by HMGN and the ongoing dialogue for the prioritization of projects carried out under the then proposed Structural Adjustment Credit.*' The proverb '*Jiske hath me lathi, uske bains – Whosoever has the stick in hand, owns the buffalo.*' aptly summed up Nepal's travails on the Babai Irrigation Project.

ii) **India's *'Perpetual Nightmares'*[10] on Nepal's *'Diversion Upstream'*:**

The following April 24, 1983 minutes[11] of the meeting between Nepal's Water Resources Secretary Madhusudan Dhakal and India's Irrigation Secretary MG Padhye provide insights into India's '*perpetual nightmares*' regarding Nepal's construction of '***diversion upstream which would reduce the supply*** *and ultimately affect the irrigation beneficiaries in India*':

'*The Engineer-in-Chief, UP, Shri D.R. Singha stated that a pump canal for serving*
25000 ha in UP territory was under construction and it was learnt that HMG of Nepal
was constructing a barrage for diversion upstream which would reduce the supply and
ultimately affect the irrigation beneficiaries in India. The Director General of Irrigation,
HMG of Nepal stated, Nepal was irrigating Bardia district since a long time and utilizing
the waters. A barrage was being planned to improve the management of the irrigation
system which is already existing in the area.
The Secretary, Irrigation, GOI requested for the exchange of data on existing and
planned uses as was earlier agreed to. This would help in quantification of problems of
sharing of water resources. He also requested that details of the storage study may be
made available. He explained that what is uneconomical from one point of view could
become economical in an entirely another context, as the criteria for economical
evaluation may also differ. Secretary, Water Resources, HMG of Nepal stated that this
was not agreed before and reiterated the earlier stand.'

Despite the World Bank abandoning Babai Irrigation Project at the last minute, not unlike the Arun III hydropower project after a decade of involvement, and despite the above '*sleepless night queries*' of India, Nepal through her own meager resources started construction of the Babai Bridge cum Weir in BS 2045/046 (1988/1989). The Babai bridge cum weir together with the 28 km main canal was completed in BS 2053/054 (1995/1996) at a cost of Rs 63 crores.

iii) **Resurrection of the Bheri-Babai Diversion Project:**

It is indeed heartening to note that the Irrigation Department started discussion on the economic viability[12] of letting the Bheri water continue to flow into Karnali river or divert it into Babai river. The average generating head at Chisapani dam is about 200 meter but that at the Bheri-Babai diversion only 100 meter thus the Bheri-Babai diversion would generate only 50% of the energy attainable at Chisapani dam. Though the Bheri-Babai project area can also be fed by the Karnali Chisapani Project's proposed eastern canal system, if the Karnali project is implemented *'soon'* then the Bheri-Babai diversion would not be viable. But if the Karnali project takes a *'long time'* then the diversion would become viable. Nepal requested India to accept the World Bank's 24 volume 1989 report of the 10,800 MW Karnali Chisapani Multipurpose Project but India refused[13] expressing the following reservations in the Report : i) ***Probable Maximum Flood value ii) sedimentation rate iii) Seismicity iv) dam height/reservoir capacity*** *be fixed to meet the* ***existing and committed Indian irrigation demand*** *as well as take 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 vi) studies also of 500 MW generating unit size.*

Thus, the Bheri-Babai diversion got resurrected in BS 2064/065 (*AD 2008/09*) when the Irrigation Department initiated[14] the detailed design study and the National Planning Commission approved the project in BS 2065/066 (*AD 2009/'10*). The Bheri-Babai Diversion Project was established at Birendranagar/Surkhet in BS 2068/069 and Prime Minister Sushil Koirala inaugurated the Project works in Baisakh 2072. The agreement with the Chinese contractor to drill the 12.2 Km tunnel using the Tunnel Boring Machine for the first time in Nepal was signed on 15th Magh 2072 (*29th January 2016*). Four years later in Baisakh 2076 Prime Minister KP Sharma (Oli) inaugurated the breakthrough of the tunnel. Unfortunately, due to several shortcomings in the project formulation, the Bardiya/Banke farmlands are not expected to get Bheri waters for another two three years.

C. **Sunkosi-Marin Diversion Multipurpose Project**

i) **Bagmati Irrigation Project:** During 1967-1972 UNDP-FAO carried out the Master Plan of Bagmati Irrigation Project to irrigate 122,000 ha in two phases. Phase I comprised of two Stages with the first Stage constructing the Bagmati Barrage and irrigating 45,600 ha in Rautahat and Sarlahi districts. The second Stage involved irrigating 22,400 ha in Bara. This meant converting 68,000 ha of rain-fed cultivable land into irrigated land. Phase II involved construction of the 117 meter high Bagmati Dam at Noonthar, about 3 km upstream of the present East-West Mahendra Highway bridge and irrigate through the Eastern Main Canal another 54,000 ha in Mahottari and Dhanusha.

Nepal, thus, in 1973 requested the World Bank assistance for the Bagmati Multipurpose Project. The Bank staff determined '***the Project would likely adversely affect the availability of irrigation waters downstream for users in India.***' However, the Bank was prepared to finance the Feasibility Studies of the Project out of the Funds from the ongoing Birganj Irrigation Project (Development Credit No. 373-NEP) provided the Study '***undertakes to ensure availability of water at current levels to downstream users.***' The Bank wanted Nepal to discuss the Bagmati Project with India. But Nepal preferred to settle the question of sharing waters of particular rivers in the larger context of relations between the two countries. Due to unsettled riparian issues, the World Bank withdrew from the Feasibility Study of Bagmati Project.

ii) **1981 – Bagmati Multipurpose Project Study by German Mission:** Nepal then approached the Government of Federal Republic of Germany and in 1981 the German Mission carried out the Phase 1 Study[15] of the Bagmati Multipurpose Project and submitted the following report:

Dam and Reservoir: An embankment type dam of 117 meter high located in the gorge of the Siwalik Hills before Bagmati breaks onto the Terai creating a gross reservoir capacity of 2,400 million cubic meter. The reservoir extended more than 20 km up the Bagmati River along the Kayan Khola and Jamuna Khola with a maximum width of about 5 km. **The tributaries Marin,** Basan, Chiruwa, Goth, Shokan and Tinkuna Kholas will also be affected. The reservoir will inundate 6,350 ha of cultivatable land including some villages. It was estimated at that time that some 10,000 people living in the reservoir area will have to be resettled.

Hydropower and Irrigation: A 140 MW (4x35 MW units) capacity hydropower plant will produce 540 GWh of energy annually. The connection to the under-construction 132 kV Hetauda-Janakpur-Biratnagar transmission line is only 4 km away. The proposed irrigation area is on either side of Bagmati River between the Nepal hills and the Indian border bounded in the west by Pasaha River, South by the Gandak Canal projecting eastwards across the Bagmati River and North-east by Janakpur and the Marha River. These areas comprise the five districts of Bara, Rautahat, Sarlahi, Mahottari and Dhanusha. The area has existing irrigation systems still in operation, Jhanj Project on the west bank of Bagmati and Manusmara Project on its east bank. The total estimated net irrigable area is about 120,000 ha.

iii) **1983 – India minutes Bagmati Barrage would *'adversely affect Committed and Proposed Downstream Uses'***: India's perpetual nightmares/concerns

10 Instead of using this '*perpetual nightmares*' of India as the **Strategic Tool** by Nepal, Prime Minister Sher Bahadur Deuba generously made that Tool dysfunctional by signing away the '**India-Nepal Joint 2022 Vision Statement on Power Sector Cooperation'** on April 2, 2022 with Prime Minister Narendra Modi. This Joint Vision on Power Sector Cooperation is another form of Bhutan Model. The 2022 Joint Vision prioritizes **Nepal's Water for Hydropower and Not for Drinking and Producing Food!**

11 Avtar Singh Bhasin. Nepal – India Relations. 2005. Geetika Publishers, New Delhi.

12 Poudyal, S. June 1992. *Irrigation Profile in Nepal – Training and Research Branch, Irrigation Department.*

13 8th Committee on Karnali meeting of March 1991 between BK Pradhan Nepal's Secretary/Water Resources and S Rajgopal India's Secretary/Power. As Karnali Chisapani is an extremely important strategic project for India, India's ambassador to Nepal, Ranjit Rae (2013 – 2017), in his 2021 book *'Kathmandu Dilemma'* admits that India has '***held in abeyance***' the 10,800 MW Karnali Chisapani Multipurpose Project. However, with Prime Minister PK Dahal now wanting to revive Karnali Chisapani (*Kathmandu Post August 22, 2023*), the go-ahead to NEA was given in November 2023 to conduct a fresh study *'to ensure that the Project is feasible and ready so that we can get investment to develop it.'* – NEA MD Kulman Ghising

14 According to Shiva Kumar Sharma, former DG/Irrigation Department, Umakant Jha, DG/Irrigation Department, initiated the Bheri-Babai Diversion Project by sanctioning Rs 10 lakhs to conduct its studies. Shiva Kumar Sharma (first Manager of the Bheri-Babai DiversionProject), Madhav Belbase (who succeeded SK Sharma as Project Manager) and Shiv Kumar Basnet were instrumental in resurrecting and implementing the Bheri-Babai Diversion Project.

15 This Phase 1 Report was prepared and submitted in February 1981 by HMG's Departments of Electricity/Irrigation/Agriculture (ED, ID, AD), German Agency for Technical Cooperation (GTZ), Federal Institute for Geosciences and Natural Resources (BGR), Snowy Mountains Engineering Corporation (SMEC) and Electricity Generating Authority of Thailand(EGAT).

regarding the Bagmati Barrage is recorded in the following April 24, 1983 minutes[16] of the meeting led by Nepal's Water Resources Secretary Madhusudan Dhakal and India's Irrigation Secretary MG Padhye:

Secretary, Irrigation, GOI referred to the ***earlier discussion on the subject of the barrage being constructed over river Bagmati in Nepal and mentioned that since this project involved consumptive uses of water it would adversely affect the already committed and proposed downstream uses in India.*** *In this connection he also mentioned that in India a project with a barrage over the Bagmati is under construction which has a large irrigation potential. The Chief Engineer, Mr. Harshman Shrestha, Department of Electricity, HMG/N stated that only preliminary study for a dam had been done. Feasibility study had not been completed. The preliminary studies however suggested the feasibility of a dam in the area. Appreciating the concern of India,* ***Secretary, Water Resources, HMG/N mentioned that if a formal request is made by GOI to HMG/N India's interest would be taken into account while making the feasibility study. He informed that the height of the dam at Noonthar would be 117 metres but storage and other details of reservoir, maps, etc had not been prepared.*** *Secretary, Irrigation,* ***GOI again enquired if a barrage was being constructed over river Bagmati*** *and if so, the scope of the project, and the extent to which the fair weather flows would be affected. Secretary, Water Resources, HMG/N replied that the* ***diversion was taken up and the diversion would be quite upstream of the Indo-Nepal border. This diversion would not affect the uses in India as there would be regeneration of water.***

Nepal started construction of the Bagmati Barrage with her own meager resources. Only in June 1987 the Saudi Development Fund[17] of Riyal 30 million financed the western main and sub-main canals for Rautahat district. India does admit to *'initial objection'*[18] to Saudi funding for Nepal. It is likely that the Saudis turned a deaf ear to India's objection as the Nepalese Muslim population in Rautahat is considerable[19]. Another package of Saudi Riyal 74 million was provided in 1995 mainly to reconstruct the barrage and canals devastated by the 1993 flash flood that had also washed out the penstock pipes of Kulekhani powerhouse. Further assistance of Riyal 40.6 million in 1997 and 56.25 million in 2007, thus totaling 200.85 million Riyal, was provided to increase the irrigation coverage and the associated infrastructures.

iv) **Sunkosi – Kamala Diversion at Kurule from Sunkosi River**

a) **1985 – Master Plan Study of the Kosi River Water Resources Development:** This 1985 Master Plan Study of the Kosi River, funded by Japan International Cooperation Agency (JICA), recommended two top priority schemes to uplift the socio-economic status of the Nepalese living in that region: the Sunkosi Multipurpose Irrigation and Arun 3 Hydropower Projects for immediate implementation of feasibility study. The Study categorically pointed out that '***diversion of water from the Sunkosi to Kamala is allowed according to the Agreement between HMGN and India.***' The Study also pointed out that as the 536 MW of Sunkosi No. 3 is too large for Nepalese domestic needs at that time, implementation of the irrigation scheme in the Terai area is urgently required.

b) **Sunkosi – Kamala Diversion:** There are three components to this trans-basin diversion: a 48.9 meter high diversion concrete gravity dam on Sunkosi at Kurule, a 16.6 km diversion tunnel with 72 cumecs design discharge capacity and a 61.4 MW powerhouse capable of producing annually 511 GWh. The Sun Kosi-Kamala diversion feeds into a tributary of the Kamala river on which a 51 meter high dam is envisaged about 20 km upstream of the Chisapani village. A 32 MW powerhouse at the dam generates 121 GWh annually. A 3 meter high re-regulating barrage at Chisapani will provide irrigation to a net command area of **175,000 ha – 108,000 ha** on right bank **in Dhanusha** and **67,000 ha** on left bank in **Siraha.**

c) **Sunkosi- Kamala Diversion Subsumed by Saptakosi High Dam:** Instead of requesting the multilateral and bilateral donors for implementing the top priority Sunkosi-Kamala Diversion, Prime Minister GP Koirala in December 1991[20] gave his nod to the Indian proposal for preparation of the Detailed Project Report of Saptakosi High Dam, India's top priority project whose report[21] she had already completed in 1983. In 1996 during Prime Minister Sher Bahadur Deuba's visit to New Delhi, Nepal agreed to include the Sunkosi-Kamala Diversion in the Joint Team of Experts' (JTE) meeting on Sapta Kosi High Dam. At the October 2004 JCWR meeting at New Delhi, India raised the multipurpose projects on Kamala and Bagmati. Though Nepal pointed out the social and environmental problems due to presence of large settlements in the proposed reservoir areas, it was agreed that '*the feasibility study of the Kamala and preliminary study of Bagmati Multipurpose Projects would also be carried out by the Joint Project Office of Saptakosi–Sunkosi Projects to ascertain the likely constraints in implementation of these projects so that these could be appropriately addressed.*' Nepal's top priority project, the Sunkosi-Kamala Diversion, was thus subsumed by the Saptakosi High Dam and tagged as the **Saptakosi High Dam Multipurpose Project and Sunkosi Storage-cum-Diversion Scheme.**

v) **Birth of Sunkosi – Marin/Bagmati Diversion:** In such an environment, Madhav Belbase, an engineer at the Irrigation Department in BS 2066/067, remembers his senior at the Department, Durga Shankar Sharma, telling him about a JICA official who told him that Nepal should explore the possibility of the Sunkosi-Bagmati Diversion. It should be noted that though JICA's 1985 Master Plan Study of the Kosi River identified the Sunkosi-Kamala Diversion as Nepal's top priority irrigation project, there was no mention at all of the Sunkosi-Bagmati Diversion. This Sunkosi-Bagmati Diversion aroused keen interest in Madhav Belbase who, after referring to Google maps, found out that only 12 km of tunneling was required to divert the Sunkosi waters into Marin, a tributary of Bagmati. Madhav Belbase along with Shiva Kumar Sharma must be given the full credit for pushing this Sunkosi-Marin Diversion concept into the project implementation stage.

Though the Bagmati Irrigation Project has completed works to cover irrigation for 45,600 ha of farmlands, during the dry season it can provide irrigation to only 13,000 ha. Hence, the Sunkosi-Marin diversion will be a god-send blessing to provide round-the-year irrigation to 122,000 ha of farmlands in the five districts of Bara, Rautahat, Sarlahi, Mahottari and Danusha in Terai/Madesh.

D. **Nepal's Top Priority – a Decade of Hydropower Development (2016 – 2026) OR a Decade of Agriculture Investment (2024 – 2034):**

i) **Nepal's Top Priority – Hydropower Development Decade (2016 – 2026):** With the 10,000 MW in 10 years and 25,000 MW in 20 years reports published, Nepal, in order to make the great leap forward[22], launched the ambitious 10,000 MW of hydropower in 10 years under the Electricity Development Decade 2016/026 flagship in February 2016. This Electricity Development Decade envisaged commissioning 133 hydropower projects[23] totaling 9,935 MW: *2,587 MW of 117 run-of-river projects, 1,975 MW of 5 peaking run-of-river projects and 5,373 MW of 11 storage projects.* Apparently Nepal's great leap forward decade caused hiccups in New Delhi's South Block. Citing electricity trade involved '***issues of Strategic, National and Economic Importance***', India immediately on December 5, 2016 issued the '**2016 Guidelines on Cross Border of Electricity**'. Two years later, repealing the 2016 Guidelines, India on December 18, 2018 issued the ***'Guidelines for Import/Export (Cross Border) of Electricity – 2018'***. And three years later, India further polished the 2018 Guidelines by issuing on February 27, 2021 the '***Procedure for Approval and Facilitating Import/Export***' wherein the controversial Clause 6.3 on Eligibility stated:

'Indian entities ***may import electricity from the generation projects located in neighbouring country(ies) ……., provided that the generating company is not owned, directly or indirectly*** *by any natural/legal personality(ies) whose effective control or source of funds or residence of beneficial owner,* ***is situated in/citizen of a third country with whom India shares land border and that third country does not have a bilateral agreement on power sector cooperation with India.***'

Such eligibility clauses in the Procedure for Approval

16 Avtar Singh Bhasin. Nepal – India Relations. 2005. Geetika Publishers, New Delhi.
17 *Sinchai Diary BS 2065*, Department of Irrigation, Ministry of Water Resources, Government of Nepal.
18 Verghese, BG. *Waters of Hope.* 1990. Oxford & IBH New Delhi.
19 Thapa, Dorak Bahadur – formerly of Irrigation Department, during informal talks.
20 Bhasin, AS. *Nepal's Relations with India and China.* 1994. Siba Exim Pvt. Ltd. Delhi. Nepal Gazette Vol. 41 No.36 Kathmandu, December 29,1991. Prime Minister GP Koirala, sans his Water Resources Minister and Secretary, flew to New Delhi with his jumbo 72 member team in December 1991. Besides signing the controversial Tanakpur MOU, Prime Minister Koirala made agreements on Nepal's all major water resources projects: Karnali (Chisapani) Multipurpose Project, Pancheshwar Multipurpose Project, Sapta Koshi High Dam Multipurpose Project, Burhi Gandaki Project, Kamala and Bagmati Schemes.
21 *Comprehensive Plan of Flood Control for the Kosi Sub-basin.* December 1983. Ganga Flood Control Commission. Ministry of Irrigation. Government of India.
22 The Leap that the veteran political commentator, CK Lal, calls '***the perilous path to quick-fire prosperity***'!
23 Ministry of Energy, Government of Nepal's white paper of February 2016 on *Electricity Development Decade 2016/'026.*

are clearly targeted at Nepal's swarms of financially muscular Chinese companies working in various hydropower projects. These Chinese companies are far more competitive and technically sounder[24] than the upcoming Indian companies. Hence, India's Guidelines and Procedures are specifically targeted at Chinese investments in Nepal's hydropower by hanging the large signboard: '*Achtung! You are trespassing over private property!*' Then on April 2, 2022 Prime Minister Sher Bahadur Deuba signed the Indo-Nepal Joint 2022 Vision on Power Sector Cooperation with Prime Minister Narendra Modi in New Delhi. Ignoring the restrictive Guidelines and Procedures, in keeping with the 2022 Vision on Power Sector Cooperation, Nepal went ahead and on January 4, 2024 happily signed away the **Long-Term Power Trade Agreement** with India that stated '*Both Parties **shall strive** to increase the quantum of export of power from Nepal to India to **Ten Thousand Megawatt (10,000 MW) within a timeframe of ten years** ……*' India ensured that her controversial Procedure is enshrined in the Agreement by inserting '*In implementing this Agreement **both parties shall abide by** their applicable laws, regulations and **Procedures related to cross border trade** in power*'.

At the recent Third Nepal Investment Summit in Kathmandu inaugurated by Prime Minister Pushpa Kamal Dahal on April 28, 2024, Nepal called on the foreign investors[25] to invest in her energy development roadmap of generating 28,500 MW in 12 years: **consuming 13,500 MW by herself** and **exporting 10,000 MW to India** and **5,000 MW to Bangladesh**. At the Investment Summit, Nepal revealed[26]: a) its installed hydropower capacity as *2,910 MW of which 2,214 MW in the private sector* b) 131 hydropower projects of *3,397 MW capacity under construction* c) 138 hydropower projects of *3,615 MW capacity under financial closure negotiations* and d) another 258 projects with *19,623 MW capacity licensed* and at various stages. This means Nepal will shortly have 6,307 MW of hydropower projects in operation with another 3,615 MW achieving financial closures and thousands more Megawatts of the licensed 19,623 MW projects heading towards financial closures. With both parties abiding by their *'applicable laws, regulations and **Procedures**'* in Nepal's strive to export 10,000 MW within 10 years, with the global commitments already made at **Glasgow's COP 26**, India is extremely pleased[27] that Nepal is making Herculean efforts to push renewable hydropower into her networks – **sans any quid pro quo from India!**

ii) **Finally Nepal's Agriculture Investment Decade (2024 – 2034) Hesitantly Raises its Head:** As early as 1985, JICA's Kosi Master Plan Report had stated[28] that due to high 76.5% production of the nation's harvest by the Terai/Madesh areas, the 1981/82 crop production of Nepal exceeded 20.8% of the total demand. The report continued '*Future food supply appears to be decreasing with an **estimated food grain deficit of 41.7% of the total demand by the end of the century**.*' With the 1990 regime change from the monarch's Panchyat to so called peoples' Democracy, our omniscient and omnipotent political leaders, instead of tackling the country's food grain deficit, were far busy dancing[29] to the musical chairs' tune on who gets the Singha Durbar chair. They bothered neither with putting food on the empty *'thalis'* of the hungry Nepalese families nor with the burning problems of ever increasing unemployed[30] youths. By 2023 Nepal, a country that once proudly exported her grains, was forced to request[31] India for '*1 million tons of Paddy, 100,000 tons of rice and 50,000 tons of sugar*' when the Indian government banned export in preparation for its upcoming 2024 general elections. This begging bowl to India extended even to the humble onions[32] in December 2023.

24 As demonstrated in the 456 MW Upper Tamakoshi Hydropower Project by the Lot 1 (penstock pipe) Indian Texamaco company whose contract, due to long delays, had to be terminated.

25 The Summit expected foreign companies and stakeholders from different countries, including China, India, Canada, Norway, South Korea, Germany, Austria, Italy, Sweden, United Kingdom and Brazil to participate. Many believe this was not unlike that of Som Sharma's **'sattu'** dream

26 Ganesh Karki, President/Independent Power Producers' Association of Nepal (IPPAN), speaking about IPPAN's Fourth Himalayan Hydro Expo in Kathmandu on 24th to 26th April 2024 – Rising Nepal February 8, 2024.

27 In fact, the Embassy of India, Kathmandu *'in collaboration with the Investment Board of Nepal (IBN) and Nepal India Chamber of Commerce and Industry (NICCI) organized a **Post Investment Summit** India-Nepal B2B Meet in Kathmandu'* on April 30, 2024.

28 JICA's Master Plan Study on the Kosi River Water Resources Development, March 1985, submitted to Ministry of Water Resources, HMGN

29 The urge to dance to the tune of musical chairs is very well illustrated by the 27 governments in 34 years from 1990 to 2024 that included the governments of King Gyanendra Bickram Shah and Khilendra Prasad Regmi, Chief Justice of Supreme Court!

30 This led to the *'Khadi muluk and Malaysia'* exodus of over 2.2 million youths and has now become a major pain in the neck for Singha Durbar with the *'bhadaka Sepoy'* being killed in the Russian-Ukraine war.

31 Kathmandu Post, August 11, 2023 – Krishana Prasai

32 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.

Agriculture is the backbone of the Nepalese economy contributing[33] **'*around* *one-third of the nation's GDP and provides employment to two third of the population*.** *But, the contribution to overall GDP has declined over time. Agriculture contributed to 36.64% of the GDP which then decreased to 23% by 2022. Similarly, the employment in agriculture has decreased from 73% in 2005 to 62% in 2021. Although the sector still contributes to a significant proportion of the overall GDP and a lot of population is engaged in agriculture, the government has allocated only NPR 58.98 billion (USD 445.21 million) for the agriculture sector in the fiscal year 2023/24 AD, out of a total size of NPR 1.751 trillion* (USD 13.20 billion) which amounts to only ***3.36% of total budget.*** ……. *Government investment is crucial in elevating rural livelihood and increasing agricultural productivity through agricultural support services, improved irrigation* services for efficient water management, access to high-quality seeds, farm equipment, trainings in improved farming techniques, and value chain infrastructure.'

After relentlessly pursuing hydropower development from the Panchyat days, finally Nepal half-heartedly launched the **Decade (2024–2034) of Agriculture Investment**[34] in its 2024/2025 Budget. The Budget states that contract farming in collaboration with farmers and businesspeople will be promoted and those engaged in commercial farming and animal husbandry *'tax exemptions on purchase of machinery and spare parts as well as interest subsidies on loans'* will be provided. Though the 2024/2025 Budget introduced ***'A Decade (2024–2034) of Agriculture Investment'***, Nepal's ***'Decade (2016–2026) of Hydropower Development'*** with '*1,200 MW **Budhigandaki**, 625 MW **Dudhkoshi**, 417 MW **Nalgadh**, 280 MW **Naumure** Projects **on the cards** plus conducting the **Feasibility Study** of 10,800 MW **Karnali Chisapani Hydropower Project***' far overshadows the miniscule investment in Agriculture development. Many, thus, believe that the Nepal government is barking up the wrong Hydropower tree!

E. Final Words: More Hydropower Projects for More Export to India Bhutan-style OR More Inter-basin Diversions for More Irrigation in Terai/Madesh India-style?

There was a time when a strong lobby in Nepal advocated duplicating the Bhutan Model of hydropower development with India. Under that Model, Bhutan has so far developed around 2,326 MW of hydropower[35], exporting over 75 percent of that to India and earning 40% of its GDP. Thus, Bhutan's tiny 0.78 million people[36] enjoys a per capita income of US$ 3,266/ (*2021 World Bank figure*) making it the richest country in South Asia. But Nepal's 30.9 million people, with a paltry per capita income of US$ 1,337/ (*2022 World Bank figure*), is the poorest in South Asia. Despite being the richest South Asian country by exporting hydropower to India, '*Of late, Bhutan is witnessing a new challenge—**a massive exodus**. In the last two years, more than 11,000* Bhutanese youths got their education visas from Australia alone. Several experienced and mid-level *civil servants, teachers, medical specialists, and employees* of private and state-owned enterprises have also left the country in search of better opportunities. For a country with a population of *less than 800,000, a shortage of manpower is being felt in every sector.*'[37] The World Bank's Report[38] says that '*Bhutan's labor market is at a critical juncture, facing challenges in creating jobs in the private sector*'. Despite the huge electricity export to India, foremost for the Bhutanese is more jobs for young educated people – a situation not dissimilar to Nepal. This message of more jobs was stridently given by the people of India during their 2024 general election when the Bharatiya Janata Party was humbled from the domineering 303 to 240 MPs in the 543 House Lok Sabha. Nepal's major political parties, however, remain both deaf and dumb to discuss/debate

33 Mahotsav Pradhan, *Economic Development*, Nepal Economic Forum, December 14, 2023

34 To ensure access to food and address food safety, Right to Food and Food Sovereignty Act 2075 (2018) is enshrined in Nepal's constitution – Khim Lal Devkota. *Food Security and Climate Change*. Kathmandu Post April 3, 2024

35 Bhutan's in operation hydropower plants are: i) Chukha – 336 MW ii) Tala – 1,020 MW iii) Kurichhu – 64 MW iv) Basochhu – 64 Mw v) Mangdechhu – 720 MW and vi) Dagachhu – 126 MW; Total: 2,326 MW. Under construction are: i) Punatsangchhu I – 1,200 MW ii) Punatsangchhu II – 1,020 MW iii) Nikachhu – 118 MW and iv) Kholongchhu – 600 MW; Total: 2,938 MW. Under consideration for implementation with India are: i) 1,125 MW Dorjilung ii) 2,585 MW Sunkosh and iii) 404 MW Nyera Amari I and II – **USAID's Guidance Note for Bhuatn to Trade in Indian Power Exchange, August 2023.**

36 With discreet nods of both India and USA, Bhutan expelled over 125,000 Lhotshampas of Nepalese origins into Nepal with the foolish affirmative nod of Prime Minister GP Koirala also.

37 India's Observer Research Foundation (ORF) March 31, 2023, **Assessing Bhutan's Migration Trends and Policies** – Aditya Gowdara Shivamurthy, *Associate Fellow with ORFs Strategic Studies Programme*..

38 World Bank, **MARCH 12, 2024 :** A Strong Labor Market is key to Bhutan's Inclusive Growth

why over 2.2 million Nepalese are forced to work abroad on *'cheap, dirty and dangerous'* jobs to feed their families back home in Nepal. Some, to keep their kitchen fires burning at home, have recently been forced to become *'Lahures'* in the Russian army only to be pummeled by Ukraine with the arms supplied by the pleased Western arms suppliers. The remittances, 30% of Nepal's GDP, sent by these Nepalese working abroad keeps the Nepalese economy afloat for the political parties to relentlessly vie for the Singha Durbar chair!

Bhutan has very well demonstrated that hydropower export does not create jobs for the exporting country. That is, Nepal's great leap forward with the Decade of Hydropower Development to export 10,000 MW in 10 years to India would not create jobs in Nepal. Jobs would, definitely, be created for the country importing cheap renewable Nepalese and Bhutanese hydropower. Yet, Nepal's key policy and decision makers continue to harp the same bygone Panchyati slogan of Nepal getting rich through hydropower export to India. They insist[39] '*The **first benefit** is the **energy royalty** that Nepal gets. For example, in the case of Arun-3, the developer pays two percent of what it gets from the energy sold in the Indian market in the first 15 years. In the next 15 to 30 years, it pays 10 percent energy royalty. **Two**, it pays **capacity royalty** at the rate of Rs 100 per kW for the first 15 years and Rs 1,000 per kW after 15 years. **Third**, it pays **income tax**. **Fourth**, we get **21.9 percent of the total energy** produced by Arun 3 for **free**. **Fifth**, the **entire project is handed over to the government after 30 years**.*' Bhutan has proved that this reliance on hydropower as Nepal's growth engine is totally untenable. Former Minister Dipak Gyawali has aptly termed it ' *rent-seeking*' mentality. There is not a word on the employment the 900 MW Arun-3 project creates for the youths in Nepal. In 2021, Nepal's agriculture sector provided employment to 63% of the Nepalese population. If round-the-year irrigation is provided in the Terai/Madesh, not only these 63% of the Nepalese will continue to work in agriculture and not be forced to migrate abroad for enlistment in the Russian army but they would also help to make the country self-sufficient in food.

That is why CK Lal, a veteran political commentator, finds[40] the Nepal Government's pursuit of **Hydropower** '***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.***' On Agriculture, Lal further added '*…. **a country that cannot feed itself** has to perforce **hawk its independence to keep itself afloat.***'

In the 1950s and 1960s India was forced to *'hawk her independence'* by importing cheap American grains under the Rupee-paid American PL-480 (Public Law) Program. But in two decades by 1971, India stopped that import when her Kosi (*8.5 lakhs ha*), Gandak (*16.5 lakhs ha*), Bhakra Nangal (*40.0 lakhs ha*) and Beas (*21.0 lakh ha*) irrigation Projects ushered in not only the famed Green but White (**AMUL**[41]) revolutions as well. Should Nepal, shamelessly, *'hawk her independence'* for even the humble onions? Should Nepal for *'quick-fire prosperity'* take the *'perilous hydropower path'*? Or should Nepal priotize her **'Decade of Agriculture Investment'** instead of pursuing the '*1,200 MW **Budhigandaki**, 625 MW **Dudhkoshi**, 417 MW **Nalgadh**, 280 MW **Naumure** Projects **on the cards** plus conducting the **Feasibility Study** of 10,800 MW **Karnali Chisapani Hydropower Project***'**?** During this Decade of Agriculture Investment (2024-2034) shouldn't Nepal implement more inter-basin diversions like the **Kali Gandaki-Tinau** for Rupandehi/Kapilavastu, **Sunkosi-Trijuja** to expand Chandra Nahar's additional irrigation networks, **Tamor-Chisang** for Morang/Jhapa to provide irrigation for more Terai/Madesh farmlands? This is NOT the million dollar denominated question but a SIMPLE one Nepalese Rupee tagged question for our omniscient and omnipotent political leaders!

The writer of this article is the former Managing Director of the Nepal Electricity Authority.

39 Kathmandu Post January 8, 2024. TR Bhusal and PM Shrestha's interview with Dinesh Ghimire, retired Energy Secretary, who was intimately involved in negotiations with India on the Long-Term Power Trade, the 10,000 MW in 10 years Agreement, that was signed by his successor Gopal Prasad Sigdel on January 4, 2024

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

41 AMUL, acronym for India's Anand Milk Union Limited, the cooperative founded in Gujarat by Tribhuvandas Patel on 14th December 1946 and transformed by Verghese Kurien into a multinational selling milk and milk products globally. It is under the ownership of Gujarat Cooperative Milk Marketing Federation Limited, Government of Gujarat and is controlled by 3.6 million milk producers. AMUL spurred India's White Revolution and in 2022 its revenue was Rs 52,000 crores (US$ 6.2 billion). On the other hand, Nepal's Dairy Development Corporation (DDC) was established in 1969 with the support of the Swiss Government. Despite fifty years of operation, DDC's recent sad plight, unable to pay Rs 6 billion to its milk producers, fails to enlighten our policy and decision makers. – Republica April 8, 2024.

From Watershed to Wattage: Unraveling Influences of Different Factors on Hydropower Generation in Nepal

Madan Timsina

Prabhab Bista

"From small-scale micro-hydro systems to large dams, the country's hydropower projects play a vital role in enhancing energy self-reliance and fostering economic growth."

1. Introduction

Hydropower generation stands as a fundamental pillar of Nepal's energy sector, leveraging its vast water resources to a remarkable extent. With an extensive network of rivers and challenging terrain, Nepal has one of the world's most significant potentials for hydropower. From small-scale micro-hydro systems to large dams, the country's hydropower projects play a vital role in enhancing energy self-reliance and fostering economic growth.

According to a report of the NEA, Nepal's total installed capacity, including hydropower plants, solar plants, diesel and bagas, reached 2829.99 MW (excluding microhydro plants being generated by AEPC) by the end of Chaitra, 2080. However, operational capacity may vary due to certain plants being inactive at present. Despite surpassing the national peak load, recorded at 1986.39 MW (as per A Year in Review, 2022/23) in the last fiscal year, Nepal still imports power from India in dry seasons to meet its demand since the full installed capacity cannot be consistently realized throughout the year.

The article briefly explains the different influencing factors in power generation.

2. Generation Records

Generation from Hydropower Stations of NEA in this FY

FY	Shrawan	Bhadra	Ashwin	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad	Total
2077-78	326.37	301.35	304.48	259.15	246.08	203.70	181.53	139.90	157.47	162.23	248.05	270.52	**2,800.83**
2078-79	302.62	282.85	313.41	217.42	268.76	252.53	215.05	191.04	280.07	266.16	319.42	333.15	**3,242.45**
2079-80	302.14	311.51	241.66	255.47	258.87	232.06	172.45	155.42	174.84	221.28	286.62	284.73	**2,897.03**
2080-81	279.85	283.53	299.35	254.28	245.13	199.00	170.45	141.90	171.00	242.22	303.96	286.47	**2877.13**

Source: Generation Directorate, NEA

The graph illustrates the electricity generation from NEA's Hydropower plants over the past four years. The pattern reveals a consistent trend of reduced generation during the dry season and peak generation during the wet season. Interestingly, fluctuations in energy generation are evident within the same month across different years. This article aims to explore the various potential factors contributing to these fluctuations.

3. Influences on Hydropower Generation

3.1 River Discharge

Seasonal variations in precipitation, snowmelt from the Himalayan glaciers, and monsoon patterns are the primary drivers of river discharge fluctuation in Nepal. The country experiences significant seasonal changes in river flow, with peak discharge levels observed during the monsoon season and reduced flow during the drier winter months. These fluctuations are directly impacted by variations in precipitation patterns, temperature fluctuations, and the dynamics of snowmelt in the Himalayan region.

3.2 Rainfall

Nepal undergoes a pronounced wet season, predominantly during the monsoon months from June to September. This period witnesses heavy rainfall, resulting in substantial rises in river discharge levels nationwide. Approximately

80% of Nepal's annual rainfall is concentrated within this monsoon period. Consequently, most power plants operate at or near maximum capacity during these months. Nevertheless, the natural calamities associated with monsoon floods can occasionally disrupt the operation of certain power plants to some degree.

Upon comparing the seasonal generation of NEA hydro powerhouses with the seasonal accumulated rainfall data provided by DHM, several noteworthy trends emerge from the observed graphs.

Generation, in GWh				
Year	Dec-Feb	March-May	Jun-sep	Oct-Dec
2021	578	514	1137	769
2022	697	801	1227	751
2023	612	617	1141	749

Rainfall, % of average rainfall				
Year	Dec-Feb	March-May	Jun-sep	Oct-Dec
2021	25.33	129	115.5	355.7
2022	130.7	103.4	90.3	297
2023	21.5	92.7	88.5	86

Source: Dept. of Hydrology and Meteorology, DHM

The graph depicting the generation pattern during the dry season illustrates a direct proportional relationship between energy generation and rainfall.

The proportial relation can be observed for the year 2022 and 2023. But, for the year 2021, the trend is just opposite. The reason behind the unusal trend for the year 2021 is rainfall below the average rate during most of the period of this season followed by over the average rate of rainfall during end of season. As the rainfall took place only during end of the season, the accumulated rain water became higher than average though the rivers suffered minimum discharge during most of the period in the season.

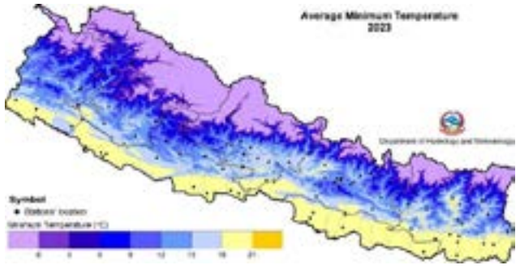
The graph above illustrates the post-monsoon season, which is typically the most favorable period for generating plants due to adequate river discharge and favorable water quality in terms of sediment content. In the year 2021, with accumulated rainfall reaching approximately 350% of the average, generation levels were notably high. The trend in generation closely mirrors the quantity of rainfall during this period.

3.3 Snow Melting

Nepal is home to a significant portion of the Himalayan mountain range, which contains vast glaciers. During the warmer months, particularly in spring and early summer, melting snow and glaciers contribute to increased river discharge levels as the water flows downstream into the rivers.

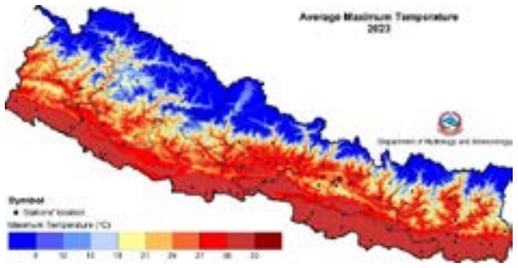
The man river basins in Nepal on which hydropower plants of NEA have been developed are Narayani, Karnali and Koshi basin having their sources in the snow and glaciers in the Himalayan region. Although permanent snow lies above 4570 m, glaciers come as low as 3000 m in some part of Nepal. Being the Himalayan snow and glaciers as the source of these rivers, the discharge in river is directly dependent on the temperature variation in different seasons.

The provided diagrams illustrate the variation in temperature across different regions of Nepal. During the winter months, a substantial area exhibits temperatures hovering around 0°C, indicating the presence of snow-covered regions. Conversely, in the summer months, these same areas experience temperatures around 9°C. This seasonal temperature variation reflects the dynamic climatic conditions present throughout Nepal, particularly in relation to the presence and melting of snow cover.



Average minimum temperature of Nepal in 2023

Source: Nepal Climate Summary, 2023 by Dept. of Hydrology and Meteorology, DHM



Average minimum temperature of Nepal in 2023

Source: Nepal Climate Summary, 2023 by Dept. of Hydrology and Meteorology, DHM

The parallel patterns of rainfall and temperature in Nepal dictate the seasonal cycles, with summers coinciding with the monsoon season and winters aligning with the dry period. This synchrony plays a pivotal role in shaping river discharge dynamics. During summer, elevated temperatures accelerate melting of snow on the Himalayas, enhancing river discharge alongside increased rainfall. Conversely, in the dry season, reduced rainfall coupled with cooler temperatures decelerates snow melting, leading to decreased river discharge. This interplay between rainfall and temperature profoundly influences Nepal's hydrological patterns.

3.4 Maintenance Schedule

Maintenance of hydropower plants is essential to ensure the continuous and reliable generation of electricity. Maintenance of hydropower plants is a critical function that ensures the reliability, safety, and efficiency of electricity generation while also addressing environmental and regulatory requirements. By implementing comprehensive maintenance programs, hydropower plant operators can minimize risks, optimize performance, and contribute to the sustainable development of Nepal's energy sector. The erosion in runners, corrosion in mechanical components due to continuous operation, contamination of lubricants, etc. demands periodic maintenance of the overall system.

The maintenance schedule of units or plants of hydropower station varies depending on their nature. Certain maintenance tasks necessitate a shutdown of the unit or plant, while others can be performed without any interruption to operations. For activities requiring a shutdown, the schedule is typically predetermined. It may occur either during the dry season when river discharge is minimal to prevent water spilling, or in the wet season when energy demand can be met by other plants. This strategic scheduling ensures that maintenance activities are conducted efficiently without compromising the overall power generation process.

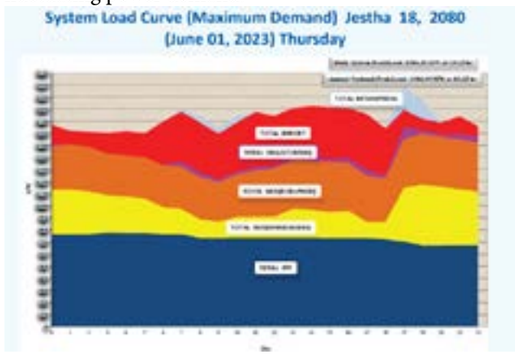
Nepal's initiation on cross-border electricity trading with neighboring India has addressed the issue of excess energy during the wet season to some extent. With the ability to export surplus energy, the problem of spillage during periods of high river discharge has been mitigated. Consequently, it is more advantageous for the NEA to operate its plants and export power rather than shutting down for repairs during the wet season. As a result, the NEA has adopted its strategy to conduct overhauls and maintenance activities on its machine units during the dry season. This approach minimizes the impact on overall energy generation and ensures optimal utilization of resources.

3.5 Generation Mix and System Management

The generation mix of Nepal is composed of mainly

a. Run-off-the River (RoR) plants (NEA and IPPs)
b. Peaking-RoR (PRoR) plants
c. Seasonal Storage Plants
d. Imports

The generation of Run-of-River (RoR) plants continues as long as the necessary discharge is available. This includes power generated from Independent Power Producer (IPP) plants, which is offtaken on a take-or-pay basis. Since electricity cannot be stored, the system operator prioritizes the utilization of RoR plants from IPPs, RoR plants from NEA, and finally Storage plants, based on power demand. During periods of lower power demand, the system operator reserves PRoR and Storage plants for peaking times. This strategic management ensures efficient utilization of resources and optimal response to fluctuating power demand.



Source: Annual Report of NEA,2079/80

The provided figure depicts the month of June, characterized by abundant water availability. Consequently, most power plants operate at full capacity during this period. The base load is primarily supplied by IPPs' power plants and NEA's RoR and PRoR plants, while the daily fluctuations in power demand are managed by NEA subsidiaries, NEA storage, and total imports. This illustrates the established priority order for operating different types of power plants. Therefore, the operation and generation of power plants are also contingent upon the operational strategy of the system operator, Load Dispatch Center (LDC) in Nepal.

3.6 Environment Regulations

Environmental regulations and considerations, such as habitat protection, fish passage requirements, and water quality standards, can influence the operation of hydropower plants. Compliance with these regulations may require changes in operations that affect generation. The Hydro Power Development Policy of Nepal requires hydro companies to allow 10 percent of the minimum monthly discharge of the river to its natural course downstream of the dam. The provision though results minimal impact is wet season when there is enough water, it hampers generation during dry season.

3.7 Natural Calamities

As stated earlier, around 80% of annual rainfall occurs during monsoon season in Nepal. On top of that, hydropower plants and substations are made at river banks and directly linked with rivers and also, the transmission lines stretched over the difficult geographical terrain is always in risk of landslides and flood. During flood due to excessive rainfall, the plants are forced to shutdown.

Numerous instances of natural disasters, such as floods and landslides, have resulted in the destruction of headworks structures and powerhouses, as well as the collapse of transmission towers. One such incident

occurred in mid-June 2021, when heavy rainfall triggered several landslides, causing Transmission Tower No. 9, a 132 kV structure, to collapse. As a result, complete power evacuation from Middle Marsyangdi HPS was halted for approximately 15 days until the erection of an Emergency Restoration System (ERS) Tower restored the power evacuation. Additionally, the flood forced the plant into a complete shutdown for three days, with several other plants also being shut down temporarily due to the adverse conditions. These events underscore the vulnerability of infrastructure to natural disasters and the consequential impact on power generation and transmission.

3.8 Sedimentations

Over time, reservoirs can accumulate sediment, reducing their storage capacity and potentially impacting power generation. Sediment management strategies may be necessary to maintain reservoir efficiency. Furthermore, a decrease in the efficiency of desander basins can lead to issues such as the choking of cooling mechanisms and erosion of turbine parts, resulting in disruptions to power generation. Data analysis has revealed sediment concentrations ranging from 300 to 11,000 parts per million (ppm) during the wet season, exceeding recommended limits for power plant operation. In such instances, power plants may be compelled to shut down operations. The high sediment load often leads to frequent filling of desander basins, necessitating frequent flushing requirements and subsequent plant shutdowns.

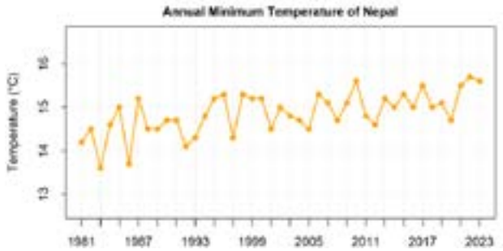
3.9 Water Management

The operating powerplants of the NEA also constitute power plants that are built under irrigation project, Gandak HPS, Chatara and Phewa HPS are among them. Gandak HPS, constructed under the Gandak Treaty between Nepal and India, aims the irrigation of some portions of both countries and basically canal management comes under jurisdiction of Department of Irrigation of respective states of India. Similarly, water management for Chatara HPS built under Sunsari Morang Irrigation Project is under control of Sunsari Morang Irrigation Project. The priority of the irrigation requirement drives the operating hours of the power plants. Hence, though the availability of water in the river, the plant remains ideal for a long time hampering the energy generation.

3.10 Climate Change

Nepal has historically made minimal contributions to global warming, yet finds itself among the most vulnerable nations to its effects. The country is witnessing accelerated snow melt in the Himalayas, alongside other consequences of climate change such as reduced agricultural productivity, flash floods, and landslides. Given that water is the primary resource for hydroelectricity generation, the disturbance to Nepal's hydrological patterns due to climate change poses a substantial risk to hydroelectric projects. Consequently, the hydropower sector is exceptionally vulnerable to these climatic shifts. Moreover, hydroelectric projects, particularly large dam initiatives, come with significant environmental and social implications.

Hydropower plants being dependent on river discharge, the effect of climate change is a massive threat to it. The river discharge of snow and glacier based rivers is highly susceptible to temperature rise due to climate change.



Annual average Minimum temperature of Nepal

Source: Nepal Climate Summary, 2023 by Dept. of Hydrology and Meteorology, DHM

The depicted figure highlights the concerning trend of rising average minimum temperatures in Nepal over the past three decades. While this immediate increase may result in a temporary surge in river flow, the long-term implications suggest a potential decrease in river flow, ultimately affecting the generation capacity of power plants.

Adapting Wisely: Financing Nepal's Energy Infrastructure in Dynamic Regional Markets

Ram Krishna Khatiwada

"Crowdfunding democratizes investment opportunities, allowing citizens to directly contribute to the country's energy future and enabling a local community benefit-sharing approach."

Historically, Nepal's energy sector financing has predominantly focused on small to medium-sized projects, which have played a crucial role in laying the foundation of the country's energy infrastructure and supplying essential electricity to households and industries. Apart from the promoter's equity, a significant portion of this investment, approximately USD 4 billion, has originated from local banks and financial institutions, highlighting the nation's robust domestic investment capacity and dedication to developing its energy resources. Local banks, financial institutions, and government-associated funds have been instrumental in supporting these projects. To ensure a steady stream of funds into the energy sector, Nepal Rastra Bank, the central bank of Nepal has implemented directive lending provisions, mandating that banks allocate a certain percentage of their lending portfolios to energy projects, thereby ensuring continuous financial backing for the sector.

Looking forward, there's a noticeable trend towards financing medium to large-scale projects in Nepal, which reflects the country's ambition to undertake more substantial and impactful energy initiatives. These are crucial for meeting the nation's growing demand for energy, integrating with regional energy markets, and fostering sustainable economic development. Future energy projects must address broader local and regional market dynamics, environmental concerns, and social issues. Adopting a holistic approach to project assessment and funding will ensure that energy developments are sustainable and beneficial to the wider community. In the past, the market explored innovative funding mechanisms such as crowdfunding, project-specific bonds, and private equity. These leverage public participation and investment to potentially unlock new capital sources for energy projects. Crowdfunding democratizes investment opportunities, allowing citizens to directly contribute to the country's energy future and enabling a local community benefit-sharing approach.

To attain its ambitious energy production targets and facilitate exports to the regional market, Nepal must tap into varieties of funding sources. Traditional banks and financial institutions (BFIs) will retain their pivotal role, furnishing the backbone of financing for big projects owing to their established financial infrastructure and adeptness in managing substantial funds, rendering them dependable partners in energy development. Contractual saving entities such as the Employee Provident Fund (EPF), Citizens Investment Trust (CIT), Rastriya Beema Sanstha (RBB), and insurance companies boast substantial financial reserves, and they are being contemplated as significant funding sources, notwithstanding the inherent

risks, particularly for contractual saving institutions where funds are earmarked for future security. In addition to traditional and government-associated financing, Nepal will explore diverse funding avenues, encompassing international investors, development banks, and private sector investments. To facilitate this, Nepal should prepare for regional integration, where international financial institutions and investors are more amenable to assuming regional market-related risks, thereby enhancing market competitiveness. Acting wisely in this regard along with fostering competitive production practices, will be imperative. This diversified approach will serve to mitigate risks and ensure a consistent capital inflow for energy infrastructure financing.

Government Strategy: The 12-Year Plan

The Government of Nepal (GoN) is preparing a comprehensive 12-year plan, which aims at significantly boosting energy production and market expansion. The plan sets a target of producing over 28,500 MW of electricity by 2035. Achieving this target would mark a substantial increase from current levels, positioning Nepal as a major player in the regional energy market. To meet these ambitious targets, the plan requires over USD 46 billion in funding. This substantial financial requirement underscores the need for robust and diversified financing strategies. The 12-year plan will likely include detailed roadmaps for project implementation, financing models, and policy frameworks. This structured approach will help attract both domestic and international investors by providing clear guidelines and reducing uncertainties.

Nepal's energy sector stands on the brink of transformative growth. By shifting focus to larger projects, addressing broader market and environmental issues, and leveraging innovative funding mechanisms like crowdfunding, Nepal is setting a bold path forward. The government's comprehensive plan, targeting over 28,500 MW of electricity production by 2035, exemplifies this ambition. Meeting these targets will require a concerted effort from all stakeholders, including financial institutions, government bodies, private investors, and the general public. With a strategic approach to financing and a commitment to sustainable development, Nepal is poised to significantly enhance its energy production capabilities, driving economic growth and improving the quality of life for its citizens.

Nepal is at the cusp of an energy revolution, with ambitious plans to dramatically increase its electricity generation capacity and expand its market reach by 2035. This vision, however, comes with substantial financial requirements and a significant funding gap that must be addressed to ensure the success of these plans. This article examines the investment needs, potential funding sources, and strategies to bridge the funding gap in Nepal's energy sector.

Investment Requirement: A Herculean Target

Nepal's energy sector development plan is structured with detailed annual targets for both generating capacity and fulfilling the associated funding needs. The goal is to increase generation capacity from 3,000 MW in 2024 to 28,500 MW by 2035. This expansion requires substantial investments each year. For instance, the additional fund requirement for generation alone starts at USD 1.53 billion in 2024 and escalates to a cumulative USD 40.46 billion by 2035. Transmission investments, equally critical, begin at USD 0.38 billion in 2024 and total USD 6.31 billion by 2035. Combining these, the total annual investment starts at USD 1.91 billion in 2024 and summing up to USD 46.77 billion by 2035. These figures highlight the scale of financial commitment needed to achieve the projected growth in Nepal's energy sector. Given Nepal's GDP could reach around USD 113 billion, assuming a 10% nominal annual growth, achieving the investment target of USD 46.77 billion, which comprises a significant percentage of the GDP, represents a Herculean challenge.

Funding Sources: Falling Short of Targets

In a bid to bridge the substantial financial gap, Nepal aims to leverage a variety of funding sources, encompassing traditional BFI credits, directive lending, increased BFI investments, contractual savings, and innovative avenues like crowdfunding. However, despite the anticipated growth in directive lending from USD 3.84 billion in 2024 to USD 10.94 billion by 2035, alongside an expected rise in overall credit from USD 38.36 billion to USD 109.45 billion during the same period, these endeavors fall short of the required funding.

It is anticipated that contractual savings and equity/crowdfunding will also make significant contributions, adding USD 4.09 billion and USD 8.18 billion respectively by 2035. Nevertheless, even with this diverse approach to funding, it's evident that these sources alone are insufficient to address the extensive financial requirements of the sector. This presents a substantial challenge to Nepal's aspirations for growth in the energy sector, emphasizing the urgent need for alternative strategies or additional avenues of funding.

The Alarming Bell

The GoN has ambitious plans to export power to regional markets, particularly India and Bangladesh. However, rapid changes in the energy dynamics in India, particularly more focus on renewable energy and storage, pose significant challenges. On the other hand, Nepal has made little effort to make its energy prices competitive. While discussing energy pricing, the focus often remains on current prices, ignoring long-term power market trends, evolving technologies, and alternative mechanisms. Nepal's hydro-nationalism, rising costs, slow adaptation, and cost behaviors could result in a scenario where India might not be willing to purchase electricity from Nepal, leaving the water resources of the Himalayan country underutilized.

India's massive investment in storage capacity, including an announcement of an estimated addition of 140-200 GW of battery storage capacity by 2040, the largest for any country, further complicates the situation (Source: IEEFA Report). Additionally, India plans to add 18 gigawatts of pumped hydro storage by 2032.

Given India's expanded renewable energy goals and its considerable geopolitical dominance in the area, there's an anticipation of it exporting renewable energy to Bangladesh as well. This dynamic shift underscores the urgent need for Nepal to review its strategies and enhance its energy sector's competitiveness, rationality, and speed of delivery to stay pertinent in the regional market.

Adapting Wisely: before it becomes a mere dream

There's no dispute about Nepal's abundant river resources for generating power, but until its benefits are realized, it remains just a dream. Given the changing dynamics in the regional market, including massive investments in alternative storage mechanisms and the significant financial resources required for Nepal's energy sector development, a cautious approach is essential due to the increased dependency on the regional market to raise large amounts of capital. Government and stakeholder actions should focus on necessary interventions and reforms to address the financing gap and promote sustainable energy development. Key steps include emphasizing project-specific benefits sharing modalities, issuing green bonds, developing the debt market, exploring alternative financing mechanisms, encouraging private sector participation in transmission and trade, and fostering a conducive investment environment. "ADAPTING WISELY" should be the primary agenda for financing Nepal's energy infrastructure in these evolving regional markets.

- **Project-Specific Benefits-Sharing Mechanism**
  The current uniform approach to benefit-sharing, particularly regarding free energy, requires re-evaluation due to the significant differences among hydroelectric projects in terms of hydrology, geology, transmission, accessibility, and social and environmental impacts. A one-size-fits-all strategy is inadequate. The recent MOU with the larger Indian PSU, which applies the same 21.90% free energy mechanism to develop projects, including storage, could undermine development due to financial viability issues. This concern is substantiated by their recent letter to the government expressing reservations about the project delivery after investing a substantial amount of time. This situation not only affects project viability but also triggers social outcry and media scrutiny. Therefore, it is recommended to develop project-specific benefits-sharing modalities. This approach involves comprehensively assessing the costs and benefits of each energy project to ensure economic, social, and environmental impacts are evaluated transparently. Tailoring the benefits sharing to each project's unique characteristics will help optimize resource allocation, enhance stakeholder engagement, and promote sustainable development. Specifically, adjusting the current provision of 21.90% free energy to the government based on the project's specifics is crucial for the viability and long-term success of future storage projects.
- **Green Bonds and Financing**
  Green bonds are pivotal in financing environmentally sustainable projects, including renewable energy initiatives. By initiating green bond issuances, governments, and financial institutions can attract investments for green infrastructure projects while aligning with climate change mitigation goals. It is essential to remove barriers to green bond issuance and offer competitive interest rates to incentivize investor participation in sustainable energy financing. This will not only provide the necessary capital for green projects but also demonstrate a commitment to sustainable development practices.
- **Development of the Debt Market**
  The development of a robust debt market is vital for mobilizing capital for energy projects from both the government and private sectors. Issuing project-specific bonds can fund energy infrastructure developments, leveraging the vast resources of the global debt market. Promoting debt market development will diversify financing sources, reduce dependency on traditional funding avenues, and unlock capital for energy sector expansion. A well-developed debt market can provide the necessary financial support to meet the ambitious energy targets set by Nepal.
- **Alternative Financing**

Mechanisms

In addition to traditional financing methods, it is crucial to promote alternative mechanisms, such as Funds, PPPs, Hybrid Annuity models, and green financing. Encouraging innovation in financing structures and instruments will catalyze investment in sustainable energy solutions, drive technological advancements, and accelerate the transition towards a low-carbon economy. By exploring these alternative financing avenues, the government can enhance the availability of capital for energy projects and foster a more dynamic investment environment.

- **Private Sector Participation in Energy Transmission and Trade**

  Encouraging private sector participation in energy transmission and trade is essential for enhancing efficiency, promoting competition, and expanding the energy market. Introducing investment modalities like Hybrid Annuity models and Minimum Revenue Guarantees (MRGs) on wheeling charges can attract private investments in energy infrastructure projects. By fostering a conducive regulatory environment and offering incentives for private sector engagement, the government can stimulate growth in the energy sector. Private sector involvement will bring in expertise, efficiency, and additional financial resources necessary for the sector's development.

Conclusion

Given the intricate energy dynamics in the region, particularly India's strong focus on renewable energy and storage, alongside Nepal's ambition to export power to neighboring markets, it's crucial to approach energy financing with prudence and innovation. The significant investment required to meet Nepal's energy generation targets by 2035, coupled with evolving market trends and concerns about future demand, underscores the urgency of the situation. Nepal must address its competitive energy pricing, adapt to changing technologies, and overcome hydro-nationalism to remain relevant in the face of India's growing energy capacity. Additionally, India's plans for massive storage capacity further complicate Nepal's energy landscape. In light of these challenges, Nepal must adapt wisely. This entails strategic government interventions, policy reforms, and collaborative efforts with stakeholders to bridge the funding gap and promote sustainable energy development. Initiatives such as project-specific benefits sharing, green bond issuance, debt market development, and private sector involvement in transmission and trade are key steps in this direction. "ADAPTING WISELY" serves as a guiding principle for financing Nepal's energy infrastructure in these evolving regional markets, ensuring prudent decision-making and long-term sustainability.

The writer of this article is the former Chief Executive Officer of Nepal Infrastructure Bank Limited

Accelerating Momentum in Energy Sector Investment

Dinesh Dulal

Out of the total loan portfolio of Rs 5,113 billion, Rs 357 billion, equivalent to approximately seven percent, has been specifically directed towards investments in the energy sector.

The Nepalese energy sector is pivotal in driving the country's economic development. Endowed with abundant renewable energy resources, Nepal has the potential to significantly enhance its energy security and address trade imbalances through the strategic development of its energy sector. Renewable resources offer sustainable alternatives to fossil fuels and present opportunities for expanding clean energy generation. By harnessing its renewable energy potential, Nepal can strengthen its energy security by providing essential energy resources that power industry, transportation, households, and various sectors crucial to economic activity. Diversifying energy sources reduces dependency on imported fuels, enhances resilience against supply disruptions, and stabilizes domestic energy prices.

Developing the energy sector, mainly through renewable energy exports, can help Nepal manage trade imbalances. Revenue generated from energy exports can contribute positively to the country's economic growth and stability. Recent initiatives and policies promoting renewable energy and enhancing energy infrastructure underscore Nepal's commitment to sustainable development. These efforts include expansions of hydropower projects, investments in solar energy, and improvements in energy efficiency. Ongoing developments in the sector reflect a proactive approach towards sustainable energy practices and economic resilience in Nepal.

In essence, investing in the energy sector, particularly in renewable resources, not only promotes sustainable development but also catalyzes broader economic benefits. It supports job creation, technology innovation, and infrastructure development while mitigating environmental impacts by laying a robust foundation for long-term economic prosperity and energy independence.

The recent developments witnessed in Nepal's energy sector appear promising and significant. Here is a breakdown of the key points:

1. **Nepal-Bangladesh Electricity Ties**

   The approval by the Government of Bangladesh to import 40 MW of hydropower from Nepal by using Indian transmission network, it marks a significant milestone. The next step is to finalize a trilateral agreement involving Nepal, India, and Bangladesh.

   This bilateral and trilateral agreement can strengthen energy ties between the two countries, potentially leading to further collaborations in the future. Through this breakthrough, the energy trade

will now expand to the second South Asian energy-hungry country that can consume bigger capacity in the future. However, the dependency is still with neighboring country India because Nepal has to use the transmission infrastructure of India to export its power to Bangladesh. The initiative will be a stepping-stone for the long-discussed concept of a regional energy grid in South Asia. A connected grid can facilitate smoother energy trade, optimize resource utilization, and enhance grid stability across neighboring countries. The regional energy integration in South Asia will foster broader cooperation and lay the groundwork for future energy security and economic growth. This aligns with regional cooperation goals and can pave the way for broader economic ties.

2. **Shift in Peak Energy Demand and Transition towards Green Economy:**

Record-high temperatures are becoming increasingly common globally, reflecting a broader trend of climate change. These rising temperatures have significant impacts on weather patterns, ecosystems, and human societies. The global challenge of soaring temperatures is affecting countries worldwide, including Nepal. Summer months are becoming hotter, leading to increased heat stress on infrastructure, ecosystems, and human health. The rising temperatures contribute to an increased demand for cooling, known as the cooling load. In Kathmandu Valley and other areas, this translates into higher electricity consumption for air conditioning and cooling systems, placing additional strain on energy resources and infrastructure.

The Government of Nepal's initiatives to promote electric transportation and electric cooking marks significant steps towards achieving a green economic transition. By incentivizing electric vehicles through policies such as import tax incentives, Nepal is encouraging a shift towards cleaner transportation options. EVs reduce reliance on fossil fuels, lowering greenhouse gas emissions and improving urban air quality. Promoting electric cooking appliances, such as electric stoves and induction cooktops, reduces reliance on traditional biomass or fossil fuel-based cooking methods. This transition not only improves indoor air quality and reduces health risks associated with traditional cooking fuels but also aligns with Nepal's goals of reducing carbon emissions. Thanks to the scorching heat and the Government's initiatives to transition towards electric transportation and cooking, Nepal's peak energy demand crossed a record high of 2,300 MW. This shift of peak energy demand from the traditional festive day of Laxmi Puja to the hotter day of June indicates an increasing demand for reliable energy supply.

3. **Exponential Investment**

As of mid-May 2024, the total loans extended by banks and financial institutions in Nepal amounted to Rs 5,113 billion, marking an increase from Rs 4,880 billion recorded at the start of the fiscal year. This growth represents a 4.77 percent rise in loan volume over the period. Out of the total loan portfolio of Rs 5,113 billion, Rs 357 billion, equivalent to approximately seven percent, has been specifically directed towards investments in the energy sector. This allocation underscores the significant role of financial institutions in supporting energy-related projects and initiatives in Nepal.

What stands out is the robust growth rate observed within the energy sector investments during this fiscal year. At 16.12 percent, the growth rate in investments within the energy sector is notably high compared to the overall industry's loan growth rate of 4.77 percent. It indicates a focused effort and increased financial backing toward enhancing Nepal's energy infrastructure, possibly driven by initiatives to expand renewable energy projects and meet growing energy demands sustainably.

This strategic allocation of loans towards the energy sector not only supports infrastructure development but also aligns with broader national goals of energy security, sustainability, and economic development. It reflects a proactive approach taken by Nepal Rastra Bank and the banks and financial institutions to channel resources into critical sectors that can drive long-term socio-economic benefits for Nepal by setting directed lending targets in the energy sectors. The banking sector has to invest a minimum of 10 percent of its portfolio in the energy sector itself by the end of fiscal year 2026/27.

4. **Reliable Electricity for Industrial Sector:**

The unreliable electricity supply from the Nepal Electricity Authority (NEA) disrupts industrial operations significantly during the dry season. Industries rely heavily on consistent power supply to maintain production schedules, ensure product quality, and meet customer demands. When electricity is not dependable, it directly affects productivity and operational efficiency. The inability to rely on consistent electricity forces many industrial units to shut down operations intermittently. This not only leads to lost production time but also incurs financial losses. To mitigate these disruptions, some industries use fossil fuels like diesel generators, which are costly and environmentally detrimental. This undermines efforts towards sustainability and increases operational costs.

In today's global economy, competitiveness hinges on efficient energy use. The industries that can access reliable and affordable electricity are better positioned to meet market demands and compete effectively. The unreliable energy supply puts Nepalese industries at a disadvantage compared to counterparts in countries with stable electricity grids. The challenges faced by NEA in providing reliable electricity stem from infrastructure limitations, maintenance issues, and sometimes inadequate policy support. Addressing these challenges requires substantial investment in upgrading infrastructure, implementing effective maintenance practices, and formulating policies that incentivize sustainable energy practices. To support industrial growth and competitiveness, Nepal needs to prioritize enhancing energy reliability. This involves improving grid infrastructure, investing in renewable energy sources such as hydropower and solar, and implementing smart grid technologies to manage energy distribution in a better way.

Government-industry collaboration is crucial to developing and implementing strategies that ensure a consistent and sustainable energy supply for industrial operations. Addressing the challenges of unreliable energy supply is essential for Nepal to foster industrial growth, enhance economic competitiveness, and achieve sustainable development goals. By investing in reliable energy infrastructure and promoting renewable energy solutions, Nepal can support its industries in becoming more resilient and competitive globally.

5. **Ambitious Plan**

The Government of Nepal has set an ambitious goal to achieve net-zero status by 2045, marking a pivotal shift towards sustainability. Central to this objective is developing 15,000 MW of energy infrastructure by 2030, a key priority area outlined in Nepal's strategic planning.

Additionally, the Ministry of Energy's Energy Roadmap details comprehensive plans to expand energy projects, aiming to develop approximately 28,500 MW of energy generation capacity by 2035. This roadmap can serve as a clear trajectory for Nepal's energy sector, emphasizing substantial growth in energy production capabilities over the next eleven years. The ambitious expansion in energy infrastructure not only supports Nepal's journey towards net-zero emissions but also creates significant investment opportunities within the energy sector itself. This increased demand for investment underscores the critical role of both domestic and international financial institutions in supporting Nepal's energy sector development.

Overall, these strategic initiatives not only enhance energy security and sustainability but also contribute to economic growth and resilience, positioning Nepal as a leader in sustainable development within the region and globally.

6. **Strong Rally in Secondary Market**

Despite significant challenges, including weak regulatory oversight, financial losses, opaque financial practices, and corporate governance issues within hydropower companies, the hydropower sector has demonstrated a remarkable surge in its stock market index on the Nepal Stock Exchange in recent years.

This upward trend reflects a strong vote of confidence from public investors in the energy sector. It has enabled companies to raise capital through equity offerings in the capital market, which is essential for financing substantial energy infrastructure projects. Capital formation, facilitated by this investor confidence and market rally, plays a pivotal role in scaling up investment in larger and more impactful energy

infrastructure in future.

Moreover, the resilience of the hydropower sector in attracting investment amidst challenges highlights its strategic importance in Nepal's energy landscape and its potential role in achieving broader economic and sustainable development goals. Despite facing multiple hurdles, the strong performance of the hydropower index in the Nepal Stock Exchange underscores the sector's attractiveness to investors and its pivotal role in advancing Nepal's energy security and infrastructure development.

7. Conclusion

Nepal's energy sector plays a crucial role in driving economic growth and sustainability, mainly through its abundant renewable energy resources. The country's strategic initiatives, including the Nepal-India and Nepal-Bangladesh Electricity Trade Agreement, highlight efforts towards regional energy integration and stability. These developments not only strengthen energy trade within South Asia but also pave the way for broader economic cooperation. The strong performance of the hydropower sector in capital markets reflects investor confidence and supports significant infrastructure investments crucial for economic development. Looking ahead, Nepal's Energy Roadmap outlines ambitious plans to increase energy generation capacity, positioning the country as a leader in sustainable energy practices by 2035. Continued investment in infrastructure, technology, and policy frameworks will be essential to achieving these goals and ensuring a reliable energy supply for industrial and domestic consumers and cross-border electricity trade.

In summary, Nepal leads sustainable energy development in South Asia, with its energy sector poised to drive economic resilience and prosperity. Banks and financial institutions have played a pivotal role in supporting these initiatives, directing substantial investments toward the energy sector. This strategic allocation underscores the critical role of financial institutions in driving infrastructure development and economic growth. By leveraging renewable resources while promoting regional cooperation, Nepal has moved forward to establishing a robust foundation for long-term economic growth and energy independence. Continued investment in infrastructure, technology, and policy innovation, facilitated by financial institutions, will be pivotal in achieving these goals and securing a sustainable future for generations to come.

In Nepal, the energy sector's expansion and modernization heavily rely on robust financial support from banks and financial institutions. These entities play crucial roles in providing the necessary capital to fund large-scale energy infrastructure projects. This shows that the financial sector's commitment to supporting the energy sector's growth and sustainability initiatives.

The financial support provided by banks facilitates the development of various energy projects, including hydropower, solar, and other renewable sources. These investments are essential for expanding Nepal's energy generation capacity, enhancing energy security, and promoting sustainable development practices. By mobilizing necessary funds into energy infrastructure, financial institutions can contribute to job creation, technological advancements, and overall economic growth.

Moreover, the strategic allocation of funds toward energy projects demonstrates a proactive approach to addressing Nepal's energy needs. It enables the country to reduce reliance on imported energy sources, stabilize domestic energy prices, and improve energy access across rural and urban areas. The financial sector's involvement also fosters public-private partnerships and encourages international collaborations while leveraging expertise and resources for more efficient project implementation.

Finally, the role of bank financing in Nepal's energy sector is pivotal for achieving long-term economic growth and energy independence. Continued investment in energy infrastructure, supported by banks and financial institutions, will be crucial in advancing Nepal's sustainable development goals and ensuring a resilient energy future for upcoming generations.

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Rahul Shah

Building Sustainable Energy Ecosystem in Nepal and Introducing Disruptive Technology

CHAPTER 1

"The Himalayan glaciers are melting in Nepal and 1.5-degree limit is only possible if we; not reduce, not abate but phaseout fossil fuels." ***UN Chief, COP28***

1.1 Introduction

Numerous developing nations grapple with power shortages, and until FY2018, Nepal, despite its mountainous and landlocked terrain, was no exception. However, the country's energy landscape has undergone a significant transformation since then, transitioning from an era of electricity crises to surplus. Recognizing energy's pivotal role in national development, it is imperative that the government prioritizes its growth and sustenance through legislative frameworks, policy stability, and robust institutional support, while fostering a conducive environment for private sector participation. A reliable supply of electricity is fundamental to the prosperity and sustainability of any economy.

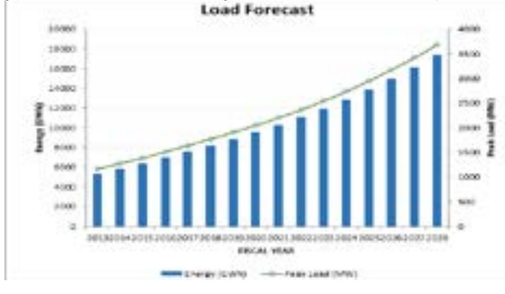
In Nepal, energy resources are categorized into three main types: traditional, commercial, and alternative sources. Despite the escalating demand for electricity, which increases by 10-15 percent annually, the incorporation of renewable energy into the national grid remains disproportionately low. Consequently, Nepal relies on electricity imports from India, particularly during the winter months when domestic deficits are pronounced. Despite possessing significant hydropower potential, only a fraction of it, approximately 5 percent, has been harnessed due to the complexities involved in investment. Biomass predominates Nepal's energy mix, highlighting a concerning reliance on oil and LPG imports to meet energy needs. The transportation sector, a major consumer of energy, primarily relies on petroleum products. With the escalating costs of LPG and petroleum, the shift towards more cost-effective renewable sources becomes imperative. The development of hydropower projects and the exploration of alternative sources such as solar, wind, hydrogen, biogas, and biomass are critical long-term strategies to address the prevailing energy crisis.

Traditional energy production methods reliant on hydrocarbons cannot be hastily expanded in a sustainable manner. Pursuing such conventional approaches risks undermining economic gains through ecological degradation. Thus, the solution to the energy challenge lies in harnessing energy sources sustainably. International initiatives like SE4ALL underscore this approach, focusing on renewable energy sources and environmentally friendly technologies. Nepal's participation in this initiative since FY2012 presents an opportunity to export clean energy to neighboring countries like India and Bangladesh, potentially replacing a significant portion of fossil fuel consumption.

CHAPTER 2

1.1 Current Situation

There is unanimous agreement *among policymakers and experts that the swift adoption of clean energy is the sole remedy to confront the escalating reliance on fossil fuels within the country. In Nepal, both peak-power and annual energy demand have surged by 8 and 12 percent respectively, propelled by rapid urbanization and rural electrification efforts. Over the past seven years, energy consumption has nearly doubled; however, the per-capita electricity consumption of Nepalese stands at a modest 380 units, ranking among the lowest in Asia. Presently, approximately 93% of the population enjoys access to electricity, with a distribution ratio of 96% grid-connected consumers to 4% off-grid consumers. The Nepalese government-owned public sector entity, NEA, assumes the role of the primary supplier and distributor of electricity, operating within a monopolistic framework characterized by a 'single buyer – single seller model.' Projections based on the load forecast over the past decade and data from the Integrated Power System FY2023 reveal that the domestic* power system's peak load, inclusive of exports to India, exceeds 2500MW.



Source: NEA Annual Report 2013

Figure 1: Energy Load Forecast (FY2013-2028)

The Ministry of Energy, in collaboration with its implementing agency NEA, has established an ambitious goal for the upcoming 12 years: to quadruple the consumption of clean electricity.

Table 1: Strategy Review Template for 2035 (GoN 12th Year Plan)

Strategic Initiative	Key Performance Index (KPIs)	Performance relative to each KPI	Value Proposition.
Energy Generation (NEA & IPPs)	- 28,713 MW of hydropower installed capacity. - 15,000 MW electricity export to neighboring countries i.e. India & Bangladesh.	- Current installed 2,539 MW & under construction approximately 3,500MW. - Current export to India 452MW.	- Extension of limited validity of Survey licenses. - Arrangement of $ 46.5 billion and $ 8 billion for generation projects. - Creation and employment of 6,000 skilled and 25,000 general workers. - Amendment of import/ export guidelines by India to facilitate a higher volume of export above the current permission of 630 MW.
Energy Transmission (Domestic & Cross Border)	- Increase 200kV and 400kV transmission lines (5610km) - Expand 132 k V facility to 17,446 circuit kms.	- Approximately 3,600km is of 132kV, 800km of 220kV and 78km of 400 k V. - Under construction 754km of 400kV.	- Implementation and review of Transmission expansion master plan. - Arrangement of $5.5billion for transmission projects. - More X-border facilities to facilitate enhanced trade.
Energy Distribution	- Per capita electricity consumption 1500 units. - Substation capacity to be upgraded to 40,000MVA. - Reduce and maintain the system losses within 5~ 10%.	- Per capita electricity consumption 380 units. - Substation capacity 8867MVA and under construction 10,470MVA - System losses 13.46% by the end of F/Y 2022/23.	- Arrangement of $1.2 billion Investment for improving distribution infrastructure to facilitate higher per capita consumption, better quality of supply and reduction of distribution losses. - Introduction of state of art technologies in distribution business by privatization through direct divestment or franchise model.
Alternate Energy (On-grid/Off-grid)	- Composition of other renewable in the energy mix of grid supply to be 10%. - SDG target to limit LPG for cooking below 40%, electric cooking 25% of household - 100% access to electricity.	- Alternate Energy in operation: Solar – 86MW and Bagasse – 6MW - LPG cooking is 44.3% & increasing trend. - Micro hydro-plant (4.5MW), biogas plants, wind power, solar homes system.	- Optimizing the energy mix for risk mitigation against hydropower vulnerability - Tariff and connection slab of 5 A to be eliminated and corresponding house wiring to be improved for higher slab. - Off-grid Rural Electrification through innovative technologies may also be viable for low demand areas.

Source: Energy Development Roadmap and Action Plan 2080., NEA, 2023.

1.1.1 Energy Generation

The collaborative efforts of NEA and independent power producers (IPPs) have yielded a total generation capacity of 2,684MW, primarily driven by hydropower, supplemented by solar, thermal, and bagasse sources. However, notable declines in hydropower output during dry seasons necessitate imports, whereas surplus energy during wet seasons facilitates exports to India.

Nepal views sustainable hydropower as pivotal to its transition towards clean energy, leveraging its abundant rivers for dam construction to meet energy demands domestically and for export to neighboring countries like India and Bangladesh. The Government of Nepal (GoN) is resolute in its commitment to advancing this agenda, embarking on multiple hydro projects and harnessing water resources for electricity generation as outlined in the Electricity Development Decade Plan. With substantial investments pledged by the GoN, private sector entities, Nepali migrants, foreign direct investments (FDIs), and through general public IPOs, NEA has allocated 90% of the national grid capacity to hydroelectric power.

1.1.2 Energy Transmission

The lack of clarity regarding transmission connectivity, both nationally and across borders, has raised concerns among power developers. Without adequate power evacuation infrastructure, many Power Purchase Agreement (PPA) concluded projects have been unable to commence construction. The FY2014 budget highlighted the prioritization of transmission line construction by the Government of Nepal (GoN). It became evident that without the addition of 200/400kV transmission lines, the existing grid capacity, primarily comprising 132kV lines, would be insufficient to accommodate additional megawatts of electricity for two key reasons: power evacuation and system stability.

In response, NEA has undertaken the development of several kilometers of high-tension lines and has laid out ambitious plans to construct over 1000 km of 200 kV and 400 kV transmission lines. These efforts aim to enhance the grid's capacity, allowing for the transmission of over 300-400MW and 1,200MW of electricity through single-circuit lines, respectively.

1.1.3 Energy Distribution

NEA manages approximately 90% of power distribution in Nepal. Despite experiencing a high system loss of 24% in FY2013, NEA implemented rigorous measures to reduce it to less than 14% by FY2023. Discussions with NEA have revealed their openness to private-sector involvement in metering, billing, and transformer upgrading initiatives. Projects such as computerized billing and smart metering have been instrumental in implementing a standardized and improved billing system across all revenue collection centers of NEA, enhancing efficiency and cost-effectiveness. These initiatives have contributed to minimizing human errors during meter reading, reducing operational expenses, and fostering better relationships between NEA and its consumers.

1.1.4 Alternate Energy

In addition to hydropower, Nepal boasts significant renewable energy (RE) resources, including solar, various forms of biofuels, and wind, which can be harnessed to supply commercial energy to the national grid or rural communities. It is estimated that Nepal has the potential to develop over 100MW of micro hydropower, 2,100MW of solar power, and 3,000MW of wind power. Additionally, there is potential to install another 1.1 million domestic biogas plants.

The Government of Nepal (GoN) has responded to climate change with ambitious targets aimed at increasing the share of renewable energy in the energy mix to up to 10%. Multiple power purchase agreements (PPAs) have been concluded on solar and biomass energy between NEA and independent power producers (IPPs), demonstrating the significant potential of these sources to contribute to the renewable energy transition sector.

1.2 Situation Analysis

While Nepal boasts a high access rate of electricity at 95%, the quality of supply remains a pressing concern. To gain deeper understanding into the external dynamics shaping Nepal's energy sector bottleneck and to pinpoint macro-environmental factors influencing its development, a PESTEL analysis proves invaluable. Despite widespread recognition of the necessity for investment, formidable barriers obstruct progress. These barriers span across political, legal, governance, institutional, commercial, and financing realms, all of which warrant thorough examination within the following framework.

Table 2: PESTEL Analysis on Current Energy Sector Outlook of Nepal

Political (P)	Economic (E)	Social (S)
- Lack of political consensus on energy cross-border trade - Discouraging commitment to support private-sector participation - Lack of adequate security to personnel and facilities at plant sites - Fragile governance, although 'Zero Tolerance' policy adopted - Political intervention within executing agencies (DOED, NEA) resulting to inadequate planning	- Petroleum products and electricity tariff are strictly regulated by the government - Creditworthiness of NEA and monopoly on PPA mechanism with IPPs - Access to Capital and need for FDI - Underdeveloped long-term bond market - Price hike of construction material and equipment, due to delay of the project - Tariffed insurance premium to the IPPs	- Labor issues/unions and existing skill sets - Access to land acquisition for construction of Generation and Transmission projects - Local obstruction at the project site demanding for charity shares and jobs - Dam construction can impact disruption of river ecosystem
Technological (T)	**Environmental (E)**	**Legal (L)**
- Inhibited advent of advanced technologies - Lack of R&D and innovation on RE - Concerns on RE Connection to the gird & storage during off-peak hour - Lack of technical know-how causing delay in project construction - Digitalization of electricity services	- Difficult mountainous terrain and poor infrastructure - Challenges for forest/wildlife restoration and environment conservation - High risk of natural calamities troubling project operations	- Unstable integrated policy and regulatory framework - Independent functioning of NEA and reforms - If PPA signing in USD, there is no clarity on hedging mechanism - NRB lack clarity and legal policy on Green Finance Taxonomy & long-term infrastructure bonds

Political - At the political level, fundamental differences and a lack of consensus persist regarding the use of natural resources and bilateral treaties concerning power trade. While new projects have been contracted, the Government of Nepal (GoN) has yet to finalize agreements for electricity exports to India surpassing 600MW. Conversely, the GoN has agreed to initiate 40MW of clean electricity trade with Bangladesh through a trilateral mechanism, contingent upon the approval of utilizing an 18km Indian grid connection linking Nepal and Bangladesh.

Economic - Electricity Tariff Fixation Committees (ETFCs) in Nepal are grappling with safeguarding public interests against electricity tariff adjustments. This inaction has severely impacted the creditworthiness of the Nepal Electricity Authority (NEA) in addressing foreign currency and payment risk guarantees. Operating as the single purchaser of electricity in a multi-seller market, NEA's ability and willingness to pay during Power Purchase Agreement (PPA) negotiations significantly influences the bankability of independent power producers (IPPs). Discussions with the Nepal Bankers' Association (NBA) revealed that collective guarantees from Nepali commercial banks only cover up to 100-150MW of hydropower generation, underscoring the necessity of international debt financing and foreign direct investment (FDI) as crucial external capital sources.

Social - Nepal's labor market is characterized by rigidness and a lack of skilled workers, exacerbated by union-led unrest, posing significant challenges to investment. The GoN has struggled to develop energy market-oriented Technical Education and Vocational Training (TEVT) programs, which could potentially retain skilled youth from seeking employment abroad.

Technological - Public institutions in Nepal have neglected research and development (R&D) culture and technology transfer, hindering innovation. Restrictions on international tech startups investing in the country have further stifled technological advancements. Additionally, the absence of proper energy storage technology for power generated from alternative sources during off-peak hours discourages the construction of new projects. However, the recent approval of the 'NEA IT Policy 2023' enables the Corporation to introduce digitalization through online portals and mobile applications for bill payments, complaint reporting, and accessing information on power supply.

Environmental - Nepal faces heightened climate risks despite its negligible contribution to greenhouse gas emissions. Natural calamities along Himalayan rivers and hydrological changes have impeded many hydropower operations and compromised national grid stability. The country's struggle with transmission infrastructure facilities is exacerbated by Right of Way issues, causing power evacuation delays due to deforestation of rainforests.

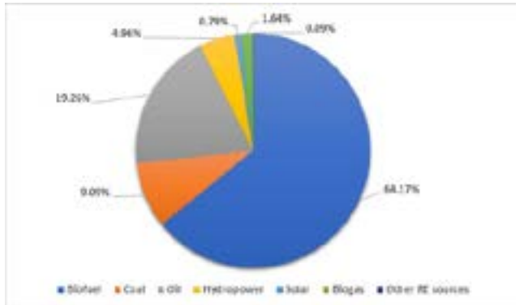
Legal - While legislation such as the Hydropower Policy 1992 and Electricity Act 1993 encouraged participation in electricity generation, subsequent policy revisions have encountered setbacks. The Electricity Act 2008 went unendorsed by Parliament, and a withdrawal from the National Assembly by the energy minister in FY2022 further complicated the regulatory landscape.

NEA's monopoly and the absence of a cartel in the energy market have raised governance concerns, while the sensitive topic of resource unbundling has been hindered by strong trade union opposition.

CHAPTER 3

3.1 Energy Consumption Scenario

Energy consumption in Nepal during FY2022 reached to 640 Picojoules, largely dominated by biofuels in the form of firewood, agricultural waste and animal dung. The commercial fossil fuels (petrol, diesel, LPG, coal, etc.) has been consistently increasing with the share of 28.35%, while hydropower connectivity to the electricity grid has also been accounted on the increasing trend for coming FY. Unfortunately, alternate energy contribution to the total energy mix has been minimal of 2.5% but observed on more increasing pattern than commercial fuels.



Source: WECS, 2023.

Figure 2: Overall Energy Consumption in Nepal (FY2022)

3.2 Sustainable Energy for Nepal

Policy and regulatory unpredictability consequent to political uncertainty, sub optimal utilization of government budget, limited capacity of institutions, labor issues and limited access to finance are the common concerns faced by energy sector in the country that need to be addressed to promote SE4ALL. Based on a certain scenario projection for the Nepalese economy to meet the country's development needs of 26% energy mix by 2030, is required from the clean electricity. Christensen's Disruptive Technology Model (1995) describes how new RE technology expansion can lead an energy industry of Nepal and transform the way their product/services are delivered from fossil fuel dependency.

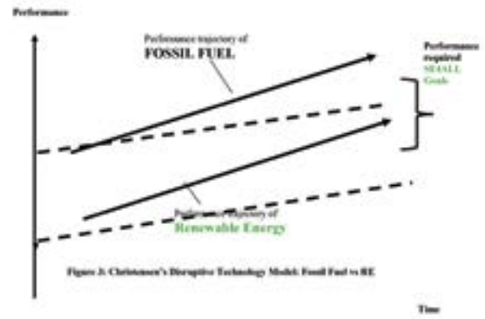


Figure 3: Christensen's Disruptive Technology Model: Fossil Fuel vs RE

Innovation in RE has been induced by a demand pull (climate change) or supply push as new technology typically arrives in the market as a 'bundle of possibilities'. Nepal to achieve SE4ALL initiative Net-Zero by 2045, rigorous progress should be made on the Action Areas platform and its linkages. Today, RE capture (including hydropower) in the market has a very low performance (below 10%); thus, GoN should put an effort through assembling dynamic capabilities to steadily improve their market share against fossil fuel.

3.3 Recommendations on Transforming the Sustainable Energy Ecosystem

The external diagnostic tools discussed in earlier chapter elaborates that the RE business environment in Nepal has been more static and require new ways of thinking with continuous improvement. In the country with increased level of uncertainty on fossil fuel, the framework comprising of dynamic capabilities Sensing, Seizing, and Shaping should be beneficial for the transformation of RE's competitive advantage. Therefore, GoN has to concentrate on enabling the following implications for scenario planning of possibilities, utilizing the resources, and eventually architecting the idea and constructing real-world outcome.

Table 3: Development of the Renewable Energy Ecosystem Embedding Dynamic Capabilities

SENSE (Generate Scenario Planning)	SEIZE (Re-engineering/Innovation)	SHAPE (Transforming Change)
Promoting Electricity for Cooking	- Upgrade NEA infrastructure from 5Amp to higher, for 50% of the population - Installing all homes and businesses to use TOU meters	- As MECS ranked Nepal 2nd among 130 countries for electric cooking viability, GoN has set target to the households (Gurung, 2023)
Utility-Scale Alternate Energy Solutions for Energy Mix	- Solar: Link large generation to the grid for minimizing risk of climate change - Solar rooftop panels adopted by commercial/industrial/household unused electricity can be sent to utility - Wind: Prediction of 3GW and winter as peak season - Biomass: Nearly half of the landmass of Nepal is covered by forest - Biogas: Use incinerator technology for converting waste-to-energy	- Regulatory landscape, grid stability and policy environment - NEA to introduce innovative grid storage mechanism and encourage energy-efficient community - Connection to the national grid and utilize the possibility of net-metering - Technology and funds from GoN for production of above ground dried biomass - GoN to promote PPP model for municipality waste management
Expansion of the Grid Infrastructure	- Maximize 400kV transmission lines for power evacuation - Private sector to construct transmission line projects: BOOT model	- Creating right condition for trading power across borders - GoN policy revision and NEA action plan to pave the way
Large Scale RE for Electricity	- Nepal requires multiple buyer market for clean energy transition	- Ensuring an amendment on policy and right project framework
Sectoral Outlook for Reduction in Oil Consumption	- Transportation: GoN mandate EV charging stations for new gas stations - Agriculture: Clean technologies i.e., wind farm and geothermal heating - Industry: Support expansion of more dedicated feeders	- GoN targets 60% of EV market for public passengers by 2030 (Gurung, 2030) - AEPC to empower innovative technology and Donor's funding program; Banks/GoN to arrange micro-financing options - NEA to provide electricity tariff subsidy for limiting coal and diesel usages

3.3.1 Promoting Electricity for Cooking

Electricity for cooking is a very important aspect for mitigation measures, adaptation and convenience building. As GoN sets a target to increase electric cooking for 25% household, this initiative can definitely reduce some extent of $500million LPG import cost. After upgrading residential infrastructure to higher capacity, NEA needs to install Time of Use (TOU) meters for charging different rates during peak hours and minimizing the high loss of generation during off-peak hours.

3.3.2 Utility-Scale Alternate Energy Solutions for Energy Mix

Solar Power

Nepal is blessed with more than 300 days of sunshine and a right condition for Solar energy generation. However, the 770MW survey license of the developers are still in dilemma because (i) discouraging PPA rates (reverse model) (ii) green land availability (iii) grid connectivity (iv) knowledge among policy makers.

Therefore, without encouraging PPAs, policy subsidies, infrastructure connectivity for transmission and storage of energy, the economics of solar power development won't be competitive for sustainable solution. One wild idea, in absence of green land an innovative cutting-edge technology as Floating Solar Panels can be possibly adopted by IPPs over the wetlands.

Wind Power

Although, some potential areas have been identified from both the government and private sectors, lack of power evacuation and policy for purchasing of the electricity has been a bottleneck. Small scale wind power is going to grow exponentially during winter season in Nepal (hydro-dry season); thus, NEA should allow wind power connection to the grid and explore the possibility of net-metering because individuals can sell excess energy back to the utility.

Biomass & Biogas

Nepal has done a sizeable progress in replacing coal by briquettes and pellets produced from above-ground air-dried biomass available on the forest's landmass.

According to CBS report, total solid waste generated by 276 municipalities in Nepal annually, around 39% is organic waste. Using incinerator technology such organic waste can be converted to biogas (waste-to-energy) on PPP model to reduce partial import of LPG.

3.3.3 Expansion of the Grid Infrastructure

NEA's concentration has mainly been the run-of-the-river type projects that generate maximum hydro-electricity during monsoon but production goes down drastically in subsequent months. To further reduce fossil fuel trade deficit with India, GoN has to rigorously pursue diplomacy channel to sell excess electricity not being restricted to any MW figures. Another wild idea can be on paving the partnership for electricity trade with land connecting neighbor, China, which can certainly bolster Nepal's foreign currency exchange.

NEA should work to prepare an action plan for attracting private sector to construct transmission line projects under the BOOT model following suitable international examples. The plan can also define to what extent the role and capital of the private sector can be accepted for the development of transmission infrastructure in the country.

3.3.4 Large Scale Renewable Energy for Electricity

GoN policies and regulatory regime mentioned in the earlier chapter, need to be supported by an appropriate institutional mechanisms and mindset that respects the role of all stakeholders. Nepal should adapt the experience from other countries on developing a special purpose vehicle for feasible hydropower projects with identified land, clearances and PPAs. Without deny, Nepal's electricity market needs multiple buyers because the state-owned NEA run by employees instead of entrepreneurs simply lack a strong motive to energy transition.

3.3.5 Sectoral Outlook for Reduction in Oil Consumption

Transportation

According to Nepal Economic Forum report, in FY2023/24, Nepal has increased the EV import by threefold making sales second largest in the world. This is encouraging news; however, in contrast NEA has only established 100 operational charging stations in the country. To support the infrastructure demand for EV's, GoN should involve private sector for construction of additional charging stations. Nevertheless, the GoN target by 2030 to provide electric public transportation i.e., Bus Transit System should enable citizens to limit the petroleum products usages.

Agriculture

Agriculture is a second largest sector to consume much of imported diesel in Nepal and the trend is alarmingly increasing. AEPC can ensure subsidy program and banks can offer micro-financing options for the possibilities of implementing some efficient and clean technologies (wind farm and geothermal heating) or by promoting/safeguarding the traditional agricultural practices.

Industrial Sector

The decision by the NEA to supply clean electricity to factories round the clock through dedicated feeders by charging double tariff (during dry season) has to be taken positively. The overall tariff measured by Time-of-Day meter has been more economical than consumption of energy from fossil fuels such as coal or diesel generators. As RE generation on-grid increases, subsidy on electricity tariff with more dedicated feeders can be supportive impact for the future expansion of industries.

CHAPTER 4

4.1 Introduction of Disruptive Technology

According to Geroski (2003), S-Curve is a technological lifecycle, once reaches separation, a new innovation is required with greater efficiency, which might create another S-Curve. In Nepal, different technology S-curves recognized below elaborates RE business positioning and can be better explored on the future performance for growth horizon.

Figure 4: Nepal's Energy Sector Technology S-Curve

Fossil fuels have always been at the foundation of energy technology; however, over the period there has been a paradigm shift to the clean energy value chain. Considering the fossil fuels to phase out by FY2045, Nepal has always witnessed its dominancy for decades in RET from biomass and run-of-river hydroelectric power. Gradually in the past 20years, solar energy technology has increased popularity on the rooftop and fractional connectivity from green land to the grid has marked it as a suitable dominant design. Outlined over the earlier chapters, the bottleneck with hydropower development as for the huge investment, climate vulnerability and likewise absence of green land for solar can restrict the aim of 26% energy mix by FY2030. Introduction of the carbon free oil for 21st century, Green Hydrogen energy has very abundant claim on the S-Curve as a new entrant and to prove itself as a scalable future disruptive technology in Nepal.

Hydrogen is the carrier of energy and a largest used commodity in the world. Grey Hydrogen is produced through electrolysis of water powered by fossil fuel; however, if CO_2 captured and stored, is renamed Blue Hydrogen. On the other-hand, hydrogen produced through renewable electricity is referred to as a Green Hydrogen, which will ultimately prevail due to lower cost and zero carbon emission.

In Nepal, GH_2 can be a vector connecting electricity carrier and the commodity excelling to succeed as a dominant design. At the onset, GH_2 can be produced by exploiting clean electricity which has been choking on the grid that IPPs cannot sell to the NEA. Further, GH_2 has an immense potential to be utilized in industrial applications (steel, cement, mining) to generate income, fuel for decarbonizing transportation, ammonia-based fertilizers and possibly supply power through smart grid.

Source: Dixit, 2022.

Figure 5: Green Hydrogen Possibilities in Nepal

4.2 Scaling Inclusive Innovation

Inclusive innovation solutions for increasing climate risk and energy life-cycle challenges faced in Nepal should be addressed by development of the new business model and scaling up of the GH_2 production. 'Green hydrogen is the technology for many and not just few'. Following framework should be suitable to define how energy stakeholders in Nepal can use this disruptive technology as a tool towards benefiting people in a positive direction and allow them to have better opportunity for future.

Table 4: Inclusive Innovation Commitment Perspective for Green Hydrogen

INNOVATION	OBSERVATION	INSIGHT	FRAMING
Business Model: Nepal Hydrogen Initiative	- Sustainable GH_2 initiation from RE sources - Enabling the commercialization of GH_2 technologies	- Policy foundation and roadmap - Industry and academia collaboration - Develop an implementation action-plan - Incubate value chain for primary and secondary activities	PHASE I (2021-2025), Inception: Basket funds, policy/regulation, national project, knowledge base PHASE II (2025-2030), Commercialization: Domestic supply chain, national energy supply, PPP Phase III (2030-2040), Global Presence: Global hydrogen chain, national commercial projects

Hydropower to Hydrogen	- Surplus spilled-off electricity in wet-season can be allocated for GH_2 production - Stored GH_2 can be utilized during dry-season and for trade	- Approx. $200million electricity from IPPs were spilled-off in FY2023 - NEA commitment to avail subsidy of 50MW for GH_2 production - India under Road Map-2019, has demand of 6million tons per-annum hydrogen infrastructure	- Start-ups to target pilot project of 1-5MW scale - Techno-economic study for domestic GH_2 storage and transmission - Feasibility Study of possible cross border pipeline for supply of GH_2
Green Ammonia for Chemical Fertilizers	- GH_2 can be processed to produce chemical fertilizers - Import of fertilizers and heavy subsidy to farmers has led GoN to trade deficit and financial burden	- GoN imports chemical fertilizers of 800,000 metric-tons annually - IBN conducted a study, 450MW of electricity can produce 700,000 metric-tons of domestic fertilizers annually	- GoN budget FY2023, designates IBN to establish urea factory and avail carbon capture from existing cement plant - Private company to provide Operation & Maintenance of the factory under long-term performance contract
Green Fuel Cells for Transportation	- Heavy dependency on petroleum products increasing 10% annually - GH_2 based FCEV can be possible replacement for diesel based long-distance heavy-vehicles	- GoN budget FY2023, advised NOC to commence work for commercial use of hydrogen fuel in Nepal - NOC for establishment of Hydrogen Fuel Producing and Distribution Company supports 2years research grant of $0.4million to KU Hydrogen Lab	- Technology transfer from South Korea and import of hydrogen fueled vehicle - Pilot project for hydrogen re-charge station at KU Lab and possible future commercial expansion

Source: Dixit, 2022., Dr. Thapa, 2023., Ghimire, 2023., Gurung, 2023., Prasain, 2021.

In developing economy Nepal with abundant RE (hydropower), inclusive innovation framework will be helpful in understanding the current perspective and what it takes to establish GH_2 economy. To produce GH_2 competitively and introduce it to the energy ecosystem, there should be ample of RE resources available at a discounted rate. As compared to solar technology two decades earlier, GH_2 can be an expensive option due to emerging new innovation. However, GoN efforts to strategically execute National Hydrogen Initiative can ensure possibility of GH_2 development as a viable alternative to fossil fuel in the country.

4.3 Non-Market Concerns for Green Hydrogen Development

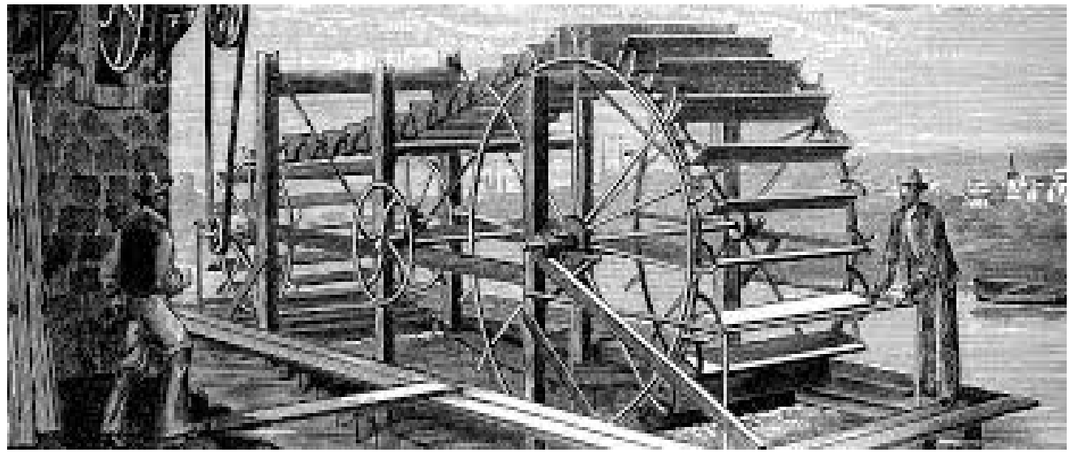
Referring to the external market environment to meet the energy transition goals in Nepal, GH_2 is being evaluated as a political future fuel to put the pause on carbon emission. Nevertheless, the initial challenge will be to understand and deal with the non-market environment impacting the development: who the stakeholders are, what do they want, how are they connected and gradually what is that the stakeholders can do to influence.

LIST OF ABBREVIATIONS

AEPC	Alternate Energy Promotion Center	IBN	Investment Board Nepal	NRB	Nepal Rastra Bank
BOOT	Build-Own-Operate-Transfer	IPO	Initial Public Hearing	PPA	Power Purchase Agreement
CBS	Central Bureau of Statistics	IPP	Independent Power Producers	PPP	Public-Private Partnership
CO_2	Carbon dioxide	IPPAN	Independent Power Producer Association of Nepal	PTC	Power Trade Corporation
COP	Conference of the Parties	km	Kilometer	R&D	Research and Development
DOED	Department of Electricity Development	KU	Kathmandu University	RE	Renewable Energy
ETFC	Electricity Tarriff Fixation Committee	kV	Kilovolt	RET	Renewable Energy Technologies
EV	Electric Vehicle	LPG	Liquid Petroleum Gas	SDG	Sustainable Development Goals
FCEV	Fuel Cell Vehicle	MECS	Modern Energy Cooking Services	SE4ALL	Sustainable Energy for All
FDI	Foreign Direct Investment	MW	Megawatt	TOU	Time of Use
FY	Fiscal Year	MVA	Megavolt-amperes	UN	United Nations
GH_2	Green Hydrogen	NBA	Nepal Banker's Association	VAT	Value-added Tax
GoN	Government of Nepal	NEA	Nepal Electricity Authority	WECS	Water and Energy Commission Secretariat
GWh	Gigawatt-hour	N_2	Nitrogen		
H_2	Hydrogen	NH_3	Ammonia		
		NOC	Nepal Oil Corporation		

Table 5: Non-Market Environment Analysis (IA)3 for Green Hydrogen Business

I + A	Explanation
What is the ISSUE?	- Nepal Hydrogen Initiatives - Hydropower to hydrogen - Green Ammonia for fertilizers - Hydrogen fuel for transportation
Who are the ACTORS?	- Politicians and Government Ministries - Executing Agencies - Development Institutions and Country Donors - Academic Institution - Financial Institution - Professional Associations
What is the actor's INTEREST?	- Development of policy and regulatory framework - Robust infrastructure and investment - R&D and capacity building - Public awareness - Tax incentives & electricity subsidies
In what ARENAS do actors meet?	- Constituent Assembly - Ministry of Energy and Finance - NEA, NOC, IBN, PTC India - KU Hydrogen Lab - Conference and Economic Forum - IPPAN
What INFORMATION moves the issue in this arena?	- Policy advocacy and approval - Plan guidance, budget establishment and project security - Framework for projects development, legal concerns - Leading analyst, Consultants, Opinion leaders, Professors to address technical/commercial aspect and skills development
What ASSETS do actors need to prevail in arena ?	- Platform creation for all stakeholders to debate, learn and network - Stakeholders influence on the government policy and business environment - Hydrogen National Policy for commercial production and end-use - One window clearance of production license and environment certification - Capital resources, infrastructure for storage facilities, distribution network and fuel stations - Technology transfer, pilot project and expert human capital - Market penetration (PPP model), bank investment and financial closure - International collaboration: urea industry establishment, vehicle accessibility



GoN recently (FY2024) has endorsed the National Green Hydrogen Policy outlining indicative directives such as tax and VAT incentives, import discounts, provide discounted electricity tariff and allow provision to build own RE project for GH_2 production. Towards the next step, as GoN is expected to establish regulatory framework on production, storage and transmission of GH_2; NEA can provide electricity similar to irrigation subsidized rates. This can motivate domestic ammonia fertilizer production at lower cost, giving certain break to trade deficit. Prime Minister of Nepal has indicated interest to ride hydrogen vehicle, which has come out as diplomatic message for establishment of the FCEV value chain at KU Hydrogen Lab, including charging station.

CHAPTER 5

5.1 Conclusion

Looking ahead, Nepal has to realize tremendous effort to further address the impact from climate change challenges by adopting transition to more sustainable energy ecosystem. To enhance paradigm shift towards RE and to obtain constant energy security, an advanced grid battery storage system should be reliable and economically viable option to minimize dependency on the fossil fuel. Beginning of the FY2024, Nepal has signed a long-term trade agreement with India confirming export of 10,000MW electricity within a decade and also allowing usage of Indian grid to transmit Nepal's power to Bangladesh. This cooperation shall definitely foster all the stakeholders to fulfil the expectation drafted in the 12th year plan towards unbundling investment and clean energy development challenges.

On the other-hand, GH_2 policy definitely has provided an enabling environment for developers addressing Nepal as an attractive destination for GH_2 production and investment. Nonetheless, GoN with the right vision and leadership should establish, Green Hydrogen Development Board to deal with mega projects to develop hydrogen from hydropower over coming years and possibly also advocate for the cross-border trade.

In summary, balance between Exploiting Renewable Energy and Exploring Green Hydrogen in the coming years, is the creditable strategy for Nepal in making sustainable energy ecosystem optimum, more efficient and more reliable.

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REFERENCES

Aguilar, F.J. (1967). 'Scanning the Business Environment', New York: Macmillan.

Alternate Energy Promotion Center. (2008). 'Solar & Wind Energy Resource Assessment Report'

Alternate Energy Promotion Center. (2009). 'Biogas Support Program Phase IV (2003-2010)'

Asian Development Bank (ADB). (2013). 'Private Sector Assessment - Nepal Country Partnership Strategy (2013-2017)'

Rahul Shah. (2016). 'Privatization of utilities: Obvious alternative', The Himalayan Times

Rahul Shah. (2014). 'Sustainable Energy for All (SE4ALL) by 2030: Nepal Action Plan (SNAP)', EWC/EWCA 2014 International Conference in Okinawa, Japan.

Bach, D. Allen, B. (2010). 'What Every CEO Needs to Know About Non-Market Strategy', MIT Sloan Management Review.

Cook, D. (2016). 'What is inclusive innovation? Technology for many and not just few', Interview – Thomson Reuters.

Dixit, K. (2022). 'Can Nepal Go from Hydro to Hydrogen', Nepal Times.

Dr. Thapa, B. S. (2023). 'Project Ideation – Green Hydrogen for Development in Nepal', Green Hydrogen Lab and Conscious Energy, Kathmandu University.

Enapter. (2022). 'Enapter White Paper', www.enapter.com

Galpin, T. (2023). Strategy Workbook. Said Business School, University of Oxford.

Geroski, P. (2003). 'The Evolution of New Markets', Oxford University Press.

Ghimire, S. (2023). 'Hydrogen: The fuel of the Future', Annapurna Express.

Gurung, K. (2023). 'Future proofing Nepal's energy sector', Urja Khabar.

Klingler-Vidra R., Glennie, A., Lawrence, C.S. (2022). 'An introduction to inclusive Innovation', Routledge Taylor & Francis Group, London and New York.

Lamsal, H. (2023). 'Plan 2035 Govt sets a target of 1,500 units of energy consumption per capita within 12 years', The Ministry of Energy -Water Resources and Irrigation, Nepal.

Lawrence, T. (2023). 'Strategy in Action'. Said Business School, University of Oxford.

Nepal Electricity Authority. (2023). 'A Year in Review (Annual Report)'

Prasain, K. (2021). 'Project Working to Produce Hydrogen Fuel in Nepal', Urja Khabar.

Rana, SP. J. (2023). 'Enhancing of Domestic Electricity Consumption and Export', Urja Khabar – Energy for prosperity (Issue 4).

Seidel, V. (2023). 'Innovation Intensity'. Said Business School, University of Oxford.

Shrestha, H.M. (1966). 'Cadastre of potential Hydropower Resources in Nepal' (PhD Thesis) Moscow Power Institute.

The Secretary-General's High-Level Group. (2012). 'Sustainable Energy for All – A Global Action Agenda', United Nation Development Programme.

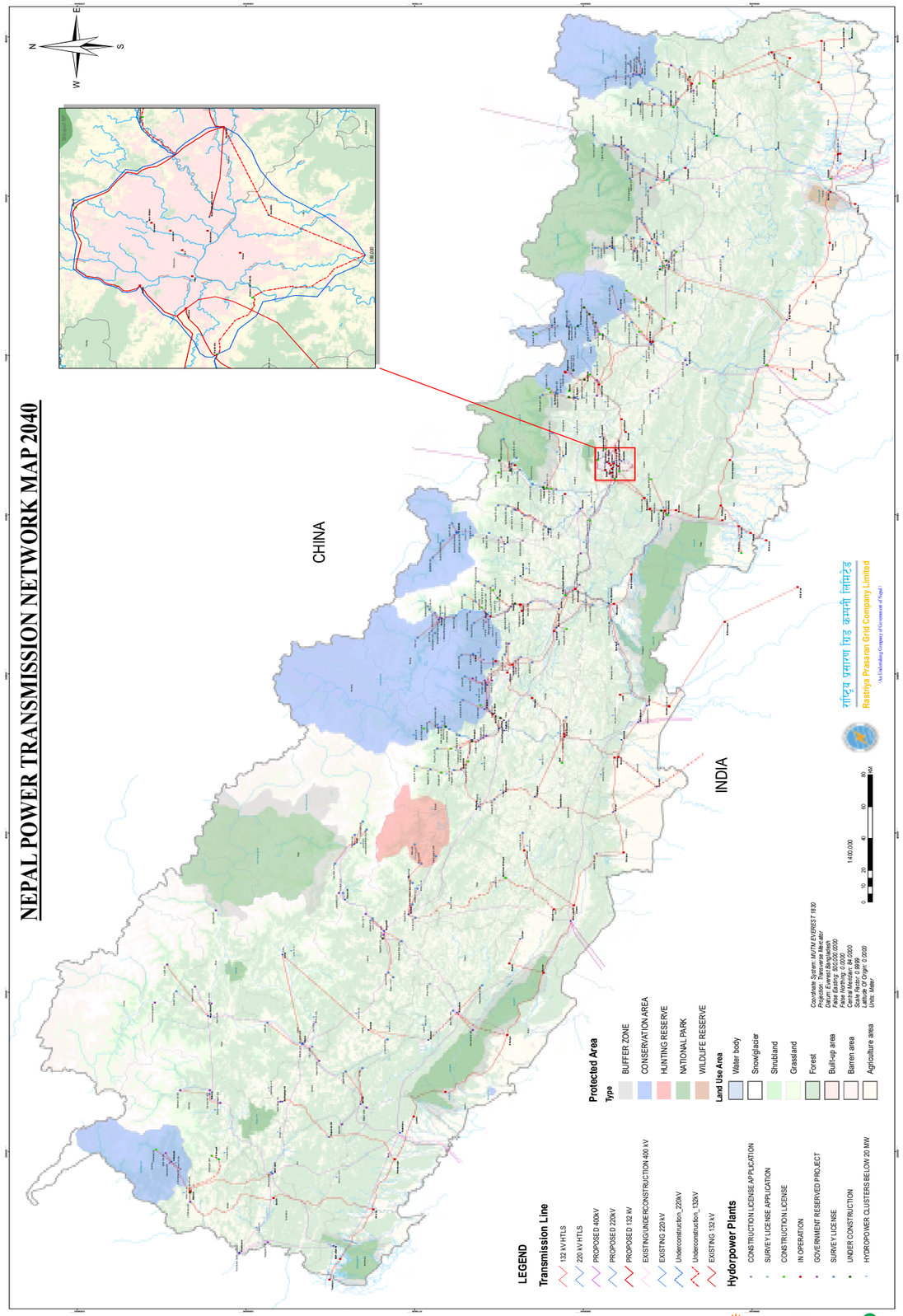
United Nations Development Programme. (2013). 'Rapid Assessment and Gap Analysis'

Ventresca, M.J. (2023). 'Why TMO? Challenges of innovation strategy and evolution of new markets'. Said Business School, University of Oxford.

Water and Energy Commission Secretariat. (2023). 'Energy Symposium Report', Nepal.

Water and Energy Commission Secretariat. (2010). 'Energy Sector Synopsis Report', Nepal.

Zhou, A. Zhou, W. Manandhar, P. (2020). 'A Study on the Prospect of Hydropower to Hydrogen in Nepal', Asian Development Bank.



Interview

Sergey Lavrov
Minister of Foreign Affairs of the Russian Federation

International Law is the Key for Co-ordinating a Mutually Acceptable Balance of Interests in the Energy Sector

Oil, gas and hydrocarbons will continue to play the crucial role in the development of the global economy and in ensuring the well-being of nearly all countries for a long time to come, for many decades

Q: ***We believe that oil is an instrument of political manipulation. The largest ever energy crisis of 1973 was a result of political manipulation following the Yom Kippur War. Do you agree that oil is an instrument of political manipulation? Can you provide more striking examples of this or arguments to the contrary?***

All natural resources on which economic development, influence and might depend are instruments of political struggle. It is logical that they are used for political purposes, including geopolitical ones. We saw this in the 1980s, when the United States put colossal pressure on Saudi Arabia and other Gulf countries, which were the main oil producers, bringing about a collapse in oil prices to $10 or even lower per barrel in the hope of reducing the Soviet Union's foreign exchange earnings and hence its capacity to continue to develop and ensure its security. At that time, we continued to compete with the United States and the West as a whole. They achieved their goal. The Soviet Union's revenues plummeted, which was one of the causes, though not the main or only one, that led to its dissolution. They put pressure on the oil market, used speculation for the fall, drew the Soviet Union into an arms race, and promoted "democratic reforms" when our country was not prepared for them. Taken together, this contributed to the fall of a great power.

All natural resources on which economic development, influence and might depend are instruments of political struggle.

It is obvious that nobody is happy about the use of these underhanded methods, although few people, especially in the West, dare to put their uneasiness into words.

A year ago, French Minister for the Economy and Finances Bruno Le Maire said in a public statement that businesses paid four times more for energy in Europe than in the United States. I believe the balance is approximately the same now.

Since then, the Americans have been using oil and oil prices as a weapon. A relevant example is Iran, which had its oil exports banned and the channels of oil deliveries contrary to that illegal ban were blocked. Today, oil sanctions against Iran have been lifted. The latest example is Venezuela, which was the third largest oil supplier to the United States in 2019. In 2022, the Americans adopted an oil embargo against it, allegedly in the struggle against the "regime" of Nicolas Maduro, as they put it. But later they faced the consequences of the OPEC and OPEC Plus efforts to stabilise the oil market based on the main economic factors and a balance of interests of producers, importers and transit countries. Today, the Americans are playing new political games against Venezuela, offering it an agreement to resume oil exports to the United States in exchange for political concessions. However, it is a fact that Washington is suffering the consequences of its own actions considering that a vast number of American oil refineries were equipped to process Venezuelan oil. It is a combination of purely economic factors and a desire to take advantage of economic ties, in this instance, use oil as a weapon.

As for Russia, what is the oil price cap imposed on Russian oil by the Americans, which the West was pressured to adopt as well? It is flagrant interference in the workings and principles of the free market, which the Americans have been promoting for decades. They described the dollar not as an American currency but as a global element of interconnectivity between the global economy and finances. The structure collapsed when they decided to use these instruments to inflict what they described as "geopolitical defeat" on Russia. It is obvious that nobody is happy about the use of these underhanded methods, although few people, especially in the West, dare to put their uneasiness into words.

The pinnacle of using hydrocarbons as a weapon was the explosion of the Nord Stream pipelines, which directly targeted Germany. American analysts have admitted it, and many in Germany are openly saying this. It is evidence of the current German government's impotence and inability not just to think independently but to even protect its vital interests on which the prosperity and well-being of German citizens depend.

As a result of that subversive terrorist attack, businesses, faced with rising gas prices, are leaving Germany and other European countries, and relocating, for the most part, to the United States. They have started to talk about the de-industrialisation of Europe. A year ago, French

Minister for the Economy and Finances Bruno Le Maire said in a public statement that businesses paid four times more for energy in Europe than in the United States. I believe the balance is approximately the same now. It is a fact that the United States has created much more favourable conditions for businesses, including by approving credit subsidies under the Inflation Reduction Act. Business is moving to the United States. At the same time, immediately after blowing up the gas pipelines, Washington said that in the absence of Russian gas Europe needed to buy American LNG, even though it cost more and there was a lack of the necessary infrastructure, which was still to be built.

Four years ago, when Angela Merkel was chancellor and life was easier, the Americans attempted to convince Germany that it had no need for Nord Stream or Russian gas in general, that it could buy American LNG instead. Angela Merkel argued that it would be more complicated and much more expensive. The Americans agreed that it would cost more and suggested covering the difference with higher taxes. After all, they said, you can tell your people that it is a good cause in the interests of peace and democracy throughout the world. There are more examples of this kind.

Q: ***After the assassination of King Faisal in 1975, Saudi Arabia became a committed ally of the United States. The decision to quote oil contracts in US dollars and the creation of petrodollars would have been impossible without Saudi Arabia. But it has recently embarked on a path that suggests a divergence from this alliance with the United States. Is this true, and if so, what are the underlying reasons for this? And how predictable is this trajectory? Is there a risk that we will lose Saudi Arabia again? Could it follow the US lead again?***

I wouldn't say that the Saudis have steered away from the United States. They simply decided to pursue their own national policy without interference from any direction, from the left or right, above or below, primarily from the United States. This trend has become stable in Saudi Arabia, especially since Crown Prince Salman bin Abdulaziz Al Saud was appointed Prime Minister and launched Vision 2030. There is still a great deal to be done by this deadline, which is not far away. A lot has already been accomplished. Saudi Arabia, acting in the interests of the kingdom and its people, wants oil prices to be stable and to ensure good profits for oil producing countries while also being attractive for buyers.

This is exactly what we are doing within the framework of OPEC Plus, with support from all other group members. Saudi Arabia is steering this line very clearly. We will not tolerate any attempts to interfere in these processes.

I read the other day that Ukraine has been trying to convince Washington to halve the price cap for Russian oil, to $30 per barrel. This is outrageous, not to mention the fact that the idea of a price cap contradicts market rules and reflects a desire to dictate conditions. However, it is notable that the United States is unlikely to yield to Ukraine's demand, if only because this would harm the Americans themselves and provoke undesirable reactions in the oil market. I hope the United States has at least some national pride left and will not dance to Zelensky's tune.

Q: ***You mentioned Venezuela, where our companies, notably Rosneft, are very active. Chevron is now being pressured by the Unted States. Can "Bolivar carry double," or will Venezuela have to choose?***

According to many experts, Venezuela has the largest oil resources in the world. We are against monopolism in principle. There is enough space for everyone [in this market], provided everyone plays fair and the process of assigning investment opportunities in Venezuela's oil sector is honest.

Our Venezuelan friends are aware of the situation. Of course, they listen to what the United States says. Nobody will deny the United States the opportunity to engage in serious discussions if that is what they truly want. Any normal country will be prepared to listen. They [Venezuelans] are talking [with the United States]; they want sanctions to be lifted. But the Americans only press for concessions in the sphere of human rights and advance the usual "democratic" demands without explaining their meaning. As Washington sees it, loyalty to the United States is the criteria of democracy. But the Venezuelans remember that the Americans auctioned the US branch of Venezuela's national oil company PDVSA during the period of embargo. They just did it. In fact, they expropriated it.

Everyone is well aware of Washington's methods. There can be no expectation of mutually beneficial solutions. When talking with Washington, you need to firmly press for your own advantage and never expect it to fulfil its sweet promises.

Q: ***We are becoming Iran's rival in the oil market. Will it be friendly competition, or won't our interests clash at all?***

I see no issue with Iran regaining its legal right to develop by selling oil and investing the oil revenues.

The OPEC Plus, where both Iran and Russia are members, has a clear formula for reaching agreements and finding compromises. It has been used for years, and nobody has been disadvantaged or dissatisfied, especially since the hydrocarbon market is bound to grow, as I see it. China's growth has slowed down a little, but figures show that it has been growing two or three times faster than many other countries, in particular Western ones. India is growing even more rapidly. Therefore, there will be no shortage of consumers. Look at Africa, where we doubled the export of petroleum products over the past year or year and a half.

There is no reason for fear. Normal countries whose actions are based on international law will always coordinate a mutually acceptable balance of interests.

Q: ***The invention of the ICE and its active use have ushered in an era of wars on the planet, which in one way or another are fuelled by rivalry for the possession of oil-rich territories. Do you agree with this idea? Some experts strongly oppose it, while others share it. What is your view?***

It depends on the point of view you choose (pardon the tautology). The most recent notable case is the special military operation, the fighting in Ukraine. From the materiel point of view, they have 100 percent of their needs satisfied by the United States and their NATO allies. In terms of personnel, they have a full complement of Ukrainians, mercenaries, and instructors. The stated objective of this war against Russia is ostensibly to prevent us from impinging on Ukraine's sovereignty and restore its territorial integrity, among other things.

We cannot ignore the fact that Russia is one of the oil and gas producers and exporters of oil and gas. Our country was the principal gas supplier for Europe. The Soviet-built gas pipelines provided Europe, especially Germany, with decades of ease and prosperity. There were no beggars or poverty there on the scale observed in the United States. But even before the Nord Stream pipelines were blown up, the West was pressuring Europe to stop using Russian gas. It was directly imposing its own energy. Their stated goal is to defeat Russia on the battlefield, weaken it, and strip it of its status as a global player. Many NGOs and even high-ranking politicians issue official statements to the effect that Russia must be "decolonised." Puppet organisations are created abroad, seeking "freedom" for certain Russian republics. It is evident that this is somehow connected to their plan to undermine the country that competes with the United States in energy markets.

Another example is the current war in Syria. During the Arab Spring, an attempt was made to crush the Syrian statehood in the same way as NATO had done in Libya and a number of other countries. We intervened and saved Syria, which came as a complete surprise for the Americans and those who were planning a regime change in Damascus. Bashar al-Assad's "regime" (as they say) is still a fully-fledged member of the United Nations and enjoys support from the majority of Syrians. But this does not suit the United States. Unlike us, the US illegally sent its occupying force to northeastern Syria, the country's main oil-bearing and agricultural region. In Syria, the oil and grain production is concentrated in the northeast, and the Americans have occupied this area. They are producing oil there and are stealing it. Every day, convoys are sent to US-designated addresses via Iraq. This is colonialism pure and simple. There is nothing more to say. Simultaneously, the Americans "maintain" camps in the same US-occupied northeastern areas of Syria. They are formally referred to as "refugee camps." However, this is where they train insurgents, including members of terrorist organisations banned by the UN Security Council, such as Hayat Tahrir al-Sham and its affiliates. These militants are involved in sabotage attacks instigated by the US in various parts of the world, including against us in Ukraine. As you can see, oil is inseparably linked to geopolitics here.

Q: ***You said that the collapse of the Soviet Union was provoked, in part, by plummeting oil prices. When the Soviet Union fell apart, one of the first economic laws was the law on Natural Resources and the transfer of oil production to private companies, including foreign ones, under production sharing agreements and the like. There are two opposing views on that. Some think that it was vital at the time to save the economy…***

Don't ask me. This is not an issue for the Foreign Ministry to comment on. This is not our competence. It is beyond our competence. Besides, I knew many of those people very well…

Q: W***e all know them very well.***

A simple question then. What is the first word that pops into your head when I say "oil"?

I have never thought about it.

Q: ***What if I ask you anyway? Oil is…***

In terms of associations, I have just remembered that there is a brand of vodka called Oil; it's a small black barrel. That's one of the associations.

President Vladimir Putin has talked about this many times, commenting on the green transition initiatives. Their accelerated implementation led to food and energy crises because investment in hydrocarbons was slashed in the hope that the sun, the wind and water could provide sufficient energy. Those who are advocating the green agenda in Europe, including the Greens and

similar parties in Germany, have placed their political ambitions above logic and economic interests. That's why oil, and not oil alone, is being mentioned more often now. The plans for an immediate green transition have failed because the wind was not strong enough, the sun was not hot enough, and the tides were weak. Coal is being widely used in Europe again, on a larger scale than in Africa.

I attended a recent BRICS summit, where African delegates complained on the sidelines that the Americans continued to urge them to abandon coal and to invest in the green economy and green transition instead. At the same time, America is using much more coal than before and much more than other countries.

In short, oil, gas and hydrocarbons in general will continue to play the key role in the development of the global economy and in ensuring the well-being of nearly all countries for a long time to come, for many decades.

Q: ***Our oil supply routes have been moved towards the east, towards China and India. It is obvious that our colleagues and our current partners will look for favourable terms. Could we end up selling at a loss?***

Not at all. I don't envision this problem. As I said, China and India are growing fast. They can buy what many OPEC Plus countries offer. That organisation is regulating the market and prices honesty and fairly, respecting the consumers' interests as well. OPEC Plus will not set prices that are unacceptable for buyers. This is what an honest balance of interests is. I don't think we will become dependent on the countries that buy our oil and gas and are already doing so in increasing amounts. But we must be wary of those who blow up the infrastructure that ensured the prosperity of European countries. They were warned about "bad molecules" and told that they needed gas with "democratic molecules." But justice will eventually prevail.

The original interview was first published on the official website of the Ministry of Foreign Affairs of the Russian Federation.

https://mid.ru/en/

RAGHUGANGA HYDROPOWER LIMITED

Piple, Myagdi

Salient Features

Project	Location
Province	Gandaki
District	Myagdi
Intake Site	Jhi, Raghuganga Rural Municipality -05
Power House Site	Tilkane chaur,Raghuganga Rural Municipality -03

General

Name of River	Raghuganga
Nearest Town	Beni
Type of Scheme	Peaking run -off- river scheme
Gross Head (m)	292.83
Net Rated Head (m)	281.56
Installed Capacity (MW)	2*20=40
Average Annual Energy after Outage	238.59 GWh(Peaking Energy =27.95GWh, Non Peaking Energy =50.26GWh and Wet Energy =160.37GWh)

Advancing Nepal's Electricity Sector: Strategic Frameworks for Private Investment in Transmission

Robert Kremer

"By focusing on strategic projects, such as connecting isolated hydropower plants to the main grid or bolstering transmission capabilities in high-demand areas, ITPs can bring about targeted improvements in the network."

Nepal's transmission sector is currently defined by a confluence of challenges and latent potential. The existing infrastructure, predominantly managed by the Nepal Electricity Authority (NEA), has made strides in reaching various parts of the country but still grapples with substantive issues that hinder optimal performance. Key among these challenges is the aging and often inadequate infrastructure, which struggles to keep pace with the rapidly escalating demand for electricity fueled by urbanization, industrial expansion, and rural electrification efforts. This demand-supply mismatch is further exacerbated by the logistical and financial hurdles posed by Nepal's varied and challenging topography, complicating the expansion, and upgrading of transmission lines, particularly in remote and rugged areas.

Compounding these operational challenges is the need to effectively integrate Nepal's substantial hydropower resources into the national grid. Despite being endowed with a theoretical hydropower potential of around 42,000 MW, a substantial portion of this resource remains untapped or ineffectively utilized, partly due to the constraints of the existing transmission infrastructure. This scenario limits domestic energy supply and restricts Nepal's ability to capitalize on lucrative opportunities for regional energy trade, particularly with energy-hungry neighbors like India.

In this context, deploying Whole Network Concessions emerges as a pivotal strategy. This model presents a comprehensive solution to overhaul and expand the national grid by harnessing private sector efficiencies and capital. It offers a pathway to accelerate infrastructural development, crucial for connecting remote hydropower stations and meeting the surging energy demands of urban and industrial centers. By transitioning certain responsibilities of grid operation and expansion to private entities, Nepal can alleviate the fiscal and managerial burden on the NEA, facilitating a more dynamic and responsive approach to grid management.

Simultaneously, the role of Independent Transmission Projects (ITPs) in Nepal's energy strategy is underscored by their potential to target specific grid weaknesses. By focusing on strategic projects, such as connecting isolated hydropower plants to the main grid or bolstering transmission capabilities in high-demand areas, ITPs can bring about targeted improvements in the network. This model's emphasis on specific high-impact projects aligns well with the need for precise interventions in the grid, ensuring a more reliable and efficient distribution of electricity.

Privatization and Public-Private Partnerships (PPPs) also play a critical role in this multifaceted strategy. Through these models, Nepal can tap into private sector dynamism and resources while maintaining regulatory and strategic oversight of critical national infrastructure. This approach is particularly relevant in areas of the transmission network that require technological upgrades or capacity expansion, where private expertise and investment can make a significant difference.

Furthermore, the introduction of Merchant Lines offers a solution to optimize the distribution of electricity across Nepal's diverse terrain. By enabling private investment in transmission lines that connect surplus energy generation areas, such as hydropower-rich regions, with high-demand urban centers, these lines can help balance the grid and introduce market-driven efficiencies in energy distribution.

Table 1: Four primary business models successfully deployed around the world.

Model	Description	Advantages	Disadvantages
Whole Network Concessions	Long-term operational control granted to private entities	• Enhanced efficiency • Private investment • Advanced technologies	• Regulatory oversight • Public acceptance • Alignment with energy goals
Independent Transmission Projects	Private entities construct/manage specific lines	• Targeted improvements • Efficient power distribution	• Strategic selection • Financial feasibility • Right-of-way issues
Privatization	Transfer of ownership/management to private stakeholders	• Operational efficiency • Accelerated development • Reduced fiscal burden	• Public/political concerns • Regulatory framework
Merchant Lines	Private entities build/operate lines for profit	• Optimized distribution • Support for energy exports	• Regulatory support • Financial incentives • Socio-environmental impacts

In light of these considerations, the development of Nepal's transmission sector calls for an integrated approach that judiciously combines the strengths of various models. By aligning these models with the sector's diverse needs, Nepal can not only address its immediate challenges in energy distribution but also lay a robust foundation for future growth and regional integration. This holistic strategy is crucial for realizing the full potential of Nepal's hydropower resources, achieving energy security, and driving sustainable economic growth. The road ahead is undoubtedly complex and requires meticulous planning, policy innovation, and cooperative engagement across various stakeholders, but the transformative potential it holds for Nepal's energy landscape is immense and far-reaching.

Model 1: Whole Network Concessions in Nepal's Transmission Sector

Whole Network Concessions (WNC) involve granting long-term operational and developmental control of the transmission network to a private entity. This model aligns well with Nepal's need for significant infrastructure development, especially in its challenging topographical landscapes. Concession agreements between government entities like the NEA and private investors can redefine the transmission landscape in Nepal. These agreements, spanning several decades, provide a framework for managing and maintaining existing transmission lines and developing new ones, critical for connecting isolated hydropower resources to the main grid.

The implementation of WNC in Nepal offers multifaceted benefits. The involvement of private entities promises enhanced operational efficiency and accelerated network expansion. Private companies, driven by profit and performance, can infuse technical and managerial efficiency into the operation of transmission networks. This approach is particularly pertinent in Nepal, where transmission losses and inefficiencies currently hamper electricity distribution. Another significant advantage is the potential reduction in the fiscal burden on the government. By channeling private investment into this sector, the model relieves the state of the sole financial responsibility for expanding and modernizing transmission infrastructure. Furthermore, private companies might introduce cutting-edge technologies, including smart grid solutions, which can substantially improve grid management, reliability, and resilience against power outages.

However, the path to implementing WNC in Nepal is laden with challenges and requires strategic navigation. Regulatory oversight stands as a paramount concern. Establishing a robust, transparent regulatory framework that balances the interests of all stakeholders – private investors, the government, and the end consumers – is crucial. This framework must encompass aspects like tariff regulation, standards of service, and policies on returns on investments. Another hurdle is the potential resistance from the public and political realms, as the transmission sector is a critical national resource. Building public trust and political consensus is imperative for the successful adoption of this model. Additionally, it's essential to align these concession agreements with Nepal's broader energy goals, including rural electrification, sustainable hydropower development, and energy export ambitions, to ensure they contribute constructively to the national agenda.

For practical implementation in Nepal, a phased and inclusive approach is recommended. Initiating the model with pilot projects in select regions could serve as a litmus test, helping to identify and rectify operational challenges before a nationwide implementation. This approach also allows for gradual public and stakeholder acclimatization to the model. Active and transparent engagement with local communities, civil society, and industry stakeholders is essential from the outset. Such engagement ensures that the concession processes are transparent and considerate of local needs and concerns. Simultaneously, there is a need to augment the capacity of the NEA to manage these concessions effectively. Enhancing NEA's capabilities ensures it can oversee operations adequately, enforce compliance with agreement terms, and mediate between public interests and private objectives.

Legal and financial frameworks also play a critical role. The success of this model in attracting and retaining private investment hinges on the clarity and robustness of contracts. These contracts need to delineate terms of investment, operation, risk-sharing, and mechanisms for dispute resolution clearly. Furthermore, offering incentives such as tax benefits or assured returns could make these concessions more attractive to potential investors. Alongside these financial and legal considerations, environmental and social responsibilities must be paramount. Concessionaires should adhere to stringent environmental guidelines and ensure their projects do not adversely impact local communities or ecosystems. Additionally, risks related to construction, operation, and market dynamics should be equitably shared between the private concessionaire and the government to foster a sustainable and mutually beneficial partnership.

In conclusion, while WNC presents an opportunity to revolutionize Nepal's transmission infrastructure, their success depends on careful planning, strategic implementation, and robust regulatory oversight. By addressing these factors, Nepal can leverage this model to enhance its transmission capacity, integrate renewable energy sources efficiently, and propel itself towards energy self-sufficiency and economic growth.

Model 2: Independent Transmission Projects in Nepal's Transmission Sector

The implementation of Independent Transmission Projects (ITPs) in Nepal stands as a crucial solution in addressing the myriad challenges facing its transmission infrastructure. These projects, characterized by the involvement of private entities in constructing and managing transmission lines, offer a nuanced approach to enhancing Nepal's power grid. Their focused nature allows for targeted development, particularly crucial in a country where the topographical diversity – spanning from the lowland Terai regions to the high Himalayas – presents unique logistical and infrastructural challenges. ITPs are uniquely positioned to bridge the substantial gap between Nepal's abundant hydropower potential, often located in remote and inaccessible regions, and the national grid.

In implementing ITPs, several key factors come to the fore. First is the strategic selection of projects. This involves identifying areas where the transmission infrastructure is either non-existent or grossly inadequate, especially regions with significant hydropower capabilities yet poor grid connectivity. The prioritization of these projects is vital not only to ensure the efficient distribution of generated power but also to align with Nepal's broader energy and economic development goals. For instance, connecting burgeoning hydropower plants in the Himalayas to major urban and industrial hubs can significantly bolster Nepal's energy independence and create avenues for future energy exports.

The financial and logistical feasibility of ITPs is another critical consideration. Given the substantial investment required, especially in challenging terrains, creating an investor-friendly environment is paramount. This includes establishing transparent regulatory frameworks, ensuring equitable and competitive tariff structures, and facilitating a streamlined process for project approvals and implementation. Furthermore, logistical challenges, particularly in transporting materials and equipment to remote project sites, require innovative solutions and robust project management to keep costs and timelines under control.

The aspect of right of ways (RoWs) acquires significant importance in the context of ITPs. Acquiring RoWs in Nepal's diverse landscape is often fraught with legal, social, and environmental challenges. Negotiating RoWs involves dealing with fragmented land ownership, varied local regulations, and, in some cases, resistance from local communities. Mitigating these challenges requires a tactful and empathetic approach, ensuring

fair compensation, community engagement, and minimal environmental disruption. Failing to adequately address RoW issues can lead to project delays, legal hurdles, and escalated costs, undermining the viability of ITPs.

Furthermore, the environmental and social impacts of constructing new transmission lines must be carefully managed. This involves conducting thorough environmental impact assessments, adhering to national and international conservation standards, and implementing measures to mitigate any adverse impacts. Community engagement and ensuring social buy-in are also vital, as local resistance or lack of cooperation can significantly impede project progress.

The technological aspect of ITPs also presents both a challenge and an opportunity. Adopting advanced technologies in grid management and construction can enhance the efficiency and longevity of transmission projects. However, this requires building local capacity and expertise, as well as possibly collaborating with international partners for technology transfer and training.

In conclusion, Independent Transmission Projects offer a strategic and focused approach to overcoming some of the most pressing challenges in Nepal's transmission sector. By effectively addressing the financial, logistical, legal, and social challenges associated with these projects and leveraging technological advancements, ITPs can significantly enhance the capacity and reliability of Nepal's power grid. This would not only aid in meeting the growing domestic energy demand but also position Nepal to capitalize on its hydropower potential, marking a significant stride towards energy self-sufficiency and economic prosperity. The success of ITPs thus is pivotal in Nepal's journey towards a sustainable and resilient energy future, requiring a concerted effort from both public and private stakeholders.

Model 3: Privatization in Nepal's Transmission Sector

The contemplation of privatization as a transformative model for Nepal's transmission sector presents an intriguing intersection of opportunity, efficiency, and challenge. Privatization, which entails the transfer of ownership and management of state-run transmission entities to private stakeholders, introduces a radical shift in the operational ethos of a critical public utility sector. In the context of Nepal, where the transmission infrastructure has been historically managed by state entities such as the NEA, the proposition of privatization promises a new paradigm characterized by the potential infusion of private investment, technical expertise, and operational efficiency.

A key consideration in Nepal's pivot towards privatization is the strategic determination of its scope and form. One potential approach is the Public-Private Partnership (PPP) model, wherein both the government and private enterprises share ownership and management responsibilities. This model offers a balanced pathway, blending public oversight with private sector agility and investment. It allows for a risk-mitigated approach to privatization, ensuring continuity of government oversight in a sector that is not just economically critical but also central to national security and public welfare. Alternatively, Nepal could explore partial privatization, particularly targeting segments of the transmission network that demand substantial technological upgrades or capacity expansions. This would enable the tapping into private capital and expertise for specific high-impact areas while retaining overarching state control over the national grid.

The journey towards privatization in Nepal's transmission sector, however, is not without its complexities. Public and political apprehensions about relinquishing control over a vital national infrastructure to private players are significant hurdles. Such concerns are grounded in issues of transparency, fair pricing, and equitable access to electricity for all strata of the population. Establishing a robust and independent regulatory framework becomes imperative in this context. It would serve as the cornerstone for overseeing private sector operations, ensuring adherence to national energy policies, protecting consumer interests, and maintaining fair and competitive practices.

Privatization in Nepal's transmission sector stands to offer manifold benefits if judiciously implemented. Enhanced operational efficiency is a paramount advantage, potentially leading to a more reliable and loss-minimized transmission network. Accelerated infrastructural development and project completion are other critical benefits, as private entities driven by profitability and efficiency are likely to expedite project timelines. This aspect holds particular significance for Nepal given its vast untapped hydropower potential and the urgent need to bolster its transmission infrastructure for both domestic consumption and potential energy exports. The inflow of private investment relieves the government of some financial burdens, allowing for resource reallocation to other developmental needs.

Despite its potential advantages, privatization must be navigated with a focus on safeguarding public interests. Strong regulatory oversight is critical to ensure that private operations align with national energy goals, adhere to service quality standards, and maintain fair pricing structures. Protecting public interests, especially in terms of affordable electricity tariffs and equitable access, is vital. The transition process, moving from a public to a private or a partnership model, calls for comprehensive planning to address workforce implications, operational transitions, and continuity of services.

In conclusion, the privatization of Nepal's transmission sector poses as a potentially significant step towards modernizing and revitalizing its energy infrastructure. The model, if strategically and sensitively implemented with robust regulatory frameworks and a balanced approach to public and private interests, could herald a new era of efficiency, innovation, and development in Nepal's energy landscape. This approach aligns not only with the nation's immediate infrastructural needs but also with its long-term economic and sustainability aspirations.

Model 4: Merchant Lines in Nepal's Transmission Sector

In Nepal's quest to enhance its transmission infrastructure and maximize its hydropower potential, the implementation of Merchant Transmission Lines offers an innovative pathway. This model, which involves private entities building and operating transmission lines for profit primarily by transferring electricity from surplus regions to areas with higher demand, could be particularly transformative in a country marked by significant geographical diversity and varying energy production capabilities. Merchant lines in Nepal could effectively bridge the gap between remote hydropower generation sites and major consumption centers, including urban hubs and industrial areas, optimizing the distribution of generated power across the national grid.

The strategic implementation of merchant lines in Nepal requires a comprehensive understanding of both the country's energy generation landscape and its market dynamics. Key to this is identifying optimal routes for these lines, which involves a thorough analysis of hydropower generation patterns, regional electricity demand, and existing grid infrastructure. Routes that connect burgeoning hydropower plants in the Himalayas with populous regions and burgeoning industrial areas in the Terai plains, for instance, might offer viable and profitable opportunities for private investment. Additionally, considering cross-border connections, particularly with neighboring India, could open up avenues for lucrative electricity export, leveraging Nepal's potential as a significant energy provider in South Asia.

The operational feasibility of merchant lines hinges on a regulatory framework that supports and governs their function. Establishing clear guidelines regarding construction standards, operational safety, grid integration, and pricing mechanisms is crucial. The regulatory environment must ensure that these privately-operated lines operate harmoniously within the broader national grid, augmenting rather than disrupting the existing network. Fair and competitive market practices must be a cornerstone of this framework, ensuring that the introduction of merchant lines does not lead to monopolistic practices or market distortions.

Furthermore, financial incentives and policy support play a critical role in attracting private investors to fund merchant line projects. Given the significant initial capital required for the construction of transmission lines, especially in Nepal's challenging terrain, mechanisms such as tax benefits, streamlined permitting processes, or even government guarantees can be pivotal in making these projects financially attractive.

The socio-environmental impact is another crucial consideration. The construction of new transmission lines across diverse ecological zones requires rigorous environmental impact assessments and proactive community engagement strategies. Balancing infrastructural development with ecological preservation and social responsibility is key to gaining public support and maintaining the environmental integrity of Nepal's diverse landscapes.

In the broader context, the integration of merchant lines into Nepal's transmission sector strategy should align with the country's long-term energy goals. This involves not only addressing current electricity demands but also planning for future energy needs and potential market changes. The success of this model will depend on its adaptability and resilience in the face of evolving energy consumption patterns, technological advancements, and shifts in regional energy economics.

In conclusion, the adoption of merchant lines in Nepal's transmission sector offers a unique opportunity to diversify the country's energy infrastructure development strategy. By efficiently linking remote hydropower sources with key demand areas and potentially regional energy markets, merchant lines could significantly contribute to Nepal's goal of energy self-sufficiency and economic development. However, this necessitates careful planning, supportive regulatory and policy frameworks, market viability analysis, and a balanced approach to environmental and social considerations, ensuring that the merchant line model is effectively

integrated into Nepal's dynamic energy landscape.

Conclusion and Recommendations for Nepal's Transmission Sector Development

The journey towards revolutionizing Nepal's transmission sector through the strategic integration of Whole Network Concessions, Independent Transmission Projects (ITPs), Privatization, and Merchant Lines marks a transformative chapter in the nation's pursuit of energy autonomy and economic revitalization. Each model, with its distinct approach and nuanced benefits, converges towards a singular vision – to efficiently harness Nepal's abundant hydropower potential, enhance grid reliability, and position the country as a robust participant in the regional energy market. This endeavor is more than an infrastructural upgrade; it's a pivotal shift towards sustainable development, energy security, and socio-economic upliftment.

The potential of Nepal's hydropower is not merely a resource – it's a national asset that, if harnessed correctly, can propel the country towards remarkable economic growth and stability. The implementation of Whole Network Concessions and ITPs promises to bring much-needed efficiency and targeted development in the transmission sector. These models provide avenues to overcome historical challenges of underinvestment and inefficiencies, enabling the effective integration of remote hydropower plants with the national grid and beyond. However, the transformative power of these models hinges on meticulous implementation, underscored by robust regulatory oversight, equitable risk-sharing, and a commitment to sustainability.

Privatization and Merchant Lines introduce a paradigm where private efficiency and innovation are leveraged yet balanced with the imperative of national interests and public welfare. The cautious yet strategic approach to privatization, potentially through PPP models, opens doors to capital, technological advancements, and operational efficiencies. Merchant lines, on the other hand, offer a novel solution to optimize the distribution of electricity, fostering an environment conducive to investment and development. However, these models demand rigorous regulatory frameworks, market viability assessments, and a harmonious integration with the broader national energy goals.

Strategic Imperatives and Forward Path:

As Nepal stands at the cusp of this transformative journey, several strategic imperatives emerge:

- **Collaborative Policy Frameworks:** Develop collaborative policy frameworks that foster public-private partnerships, ensuring that private sector participation aligns with national energy priorities and public interests.
- **Inclusive and Transparent Governance:** Adopt inclusive and transparent governance practices in the energy sector to build public trust and ensure equitable access to energy resources.
- **Sustainable Development Focus:** Emphasize sustainable development in all facets of transmission sector planning, prioritizing environmental conservation and community welfare alongside infrastructure development.
- **Technological and Operational Excellence:** Encourage technological and operational excellence, adopting global best practices to enhance grid reliability, efficiency, and resilience.
- **Regional Integration and Cooperation:** Pursue regional integration and cooperation to leverage cross-border energy trade opportunities, enhancing Nepal's standing in the South Asian energy landscape.
- **Long-Term Vision and Agility:** Maintain a long-term vision for the energy sector coupled with the agility to adapt to evolving technological landscapes and global energy trends.

he comprehensive development of Nepal's transmission sector is an intricate tapestry of strategic planning, policy innovation, and collaborative effort. It requires a confluence of government resolve, private sector dynamism, and community engagement. The path ahead is complex and challenging, yet it is imbued with immense potential and promise. By navigating this path with foresight, prudence, and a commitment to sustainable and inclusive growth, Nepal can not only achieve energy self-sufficiency but also emerge as a model of progressive energy management in the global arena. This journey, while demanding, is pivotal to the nation's aspirations for a future characterized by energy security, economic prosperity, and environmental harmony.

Kremer is Chief of Party of USAID Urja Nepal Program.

This article is made possible by the support of the American People through the United States Agency for International Development (USAID.) The contents of this article are the sole responsibility of author and do not necessarily reflect the views of USAID or the United States Government.

E-Cooking for All- Can We Leave No one Behind in Reality?

Kushal Gurung

Diwakar Khadka

Roshan Chhetri

Amidst the challenges posed by climate change and the imperative for sustainable development, Nepal stands at a critical crossroads in its quest for cleaner cooking solutions. The Government of Nepal has articulated an ambitious objective within its second Nationally Determined Contribution (NDC) target, to ensure at least 25% of the population is using electric cooking (e-cooking) by 2030. This target assumes critical significance for Nepal, where the majority of households still rely on traditional biomass for cooking, thereby engendering notable health, environmental, and societal ramifications. The recent census data, as of 2078, underscores the prevailing situation, with a mere 0.53% of Nepalese households embracing e-cooking, thereby accentuating the substantial chasm separating the present state from the envisioned future. To realize the stipulated 25% target, Nepal confronts the imperative of augmenting e-cooking adoption by an order of magnitude nearly 50-fold within the next six years. Foremost among the requisite infrastructural prerequisites is the assurance of reliable access to electricity. Absent a steadfast and pervasive electrical grid, the transition to e-cooking remains a distant aspiration. The availability of dependable electricity is indispensable for fostering the wide-scale acceptance of e-cooking solutions, facilitating households in transitioning away from conventional biomass fuels towards cooking solutions that are both sustainable and conducive to human health.

Nepal has made notable progress in expanding its electrical infrastructure, achieving an electrification rate of 95.03%.

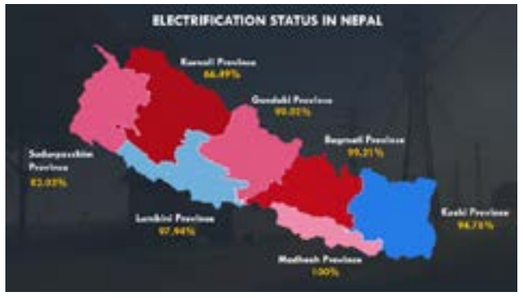


Figure 1: *Electrification status in Nepal (NEA, 2080)*

As of the fiscal year 2079/80, NEA had 5,134,058 customers, marking a 7.72% increase from the previous year. Among these consumers, a significant proportion—approximately 41.32% or 2,121,371 domestic consumers—possess a connection capacity of 5 Ampere (A) Miniature Circuit Breaker (MCB) only.

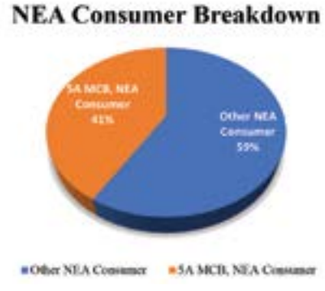


Figure 2: *Breakdown of NEA Consumers for Fiscal Year 2080/81*

This low-capacity connection could, however, potentially impede the widespread adoption of e-cooking solutions. 5A meter could take up to 1150 Watts (at 230 Volts) size e-cooking stove. Meanwhile, a typical e-cook stove, in general, has approximately 2000 Watts of power capacity. Hence, an upgrade to a 15A size is recommended for optimal performance. Such an enhancement ensures an ample power supply, thereby augmenting the efficiency and effectiveness of the e-cook stove, while offering a more reliable cooking experience. Addressing the needs of these consumers will be essential to ensure they have access to the necessary electrical infrastructure and support to transition to cleaner cooking methods. But what does the market data reveal about the demand for e-cooking appliances?

The import data demonstrates a remarkable trend in the demand for induction cooktops. Beginning in 2076/77 with a modest import of 10,435 units, the subsequent years witnessed an exponential surge in import, indicative of a growing preference for this eco-friendly cooking technology. Notably, in 2077/78, the import of induction stoves skyrockets to 152,588 units, marking a staggering increase from the previous year. However, from 2077/78 to 2078/79, there is a slight decrease in imports, indicating a possible stabilization or saturation of the market . From 2078/79 to 2079/80, there's another increase, although not as dramatic as the initial surge. Simultaneously, the data highlights a burgeoning interest in infrared cooktops, albeit on a smaller scale than that compared with induction stoves.

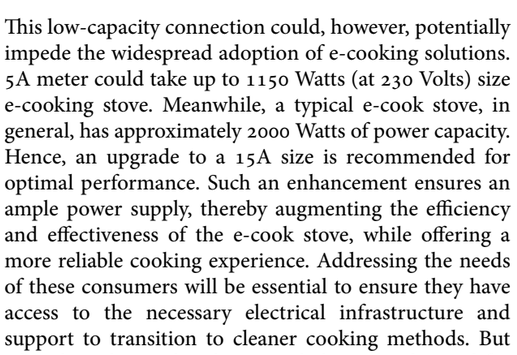


Figure 3: Import of Induction Stove in Nepal

Furthermore, the customs data of the fiscal year 2080/2081 reveals that the import duty rate for induction stoves is merely 1%, regardless of whether they are imported from SAARC countries or from another third country. This low import duty rate is likely aimed at making e-cooking stoves more affordable and promoting their adoption as a clean cooking solution in Nepal. Given this trend, it is crucial to assess the comparative costs with traditional LPG to understand the economic benefits for households.

Adoption of e-cooking in urban areas is relatively more feasible and economically viable compared to LPG. A comprehensive cost analysis comparing these two cooking methods illuminates significant potential savings for households switching to electric cooking . Though urban households are equipped with higher electrical load capacities and MCB ratings, than their rural counterparts, most of them still rely on LPG for cooking.

Transitioning to e-cooking entails an initial investment of approximately NPR 8,000 for households with a 15A MCB, covering the purchase of e-cookstove and associated with cooking utensils. However, households with a 5A MCB would have to invest an additional NPR 2,000 for wiring and MCB upgrades, totaling NPR 10,000. Considering an average family size of 4.37 members, urban households typically consume 8.70 units of LPG cylinders annually, amounting to a yearly expense of NPR 16,617- with each cylinder costing NPR 1,910.

By opting for e-cooking, the annual operating cost was reduced to NPR 8,040, resulting in savings of NPR 8,577 per year with a Benefit-Cost ratio of 1.64. For households with a 15A MCB, excluding wiring upgrades, the initial investment of NPR 16,040 covers appliances and additional energy consumption, offsetting within 11 months through these savings, rendering e-cooking a financially viable option.

Figure 4: Cost for Transition to 100% e-cooking

However, ensuring a reliable power supply, even in urban areas, is still a big challenge for Nepal Electricity Authority (NEA). Hence, using e-cooking, alongside LPG as a backup option, would be ideal. In a 50/50 hybrid scenario, where both e-cookstove and LPG are used evenly, the annual cost for a household would be NPR 20,929. This includes the fixed cost for appliances of NPR 8,000, the cost of LPG cylinders for 50% usage at NPR 8,309, and additional electricity consumption of 360 kWh costing NPR 4,620. Benefit-Cost ratio for this scenario is 0.69. The payback period for the initial NPR 8,000 investment is only 22 months, making e-cooking an economically viable option for urban households when combined with LPG.

Figure 5:Cost for Transition to 50% e-cooking

The cost analysis demonstrates that transitioning to e-cooking is not only environmentally friendly but also economically beneficial. Lower operating costs and a relatively a short payback period for the initial investment make e-cooking an attractive option. As more households adopt e-cooking, it will contribute to reducing the reliance on LPG, decreasing household expenses, and promoting a cleaner and more sustainable cooking solution.

Nevertheless, despite all the cons, traditional biomass cooking still dominates the Nepali Kitchen, raising significant health concerns. Currently, more than 60 percent of Nepal's population relies on traditional solid bio-fuels for daily cooking. Because traditional fuels do not burn efficiently, they produce excessive smoke along with countless toxic particles and harmful chemicals, putting everyone in the kitchen at risk. Consequently, there is an increased likelihood of respiratory, heart, chest, and lung diseases. According to a study by the World Health Organization, approximately 22,800 Nepalese die annually in Nepal due to smoke-related diseases.

Transitioning to e-cooking not only promises to mitigate the devastating effects of indoor air pollution on public health, but also holds the potential to reduce deforestation, empower women, and contribute to Nepal's overall sustainable development goals. However, achieving this target and ensuring that no one is left behind requires addressing multiple challenges, including affordability, reliability of electricity supply, awareness, and behavior change. Particularly for the disadvantaged groups, with minimal electricity consumption, transitioning to e-cooking poses significant challenges.

For 5A households consuming less than 20 units of electricity per month, NEA currently requires them to pay only Rs 30 as a monthly fee . If they were to use an e-cooking stove and consume an average of 2 units of electricity daily, their monthly consumption could easily exceed 60 units. This would place them in a higher tariff bracket, requiring them to pay NPR 690 per month, which represents a substantial increase of 20 times more than what they were previously paying. Hence, these households would be reluctant to switch to e-cooking.

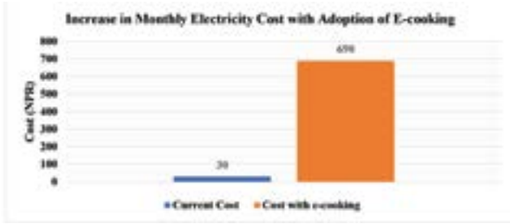


Figure 6:Comparison of Monthly Electricity Costs

Although firewood can be collected freely, there are significant opportunity costs associated with its use, including the time spent collecting it and health-related issues. Women in these households spend hours gathering firewood, which could have been dedicated to other productive activities. Additionally, indoor air pollution caused by burning firewood poses health risks to the household members. While the financial return from using e-cooking may be negative, there could still be economic benefits if the time saved from not collecting firewood is used for paid employment or other income-generating activities. However, this assumption of finding paid work may not be always true, as related job opportunities could be limited. And again, the switching cost, including wiring upgrades, and purchasing a stove and utensils (approximately Rs 10,000 per household), may pose a significant barrier. Banks may not be interested in providing loans for such small amounts. Microfinance institutions (MFIs) and cooperatives could serve this segment, but their interest rates are relatively high. Hence, incentivizing and offering subsidized financing options is imperative to facilitate the adoption of e-cooking among such households, enabling them to overcome initial costs and embrace cleaner cooking solutions.

Alternative Energy Promotion Centre (AEPC) has been undertaking various initiatives to promote clean cooking solutions in Nepal. One notable project by AEPC is a $49.2 million Green Climate Fund (GCF) project in clean cooking solutions . This project targets distributing 500,000 electric stoves (e-cookstoves), 490,000 Tier 3+ improved cookstoves (ICS), and 10,000 biogas plants in 150 local governments, spread over 22 districts of Terai. This project alone will provide e-cooking access to 7% of the entire population.

Similarly, AEPC, through the National Rural and Renewable Energy Programme (NREP), has established a Sustainable Energy Challenge Fund (SECF) to provide capital grants and interest subsidies on renewable energy technologies (RETs), including e-cooking solutions. Microfinance institutions and cooperatives are already

leveraging this fund to offer subsidized interest rates to their clients/members, facilitating the adoption of e-cooking solutions.

While SECF's interest subsidy may alleviate financial barriers, it may not still be sufficient for the Disadvantaged Groups (DAGs), consuming less than 20 units of electricity per month. To address this, the NEA would have to introduce a subsidized tariff structure for them to reduce their operating cost. To further support the adoption of e-cooking solutions among the DAGs, Local Governments (LGs) also need to develop targeted packages in collaboration with NEA and AEPC. Additionally, AEPC can explore revenue generation through the sale of carbon credits on the international market, leveraging the environmental benefits of e-cooking projects. The funds obtained from selling these carbon credits can be reinvested into providing grants for e-cooking initiatives, creating a sustainable funding cycle that promotes clean energy adoption and reduces the financial barriers for the most economically disadvantaged communities in Nepal.

GCF vs Carbon Market

Green Climate Fund was established in 2010, within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) to assist developing countries with climate change adaptation and mitigation activities. The first GCF project was approved in 2015, and already four GCF projects have been approved for Nepal. Meanwhile, the Carbon Market has a little longer history-UNFCCC's Kyoto Protocol in 1997 formally opened the platform for emissions trading between countries with binding targets, through various market-based systems. One such initiative was the Clean Development Mechanism (CDM), which permitted a country with an emission reduction or limitation commitment to execute or finance a project in a developing nation. This project could then generate saleable certified emission reduction (CER) credits to help the country meet its Kyoto Protocol targets. Nepal registered its first CDM project in 2005, by AEPC.

GCF is indeed a good platform for countries like Nepal to access grants for clean cooking projects, however, it could be debated if it is a better option than Carbon Market, in terms of value for money. Furthermore, GCF project approval process is very lengthy, with a median line of 21 months, which could make the project itself redundant by the time of implementation!

For the GCF-funded clean cooking solutions project, of a total of USD 49.2 million, AEPC received only USD 21.12 million as a grant. However, by entering the carbon market and selling carbon offsets generated from the project, AEPC could have potentially earned even more revenue. If an e-cooking stove could save 1.5 tons of CO_2e annually, then the 500,000 electric stoves would save 3,750,000 tons of CO_2eemission over 5 years. Though carbon credits from an e-cooking project can fetch up to $25 per credit for 7 years in the voluntary market, if we take a conservative value of the carbon credits at $20 per ton, for 5 years only, this could still earn $75 million from carbon revenue!

The calculation details
Annual CO2e Savings per Stove: 1.5 tons
Number of Stoves: 500,000
Annual Total CO2e Savings:
1.5 tons/stove * 500,000 stoves = 750,000 tons CO2e
Total CO2e Savings over 5 Years:
750,000 tons/year * 5 years = 3,750,000 tons CO2e
Revenue from Carbon Credits:
3,750,000 tons CO2e * $20/ton = $75 million

Thus, for e-cooking projects, Nepal can decrease reliance on grants by tapping into the carbon market. Carbon finance can make e-cooking more affordable for economically disadvantaged groups by monetizing offsets from its widespread adoption. This revenue can fund subsidies, lower tariff rates, and provide financial assistance, ensuring environmental and health benefits reach those most in need. This approach improves access to e-cooking while reducing greenhouse gas emissions and enhancing community welfare.

E-cooking holds great promise for environmental sustainability and public health, but it also presents significant challenges, particularly in making it affordable for disadvantaged groups. To ensure that no one is left behind, it is essential to implement targeted financial assistance, subsidies, and support mechanisms that address these economic challenges. This includes subsidized tariff structures, targeted financial assistance, and leveraging carbon finance to generate sustainable revenue. This integrated approach will facilitate the widespread adoption of e-cooking, directly contributing to Nepal's sustainable development goals and fostering a cleaner, healthier future for all its citizens. It is imperative that we act now to ensure benefits to everyone out of these advancements!

The writers of this article are affiliated with Wind Power Nepal Pvt. Ltd.

Potential GHG Emissions in the Transport Sector by 2050 and Counter Role of Electric Mobility – a Case of Kathmandu Valley

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Dr. Ajay Kumar Jha, Dr. Hari Bahadur Darlami, Prof. Dr. Ramchandra Bhandari

"The unique bowl-shaped topography traps pollutants inside the valley for longer periods which is home to around three million people making it prone to adverse health effects that are not only diminishing the quality of life but also threatening the prosperity of an urban economy. "

Background

Globally, the transportation sector is a third contributor to greenhouse gas (GHG) emissions. Out of 36.80 gigatonnes (Gt) of global energy-related carbon dioxide (CO_2) emissions, 7.98 Gt was counted from the transport sector alone, making it the third largest contributor in 2022. Emissions from this sector have almost tripled due to growing populations and economies since 1970. Nepal is no exception relying completely on imported petroleum products. The capital city of Nepal, Kathmandu Valley, with its unique bowl-shaped topography faces major urban challenges including inadequate mobility and poor air quality. This article aims to quantify GHG emissions from conventional vehicles and analyze the counter role of electric mobility in Kathmandu Valley to make it a livable place.

GHGs are responsible for global warming on earth. Human induced activities - primarily fossil fuel burning, which increases heat trapping GHG levels in earth's atmosphere - are the dominant cause behind the observed global warming since the mid-20th century. Energy is a vital commodity for economic development and a key factor for anthropogenic GHG emissions.

Nepal is among the ten least urbanized countries in the world; however, it is among the top ten countries with highest growth rate of urbanization. Kathmandu Valley, the capital and the largest city of the country, is one of the fastest growing metropolitan areas in the South Asian region. The valley is experiencing rapid and haphazard urbanization with the increasing demand for motorized travel, rising CO_2 emissions, poor urban air quality and higher concentrations of particulate matter well above the World Health Organization (WHO) guidelines. Valley holds 10.4% of the country's total population and occupies 0.5% of the total area of the country.

The unique bowl-shaped topography traps pollutants inside the valley for longer periods which is home to around three million people making it prone to adverse health effects that are not only diminishing the quality of life but also threatening the prosperity of an urban economy. As per the WHO, air pollution kills an estimated seven million people worldwide every year and every nine out of 10 people breathe air containing high levels of harmful particles. The air pollution levels in Nepal are 4.9 times higher than those recommended by the WHO. Such pollution has been consistently found to be the leading risk factor for death and disability in Nepal.

Nepal has undergone a remarkable vehicular growth, although the country is still in the early stages of motorization. The number of registered vehicles in the country grew at a rate of 14.6% during 1997 to 2021, while this growth rate exceeded 17% during the past 6 years from 2015 to 2021. Among the vehicle types, the growth in the number of two-wheelers is particularly high in the country, which grew at a rate of 16% during 1997 to 2021. Out of the total vehicles registered in Nepal, the Bagmati Province constitutes a major share of about 45%. The majority of these vehicles registered there run on the roads of Kathmandu Valley. This growth in the number of vehicles is expected to rise continuously with the increasing road infrastructure development, urbanization, motorization, and economic progress.

Domestic Energy Availability and Policies on EVs

Nepal has immense potential for generating electricity using renewable energy, especially hydropower. It can be harnessed to support the growth of electric mobility. The Government of Nepal (GoN) has committed to increase the share of electric vehicles (EVs) in transportation system through various policies such as the Second Nationally Determined Contribution (NDC); Long-Term Strategy for Net-Zero Emissions; Five-year Periodic Plan; National Transport Policy; and Environment Friendly Vehicle and Transport Policy. Explicitly, GoN aims to achieve the share of EVs to 25% and 20% for private vehicles and public passenger vehicles sales respectively by 2025, and further targets to increase the share of EVs to 90% and 60% for private vehicles and public passenger vehicles sales by 2030. To attain the set target, GoN has introduced various policies and incentives to promote electric mobility via periodic financial legislations, including tax exemptions, subsidies, preferential treatment in registration, exemption of annual road tax, reduced custom duty, and excise duty ranging from 10-60% and 0-60% respectively. Tax holidays for domestic manufacturers of EVs are provided for 5 years with a 40% discount in trade tax. Further, a custom duty tax relaxation of up to 75% is given to import spare parts of EVs. Also, the GoN has promotional policy to convert Internal Combustion Engine (ICE) vehicles to EVs; while doing so, it charges only 1% custom duty to import the needful conversion kit. These policies have made EVs more affordable and accessible for consumers in recent years. As a result, there has been a gradual shift towards electric mobility in Nepal, with increasing adoption of electric two-wheelers, cars and buses.

Several fiscal and non-fiscal incentives have been put forward to facilitate the adoption of clean mobility across Asia. India has introduced a flagship scheme offering various incentives for promoting electric mobility and hydrogen fuel cell vehicles. India's state level policies prevail financial incentives, waiving road tax and registration fees, establishing a wide network of charging stations and swappable battery stations, setting up of recycling ecosystem for batteries, levying of additional taxes and fees on inefficient or polluting vehicles, etc.

Maharashtra state of India has adopted policies to accelerate the adoption of battery operated EVs (BEVs) such that they contribute to 10% of new vehicle registration by 2025. India is aspiring to establish Delhi as the EV capital of the country by accelerating the pace of EV adoption across vehicle segments contributing BEV's by 25% of all new vehicle registrations by 2024. Bangladesh proposes a 10-year tax holiday for local EV assembling and manufacturing, establishment of energy-efficient vehicle manufacturing fund to deposit fines and taxes collected from environment polluting vehicles to meet the country's targets of transforming the majority of the passenger cars and public vehicles (mainly buses, trucks, and three-wheelers) to EV by 2030.

Likewise, China, which is the giant share-holder (47%) of EVs globally, has been promoting EVs by the urgency of reducing GHG emissions in the transport sector starting from the most polluted cities including Beijing, Shanghai, and Shenzhen. A range of monetary incentives such as financial subsidies and tax exemptions for fuel-saving capacity, mileage per charge performance, new vehicle purchase and exemption/reduction of annual vehicle tax have been implemented in China.

Non-monetary incentives such as traffic control exemptions, research and development support, license plate/registration privilege, parking fee incentive, road access privilege with city's traffic control during peak hours have also been exercised. Chinese government has also set the rule for new vehicle manufacturing companies to compulsorily include EVs production along with petroleum vehicles.

Materials and Methods

The study conducted a primary survey, a structured survey, to

estimate transport energy consumption and mobility characteristics for the base year 2022. The survey questionnaire included the information such as energy consumption along with the mobility characteristics, the socioeconomic information of the vehicle users, details of transportation registration, technical parameters like mileage, distance covered per day, fuel consumed per day, load carried etc. Besides data, the survey also provided information on barriers and hindrances for a widespread shift towards electric vehicles and the preferred mode of electric vehicles. The surveyed respondents include EV company professionals, vehicle users and national experts/policy makers. To realize the existing context and knowledge extension for future analysis, base year primary dataset collection and analysis are major contribution.

The secondary data was collected through literature. Information included such as demographics, national and provincial energy consumption, emission factors, macroeconomic data such as Gross domestic product, transport gross value added of the valley has been estimated using the proportions of GDP of the valley with respect to the national GDP provided in the National Human Development Report, and transport sector plans and policies.

This study has used the Low Emission Analysis Platform (LEAP) as the modeling tool to forecast energy consumption and to quantify the associated GHG emissions in the business-as-usual (BAU), sustainable development (SD), and net-zero emission (NZE) scenarios. Additionally, the study has estimated co-benefits, focusing on local pollutant reductions.

Results

With the present trend of increasing urbanization, motorization and development, the GHG emissions from transportation sector are estimated to increase to more than triple by 2050 in the BAU scenario, as presented in Figure 1. With the adoption of electric mobility, the SD scenario would reduce GHG emissions up to 95% in 2050. The NZE scenario foresees complete electric and hydrogen-based vehicles by 2045 with complete abatement of GHG emissions as well as local pollutants. The SD and NZE scenarios will demand 64% and 84% less energy than the BAU scenario respectively as shown in Figure 2 contributing to enhanced energy security and energy sustainability. For this, the adoption of electric mobility will demand about 1048 GWh and 1390 GWh additional electricity solely for Kathmandu Valley to achieve the SD and NZE scenarios respectively by 2050.

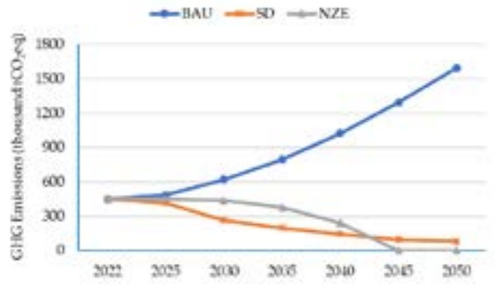

Figure 1: Comparative analysis of GHG emissions from transport sector

Figure 2: Comparative analysis of transport energy consumption in Kathmandu Valley

Co-benefits of GHG Emission Reductions

The actions to reduce GHG emissions will produce co-benefits in terms of local air pollutant reduction from the transport sector. The complete replacement of the conventional ICE vehicles with the electric and hydrogen fueled ones in the NZE scenario would also subside carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), nitrogen oxide (NO_X), particulate matter-2.5 ($PM_{2.5}$), black carbon (BC) and organic carbon (OC) emissions. This will be a substantial relief to dwellers of the valley where local pollutants are being resident due to its bowl-shaped topography. The local pollutant CO emissions from the road transport sector in the valley are estimated to rise by 5.8 times by 2050 under the BAU scenario, while the increased electrification schemes would cause it to fall by 99% in the SD scenario. NMVOC emissions in the BAU scenario would increase more than seven folds while it would be completely abated by 2050 in the SD scenario, and from 2045 onwards in the NZE scenario. The OC, PM2.5, BC, and NOX emissions would undergo nearly eight folds, seven folds, four folds and two folds increase respectively in the BAU scenario. These local air pollutant emissions would be abated by more than 90% in the SD scenario by 2050 compared to the BAU scenario. This provides an informed decision to city planners on strategies to transform the city into a more breathable environment.

Requirement of Electricity Infrastructure

More importantly attainment of the NZE scenario requires a large increase in the number of electric vehicles, nearly 1.4 million in 2045 and 1.7 million in 2050. Thereby, the additional electricity capacity requirement would be 247 MW in the SD scenario and 327 MW in the NZE scenario in 2050. This equates to additional electricity consumption requirement of 1048 GWh in the SD scenario and 1390 GWh in the NZE scenario in 2050. The capacity addition seems to be achievable with national existing and future power system expansion plans and would be supplemented by pipeline hydro power projects. It should be noted that the pledge for NZE scenario has been driven worldwide for 2050 while Nepal optimistically has set the targets for 2045 with conditional targets. These figures indicate that power sector development as well as the related transport sector infrastructure development should be prioritized accordingly in order to support the large-scale penetration of electric vehicles in the Valley. For this, the development of electrical infrastructure for charging stations should also be given priority. The new installation and expansion of charging stations demand high investments and sufficient space for building EV charging infrastructure, thereby imposing huge challenges for easy implementation of EVs.

Discussion on Challenges and Opportunities for Promoting EVs

Besides structured survey, broader stakeholders' consultations in presence of representatives from the National Planning Commission, different ministries, other government institutions relevant to trading/supply/generation of energy, trading/manufacturing of electric vehicles, academia/research institutes, development partners, practitioners, journalists etc. was held at the Alternative Energy Promotion Centre (AEPC), Kathmandu in April 2023 for validation as well as for further inputs of this study.

Out of the total installed electricity generating capacity of 2,190 MW about 735 MW was added into the national grid system of Nepal in FY 2021/2022 alone. This initiative has upgraded the nation into the era of surplus electricity during the wet season. This number has been in continuous rise, and it has become 3,141 MW till May 2024. Electricity generation capacity from hydropower as well as other renewable energy options (such as solar power) is likely to grow in subsequent years which can result in surplus electricity year-round. Proper planning regarding charging of EVs during off peak hours can help the country in demand management along with smoothening the load curve as well as utilization of spillage energy.

Likewise, EVs will create new jobs and avenues of local manufacturing opportunities. The increased EV promotion can contribute to technological advancements, reduce import dependence, and generate jobs in manufacturing, assembly, maintenance, and service sectors.

In contrast to massive opportunities, expansion of EVs as targeted requires sufficient electric power infrastructure. In the valley specifically, the increased penetration of EVs will increase the demands on the power network that can lead to negative consequences such as an increment of the short-circuit currents, non-standard voltage levels, reduced power quality, and accelerated aging and failure of electrical equipment. Hence, significant reinforcement and investment in the power network will be required to ensure that the GoN's targets are achieved. Huge challenge remains at the government side as well as at the private and public sector in leveraging resources in partnerships with international organizations for investments in charging infrastructure, providing technical expertise, establishment of repair and maintenance centers in par of ICE vehicle, support awareness campaigns, developing curriculum for EVs for wider acceptance and development of workforce needed in near future.

Further, challenges like high initial investment, very low-capacity utilization, smaller number of public vehicles, only import based technology, challenge on technology transfer locally, poor voltage profile, insufficient skilled manpower in EV industry, batteries and recycling, grid infrastructure development are to be mitigated at the par possible for sustainable EV promotion within the valley.

In recent years, the cost of EVs has been decreasing rapidly making it a competitive travel option for people in developing countries. Modern EVs can commute hundreds of kilometers along with the possibility of commuting in difficult terrain, making them a practical choice. A total of 51 EV charging stations have been installed across 33 locations all over Nepal by the Nepal Electricity Authority (NEA). Beside this, other private companies are also installing charging stations around the country.

Study done by GGGI in 2018 reveled that if BAU scenario continues in Nepal, GHG emissions at the national level will increase by two-folds in 2030 and five-folds by 2050. The transport sector nearly doubles its GHG share by 2050 (from 2005 levels). Being the nation's cultural and political hub, the wide adoption

of EVs in the valley would be hugely contributing for nation's NZE target. Currently, Nepal incurs high economic burden as the country fulfills its petroleum fuel, ranked as top first imported commodity with the share of 18.7% of total imports, needs solely through imports. Nepal Rastra Bank published the data of this fiscal year 2023/24, for the nine first months about 218 billion NPR was spent solely on imported petroleum products. As Nepal has huge potential to develop domestic hydroelectricity, the country has immense potential to leapfrog in EV adoption.

By addressing the challenges and leveraging the mentioned opportunities, the valley can establish itself as a hub for electric mobility, contributing to sustainable and cleaner transportation and present itself as an example city for the developing countries with similar characteristics.

Conclusions

The potential role of transport sector electrification and deployment of green hydrogen fuel vehicles in GHG mitigation in the valley has been assessed during 2022 to 2050. With the present trend of development, energy consumption would undergo a fourfold increase by 2050 in the BAU scenario. Two-wheelers would remain the most prominent mode of energy consumer. The GHG emissions are estimated to undergo more than threefold increase. Aligned with the targets of both the NDC and the SDGs, there will be a huge reduction in petroleum consumption in 2050 i.e., 74% in the SD scenario and 100% in the NZE scenario.

Hydroelectricity and green hydrogen would play a major role in complete decarbonization of the transportation sector of the Valley, phasing out the petroleum fuel in the sector. By 2050, electricity is expected to contribute 82% of the total energy consumption of the transport sector of the Valley, with hydrogen fuel accounting for the remaining 18%.

GHG emissions in the NZE scenario are projected to reach 438 thousand tons by 2030 and achieve zero emissions by 2045 contributing to the national goal of achieving net-zero emissions. The complete electrification in passenger transport along with the introduction of green hydrogen fuel vehicles, particularly in hard-to-abate heavy-duty vehicles in the freight transportation sector would support in phasing out the petroleum fuels. Hence, readiness for green hydrogen fuel for vehicles will be needed well before 2045.

Since 2003, Nepal has been utilizing 100% renewable energy for electricity production. Further harnessing the untapped renewable energy potential would support the growth of electric mobility, thereby making possibility for complete decarbonization. Nepal endowed with the potential to tap 100% renewable energy, would be a sustainable solution to replace the imported fossil fuel contributing to energy security and economic prosperity in the context of an import driven economy like Nepal.

This paper serves as evidence to motivate policy implementers and city developers to enforce wide implementation of the efficient mode of electric as well as hydrogen-based vehicles. Simultaneously this study opens an avenue for further research on potential strategies for phasing out plan of conventional ICE vehicles with the needful stable national and municipal fiscal policies to realize SD and NZE targets. Having recycling plants within the country or appropriate end-life vehicle/battery management system in view of possible environmental impacts, a specific city wise investment scenario for total transport ecosystem could also be an area of further research for proper allocation of resources.

Mitigating GHG emissions in cities is crucial for achieving net-zero emissions and addressing climate change. Cities are significant contributors to global carbon emissions due to their concentrated population, energy consumption, and infrastructure. This study can act as an inspiring example and can also be replicated to other similar growing cities of developing countries for improving pollution levels and making them sustainable and habitable. Hence, this paper is expected to help policy implementers, transport planners and city administrators to develop adequate action plans and policies for improving pollution levels and making the cities of developing countries sustainable and habitable.

Reference:

Rajbhandari, S.; Shrestha, S.L.; Bhandari, R.; Jha, A.K.; Darlami, H.B. Contribution to the Net-Zero Emissions Target from the Transport Sector through Electric Mobility—A Case of Kathmandu Valley. Sustainability 2024, 16, 1211. https://doi.org/10.3390/su16031211

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Pawan Dhakal, Managing Director at Troyer Hydro, is a Germany graduated Engineer with over 24 years of professional expertise in the hydropower and aerospace sectors. He has demonstrated his expertise in various roles including Design Engineering, Project Management, After Market Service, Sales and Marketing, and Senior Management across several multinational companies in Europe, working on hydropower projects worldwide. Dhakal is a shareholder and Managing Director at Troyer Hydro, a subsidiary of Troyer AG, Italy. He is also responsible for sales and marketing in South and Southeast Asia.

'Troyer's Motto:
Sustaining Reliability for Tomorrow and Beyond'

Could you elaborate on Troyer and its background?

It is an old and globally renowned company Troyer SpA, located in Vipiteno, Italy, capitalized on the boom in small and medium-sized hydropower plants with capacities ranging from a few kilowatts to 30 MW per unit. Founded in 1934 by Valentin Troyer as an electromechanical repair workshop, the company soon specialized in supplying small hydroelectric power plants and quickly gained recognition in South Tyrol and beyond. Today, Troyer operates in America, Asia, and Europe with a major market presence in Alpine countries (Switzerland, Austria, Italy), Brazil, Norway, and notably, Nepal. In addition to these markets, the company also has promising projects in other countries worldwide. In 2023, Troyer became part of the HTI group.

What kind of equipment has this company been producing?

Troyer serves as a single-point contact for customers, supplying water-to-wire solutions on a turnkey basis globally. It manufactures complete turbines, main-inlet valves, and automation and control systems, including protection systems for power plants at its factory in Vipiteno, Italy. For other components such as generators and balance of plant equipment, Troyer collaborates with strategic partners to provide comprehensive solutions.

How is Troyer expanding its business globally?

Troyer believes in establishing long-term strategic partnerships with customers. The company carefully selects new markets worldwide to ensure a lasting presence that meets customer expectations and market requirements, rather than pursuing short-term goals.

How does Troyer aim to establish itself in South Asia and Southeast Asia?

Troyer aims to position itself as a trusted and long-term partner for customers, offering reliable support and emphasizing quality over quantity. Quality is derived from customer trust in Troyer's services, responsiveness, and accountability. In essence, Troyer seeks to earn full customer trust in selected markets by being a dependable and accountable partner with a strong local service footprint.

When did Troyer enter Nepal, and with which hydropower project?

Troyer began its operations in Nepal in 2021, starting with the Super Chepe Khola (9.05 MW) entrusted by Ridge Line Company Limited. The project is currently operational and successful. The same business group has also entrusted Troyer with the second project, Dudhpokhari Chepe (11 MW). The Nepalese market has responded positively to Troyer, leading to the company's involvement in another 10 projects with a combined capacity of more than 250 MW at various stages of development.

Dozens of turbine manufacturers are expanding their businesses in Nepal. How does Troyer stand out among these companies?

As previously mentioned, Troyer prioritizes long-term strategic planning and local presence in its business development approach. This strategy includes establishing a local branch office in Nepal and a subsidiary in India, adhering to its motto of "Think globally, act locally." Additionally, Troyer ensures consistent quality across its equipment and services worldwide, whether in Switzerland, Brazil, or Nepal. This approach differentiates Troyer by offering reliability and accountability, supported by its own modern facility for manufacturing components and programming and installing automation, control, and protection systems.

What differences exist between Troyer and other companies regarding equipment quality?

Troyer maintains uniform standards for mechanical and electrical components manufactured at its facility in Vipiteno, Italy. With over 90 years of successful history, Troyer is renowned for its high-quality mechanical components and advanced yet straightforward automation technology, holding more than 70% market share in the small hydro sector in Switzerland. While there are numerous turbine manufacturers globally, few have their own modern facilities for manufacturing components and deploying automation, control, and protection systems. This advantage ensures reduced lead times during installation and commissioning, as well as minimal downtime due to swift remote troubleshooting—a significant benefit for Troyer's customers in Nepal.

How many projects has Troyer worked on in Nepal?

Troyer has successfully completed the Super Chepe Khola, currently operational, and is involved in another 10 projects totaling 250 MW, progressing through various stages of design and manufacturing.

Have there been any complaints regarding equipment in completed projects?

It is unrealistic to claim that no complaints have ever arisen regarding equipment. However, Troyer prides itself on its responsiveness and support, ensuring minimal complaints thus far and aiming to maintain this standard in the long term.

Why should hydropower developers choose Troyer's equipment?

Developers seeking a reliable, accountable, and trustworthy supplier will find Troyer to be an ideal choice.

Troyer is sometimes criticized globally as a financially unstable company. Can such a company compete with others that deliver quality work?

Troyer's entry into the HTI Group in 2023 presented an opportunity for substantial international growth and synergy, leveraging the group's resources and expertise. This strategic move has enabled Troyer to redefine its structure and processes while focusing on its core strengths, particularly the quality and customization of products to maximize power output. In 2023, Troyer achieved a turnover exceeding €38 million, marking a 50% increase from the previous year. Future projections indicate continued growth through increased investment and hiring, positioning Troyer to compete effectively with global industry leaders based on innovation and quality.

What are Troyer's future business plans?

As previously mentioned, Troyer intends to solidify its position as a leading supplier in the medium hydro segment, emphasizing local service and customer trust.

What strategy does Troyer plan to adopt for its operations in Nepal while competing with other companies?

Troyer's strategy involves thinking globally and acting locally, prioritizing trustworthiness, reliability, and accountability. The company adheres to its motto of "Reliability beyond tomorrow" in its partnerships with hydropower companies in Nepal.

How World Bank's Support for a Hydropower Dam Energizes Nepal's Development

Pravin Karki

Deepak Subedi

Since 1982, the Kulekhani hydropower dam has played a key role in Nepal's development. Co-financed by the World Bank Groups' International Development Association (IDA) in the mid-1970s as its first support to the power sector in Nepal, the scheme comprises a 114 meter tall dam that impounds a lake spread over two square kilometers. The dam diverts water to Kulekhani I, the first of a 3-plant cascade through a 6 kilometer tunnel.

On a recent visit to Kulekhani, a two-hour drive from Kathmandu, we met Tara Datta Bhatta, Nepal Electricity Authority's (NEA) Plant Manager for Kulekhani I. Tracing back the history of the plant, he recounted how the plant was the backbone of Nepal's national electricity supply from 1982 to 2002, before Kali Gandaki – a 144 MW run-of-river hydropower project – start generating power in 2002.

According to Bhatta, the plant currently serves as a power system backup on standby in case of an emergency or to supply power to the national grid when needed.

In addition to power, the reservoir is also generating opportunities for local tourism. The Kulekhani area has become a prime destination for domestic tourists and the fish harvested from the lake and boating have helped boost the local economy. "Kulekhani area now houses numerous hotels and resorts with the capacity to accommodate 2,000 guests and the dam is significantly enhancing local employment." Says Krishna Shrestha, a local resident and business owner. "Due to this, many people who left the area in the 70s have started returning."

Catalyzing the Impact of Hydropower

When the World Bank appraised the Kulekhani I Project in 1974, Nepal had an installed capacity of only 40 MW. The population at the time was 13 million and total GDP stood at USD 1,280 million – just US$ 100 per capita.

There were about 64,000 consumers of electricity, representing less than 3% of the total population. However, demand was increasing by 14% per annum and projections showed that, by 1984, the country would need 94 MW. At the same time, load shedding (controlled outage of electricity supply to parts of the power system consumers) and high costs for diesel were putting pressure on the Nepali economy.

When the Kulekhani I hydropower project became functional in 1983, it had a transformational effect on Nepal's power sector. Providing 60 MW of continuous power supply for all hours of the day, it notably reduced the load shedding.

The plant generated 165 Gigawatt hours (GWh) of primary energy and 46 GWh of secondary energy annually, replacing 65,000 tonnes of imported fossil fuel each year. The most significant effect was that, with its 73 million cubic meters of live storage, Kulekhani was able to meet peak demand during the winter months, when the combination of lighting, cooking, and heating caused evening peak demand to rise more than 20% above summer peak demand.

The other six hydro plants in Nepal (totaling 37 MW) were run-of-river plants that depend on the river flow, and their output was nearly 80% lower during the dry season. During the summer, Kulekhani reservoir was replenished, while the run of river plants were used.

Kulekhani I dam enabled the addition of two further projects downstream of the Rapti River, using the regulated flow from the Kulekhani reservoir. Kulekhani II (32 MW) and Kulekhani III (14 MW) were commissioned in 1986 and 2015, respectively. Additional benefits included the downstream irrigation of about 10,000 hectares of farmland along the Hetauda valley, as well as the boost in the commercial fisheries, boating, increase in resorts, hotels, and home stays in the vicinity.

Lessons from Kulekhani

Kulekhani I project, however, has had its share of challenges. It has experienced sedimentation problems, which are common to many dams, due to erosion in the watershed and cloud burst events. In addition, cost overruns have impacted negatively on the cost-benefit ratio. The construction of the dam also resulted in the relocation of several hundred local people, which necessitated working closely with local communities and the payment of compensation, as well as assistance with resettlement.

"When the Nepal government started to build this lake in the late 70s, a few hundred people were displaced," recalls Bhatta. "They were paid compensation by the government and resettled elsewhere."

Despite these challenges, Kulekhani has demonstrated how sustainably developed hydropower and water storage can be transformational, with long-term impacts on economic growth, human capital development, and regional development.

Kulekhani has also set an example for Nepal Electricity Authority in terms of maintenance, as the plant has not required any major maintenance since 2010 due to efficient operation and the quality of the equipment installed in the project.

Although all large-scale infrastructure projects have an environmental impact, hydropower with water storage has multiple benefits, providing the water and energy needed for navigation, agriculture, flood control, and economic growth.

Building on the lasting impacts of the investments like Kulekhani I, IDA continues to support Nepal's drive towards boosting energy generation and consumption for the country's greener, more resilient, and inclusive economic development.

The writers of this article include a Senior Hydropower Specialist and an Energy Consultant at the World Bank.

Success Stories of Invest in Nepal

Samrath Mogha

Furthermore, due to the construction of the projects, a local transmission line and a local grid are built much before the projects are commissioned.

Many people have a reason to be fascinated with Nepal, some due to Mount Everest, some due to the beautiful valleys and the flowing rivers, and some due to the greenery. I am enchanted by its heritage. I was born to an Indian American father and a Nepali mother about some 30 years ago. I have been observing Nepal since my childhood and seeing the gap in development, the gap in the standard of living coming here for a month out of the 12 in a year. So, when I was 16, I found out about the possibilities in the energy sector in Nepal. I mean, I know this seems like a very young age, but this is true. I found out about the possibilities in the energy sector, and I went to college determined to become an engineer in the renewable space because I could see myself coming back here and hopefully generating a few megawatts of electricity and that's what has happened.

In 2016, I established Mogha Energy, right after graduating, when I was 22. I came to Nepal to understand what the market was like and what the investments here were like. Through our local partners, MV Dugar Group, we decided in 2018 to invest in the Likhu-1, Likhu-2 and Likhu-A hydroelectric projects. We have come a long way since then, from a one-day drive and a two-day trek to reach our site. We can do it into our power plant.

Not only this, but we have also used the most advanced method of construction. Whether or not it is using the most, reliable tunneling equipment or the highest safety standards, we are the most experienced contractors and this has allowed us to set many records, one of which is the fastest tunnel construction in a month. We have done this with our formidable and skilled team in the country, and all of this has resulted in production of very highly reliable power plants at a good cost, generating more than 98 percent of the planned energy.

Now we are not only providing clean and green energy to the Nepalese grid, but we also believe that the hydropower story goes much further than that. If you look at the impact our projects have had, we've constructed 110 km of road while constructing the projects. I've not only gotten probably a little heavier, but this has impacted. This means that the people, roughly 40,000 to 50,000, who live alongside that road can now reach Kathmandu in about eight hours, as opposed to three days earlier. This means that doctors and teachers, who were not ready to walk three days to work somewhere, are now looking for opportunities in that area. This means that when a project is constructed, a hospital is built which is not only available to our local manpower but also to the local community.

Not only do roads help in an emergency but also directly affects the cost of living. Before this, a person would have to walk for two days to get a bag of rice, whereas it's now available at their local shop. Furthermore, due to the construction of the projects, a local transmission line and a local grid are built much before the projects are commissioned. This brings light to every single household, much before the light from our powerhouses is

produced. In addition, the provision of having 10 percent local people, which means 10 percent of our shares at the time of IPO, will be held by the local communities, which means that the local population is also participating in the wealth creation in which we are also gaining. That means every single local person in that area is also gaining directly and economically in their bank account.

When these projects are built, they have provided indirect and direct employment for nearly 5,000 people. Some of these people have been working in the GCC countries for five, ten and even 15 years with no hope of moving back and have seen their home maybe after a decade having, equivalent salaries, considering inflation higher than what they were receiving outside the country. Some of these people have worked for the first time on a project, developing skills that will then be used and transferred to other projects in the country as well.

Finally, every single hydropower project comes with CSR activities. As per the current government mandate, 0.75 percent of the cost of any project should be used for CSR-related activities. What this means, if we look at the broader scheme of things, is that to develop 10,000 MW over the next 7 to 8 years, which is as per the government's plan, we need to have mechanisms, that will induce a spending of almost $150 million on community support programs, and indirectly, 5 to 10 percent of every project's cost is infrastructure development. So that's one and a half to $2 billion in infrastructure development, which is the type of impact for which grant aid money is required, which can happen through the private sector, just through investment.

There are always some challenges we have to come across when developing any type of project in the Hindu Kush, whether that is, geological, whether that be technical, or whether that be social. But the government has always stood with us in helping us overcome these issues, the result of which is these commissioned assets. Without the government's support, without the local government's support, and without the local people's support, it is impossible to do these projects. So, I think by executing these projects, you can understand what type of investment climate Nepal actually has to offer the world now.

Of course, we are very optimistic. I would go on to say we are very bullish about Nepal with the continued support of the government and our neighbors and our energy uptake. Nothing can stop Nepal from becoming the green battery of Southeast Asia. Not only does Nepal have the ability to generate electricity, which is important, but it also can store electricity because of its varied topography. This could allow a green stabilizing force to the grids of our neighbors.

And lastly, I would like to mention that with these assets now commissioned, Mogha Energy is putting our money where our mouth is. We are launching an infrastructure fund with the name of Mogha Infra Blocks Fund, and we are investing an additional $100 million over the next three years into the renewable energy sector in Nepal. In addition to this, Mogha Energy has a tie-up with Tata Power through an FDI investment in Dugar Power, and we are looking forward to developing 100 MW of rooftop solar over the next five years so that everybody in the country, not just people next to the grid, will have access to clean energy. Besides, we are also looking at utilizing solar power to address the country's peak and off-peak load issues so that even in the winter, import requirements can be reduced from their current level.

To articulate simply, our plan is very ambitious. We hope to produce 1,000 MW in the next five years. It's taken us about eight years to get to 161 MW, but I think it's something that we can definitely achieve. And finally, we are also looking to bring this energy to every last in the country. For that, we are working with static to see how we could develop an EV charging network in the country. So, these are only to demonstrate that if we can do it as our friend from Unilever said, you can too.

I would like to end with an anecdote. Why do we do this at Mogha? A friend of mine asked me a year ago when we were in Pokhara. You know you're going to end up commissioning your last project. Why are you doing this? What's the purpose? What's the end goal? And I thought about it for about a second, and I said, I wish I see the mountains every day from Kathmandu. I used to come here when I was young. And every single time, even in the monsoon, we would get to see the mountains every single day. But with global warming, with the climate where it currently stands, that's not the case. So, for us, our goal is very simple. We are investing in Nepal so that our children and my grandchildren, can see the mountains every day. And we urge you to invest in Nepal so that your grandchildren can do the same.

(Mogha is a New York-based visionary engineer known for his impactful investments in green energy, he is the president of Mogha Energy as well. With a decade-long experience, he has spearheaded projects like Likhu-1, Likhu-2, and Likhu-A, adding 161 MW to Nepal's grid connection. His views are derived from his speech at the Nepal Investment Summit 2024, held in Kathmandu, Nepal, on April 28 and 29, 2024.)

Regeena Regmi

The Solar Advantage: Empowering Returnee Migrants in Nepal

In the rural landscapes of Nepal, where farming heavily depends on erratic monsoon rains, the introduction of solar irrigation pumps is revolutionizing agricultural practices. This transformation is particularly impactful for returnee migrant workers like Mr. Ram Pratap Sahani and Mrs. Binita Kumari Sahani, residents of Ishworpur in Sarlahi district. Their family enterprise has experienced a remarkable turnaround thanks to this technology.

Sahani, who once worked abroad to support his family, returned home with a hope of building sustainable future. Managing a business centered at around their 2.5-acre fishpond, Sahani duos previously struggled with unpredictable weather patterns and reliance on monsoon rain. "Before installing the solar pumps, we were completely at the mercy of the monsoon. Now, we have access to water throughout the day," said Mr Sahani, reflecting on the transformative impact of renewable energy on their lives. "As you can see, there used to be so many ponds in the area that have dried up," Mrs. Sahani remarks, pointing to the parched ponds nearby. "This is due to the weather condition and lack of capital to install pumping technologies."

Fish is in high demand in the Nepalese market, and Sahanis now carry out transactions worth Rs 2 million from their pond annually. Being clean, efficient, and reliable; these pumps have revolutionized their farming practices. "With access to water throughout the day, our fish yield has improved, and our farm has flourished a lot," said Mrs. Sahani, highlighting the thriving fishpond in the area.

The couple purchased the solar water pump through hire-purchase from Mero Microfinance as a part of the project awarded by the Demand Aggregation window of the Government of Nepal under its Sustainable Energy Challenge Fund (SECF). This focuses on the promotion and market development of Solar Irrigation Pumps. To date, 28 farmers have benefited from this project. By adopting this sustainable practice, they have enhanced rural prosperity and resilience, and are taking steps towards poverty reduction while combating climate change.

"Our land would have remained barren if we hadn't discovered this technology and had access to banks' loans" Mr. Sahani underlines. "We could not afford a diesel pump, while didn't have an access to the national grid as well" he added. "I am so happy that this new system can reach even remote farms like ours."

Access to reliable energy is a game-changer for remote and underserved communities, providing them with foundation for sustainable development. In a country struggling with a migration crisis, initiatives like these are crucial in retaining local talent. "With the sustainable farming options available, young people can now aim their future in agriculture right here at home" remarks Mr. Sahani, having returned home with bitter experiences as a migrant worker.

Renewable energy-related technologies like solar irrigation pumps not only empower families like those of Sahanis, but also contribute to environmental sustainability and national development. As more farmers adopt these technologies, the collective impact can drive positive change, fostering rural development and reducing poverty. These efforts align with the United Nations Sustainable Development Goals (SDGs), particularly Goal 7 (Affordable and Clean Energy) and Goal 13 (Climate Action).

SECF is a challenge fund mechanism promoted by the Government of Nepal through the Alternative Energy Promotion Centre with technical assistance from the NREP and financial support from the UK in Nepal. NREP is a program of the Government of Nepal, implemented by the Alternative Energy Promotion Centre (AEPC) and funded by the UK Government via the British Embassy in Kathmandu (BE-K) in Nepal

The writer of this article is a Communication Specialist at NREP

Unveiling the Factors Affecting the Energy Generation of Hydropower Plants in Nepal

Iliya Adhikari

"This form of energy generation is pivotal for reducing greenhouse gas emissions and combating climate change, making it an essential component of the global energy mix."

ABSTRACT: *Despite having substantial hydropower potential, only a fraction of Nepal's capacity is harnessed, with numerous plants struggling to meet their estimated energy outputs. This paper delves into the factors affecting the energy generation of hydropower plants in Nepal, a critical element in the country's energy sector. The study identifies key factors through a series of structured interviews with industry experts, including project developers, managing directors, and CEOs of various hydropower projects. The interviews revealed four primary challenges: delays in transmission line construction, frequent transmission line outages, inadequate hydrological assessments, and internal outages due to poor maintenance practices. These factors significantly hinder the optimal performance of hydropower plants, leading to substantial energy generation shortfalls. The study underscores the urgency for formulating strategies to optimize energy production, improve reliability, attract investment, and ensure sustainable development in Nepal's hydropower sector.*

Keywords: Hydropower Potential, Energy Generation, Transmission line, Outage

1. Introduction

Hydropower is a renewable energy source that harnesses the power of moving water, typically from rivers or dams, to generate electricity. By converting the kinetic energy of flowing water into mechanical energy through turbines, which in turn drives generators, hydropower plants produce clean and sustainable energy. This form of energy generation is pivotal for reducing greenhouse gas emissions and combating climate change, making it an essential component of the global energy mix.[1]

Hydropower stands as a cornerstone in Nepal's energy sector, harnessing the abundant water resources available due to the country's mountainous terrain and numerous rivers. As of recent years, hydropower contributes to more than 90% of Nepal's total electricity generation, making it a critical component of the nation's energy infrastructure.[2] Nepal has an estimated hydropower potential of approximately 83,000 MW. The economically viable potential is estimated at around 42,000 MW of which only around 2,684 MW has been developed and connected to the national grid.[3] Despite the extensive utilization of hydropower, several factors affecting the efficiency and consistency of energy generation in these plants remain insufficiently explored. Existing studies have primarily focused on the technical aspects, such as turbine efficiency, dam design, and water flow management.

[4]
Focusing on the challenges faced by hydropower plants in Nepal is crucial for several reasons. First, understanding these challenges can help in formulating strategies to optimize energy production and improve the reliability of hydropower as a renewable energy source. Second, addressing these issues is essential for attracting investment in the sector, which is critical for scaling up capacity to mitigate energy demands. Lastly, improving the performance of hydropower plants can greatly help in developing skills and introducing new technologies in the sector.[5]
This paper aims to investigate the obstacles encountered by operating hydropower plants in Nepal in meeting their estimated energy. The study will be conducted through a series of interviews with project developers, providing an in-depth perspective on the operational, technical, and environmental challenges. By gathering insights directly from those involved in the development and management of hydropower projects, this paper seeks to offer a comprehensive understanding and identification of the issues so that a foundation can be laid for reasonable solutions in the near future.

2. Data Sources

The data for this paper was collected through a combination of primary and secondary sources, ensuring a comprehensive understanding of the factors affecting the annually estimated energy of hydropower plants in Nepal. Detailed questionnaires were developed to conduct interviews.
The primary sources of data include structured interviews with hydropower developers, consulting engineers, CEOs of hydropower companies and plant managers. The interviews aimed to gather insights and relevant data into the operational challenges, strategic decisions, and technical factors that play a key role in hydropower plants not being able to meet their average estimated energy annually. A comprehensive and consistent questionnaire was prepared, focusing on the technical and managerial aspects of hydropower production. The information and responses obtained from the interview are checked and verified with the company's monthly produced data.
The secondary sources of data were based on research papers and online data. A thorough review of various research papers was conducted. These papers and journals provided theoretical foundations relevant to hydropower production optimization. Data published by the Nepal Electricity Authority (NEA) and academic sources were accessed. Similarly, official reports and publications from the Ministry of Energy, Water Resources, and Irrigation of Nepal were reviewed. These reports offered valuable data on Nepal's hydropower potential, project status, and regulatory requirements.

3. Results

The responses obtained from the interviews revealed four key factors affecting the energy generation of hydropower plants in Nepal, which are thoroughly detailed below:

a. Delay in construction of transmission line:

Numerous hydropower projects in Nepal face significant challenges due to the incomplete construction of transmission lines by the Nepal Electricity Authority (NEA), as stipulated or planned in the connection agreement. The development of transmission lines in Nepal is not keeping up with the rapid pace of the hydropower project's construction schedule. This delay in infrastructure development prevented many hydropower plants from reaching their annual energy production targets. As a result, these projects were only able to generate between 30% and 70% of their total potential energy output, leading to substantial financial loss to the developer (company). For instance, among the most affected were:

1. Sipring Khola Hydropower Project (9.96 MW) (delay in construction of 132 kV Barabise-Singati line in 2076/77 BS)
2. Tungun-Thosne Khola (4.36 MW) (Malta-Matatirtha 33 kV line in 2076/77 BS)
3. Khani Khola Hydropower Project (2 MW) (Malta-Matatirtha 33 kV line in 2076/77 BS)

There are several projects on the Marsyandi, Dordi, and Nyadi-Khudi rivers having a combined potential of more than 500 MW which were to be evacuated through Udipur-Bharatpur transmission line. Their present status is:

1. 220/400 kV Udipur-Khudi Hub substation is still under construction. So, the operating projects in this area are currently running in "Contingency condition" i.e. based on dispatch instruction from LDC (Load Dispatch Centre).
2. Udipur-Khudi transmission line section is still under construction.
3. Udipur-Markichok-Bharatpur 220 kV transmission line has not been constructed yet.

These lines were to be constructed and connected by the year 2021 AD but are still under construction and showing slow progress but the projects which were planned to evacuate through these lines have already been established and not being able to generate to their maximum potential. In some areas like Karnali, due to the delay in the construction of the transmission line, many project developers are hesitant to start or continue with the construction work. Some possible causes of delay in construction are:

- Delay in approval from the Ministry of Forest (Right of Way problems).
- Local and political issues.

A particular case in point is Upper-Syange in which the local dispatcher is forced to generate "0 MW dispatching" during the wet season due to transmission line constraints. The contract conditions in the PPA (power purchase agreement) which is on a "Take or Pay" basis are violated. Similar to this, 49 projects are operating in take and pay basis. So, unless transmission lines and substations are completed in time, the energy to be generated by around 800-1200MW every year during the wet season is being spilled. The major spill is observed during July, August and September.

b. Transmission line outage:

In electricity buying-selling negotiation (PPA drafting), normally, 3-5% of transmission outages are envisioned for large to small hydropower projects. However, power outages in lines with a capacity of 33 kV or less; have recorded a high percentage of outages due to the following reasons:

- Overload and insulation failure
- Poor construction standard of transmission lines resulting in frequent damage to hardware and structures due to external causes
- Delay in maintenance of lines caused by external fault
- Exceeding the standard length or distance of the transmission line

Due to delay in construction of Udipur-Khudi transmission section, Radhi Khola (4.4 MW), Siuri Khola (5 MW), Khudi HPP (4 MW), Upper-Syange (2.4 MW), Chhangdi 1 & 2 (6 MW) and other projects are connected to 33 kV Damauli-Udipur-Chame line resulting in overload and overvoltage causing high transmission outage experiencing number of tripping.

c. Hydrological Assessment

Operating a power plant requires a designed water flow. The projects so far designed/licensed are "run-of-river" and "peaking run-of-river" type hydropower plants. The natural flow of water is estimated with sufficient historical data to study the flow patterns. For dependable technical assessments in hydrology, it is essential to consider at least 30 years of data on flow patterns during wet and dry seasons before predicting a river's energy generation potential. However, for small rivers in Nepal, there is a lack of adequate hydrological and meteorological data. Most of the projects are developed from the ungauged river. So, the developers have unfortunately relied only on their 3-5 years of monthly data, leading to inaccurate hydrological predictions and a failure to meet the declared energy output.
The Department of Electricity Development (DoED) emphasizes that project designers should adhere to specific guidelines for predicting hydrology using software like the Hydest, Modified Hydest, MHSP 1997, Modified Dickens, PCJ, Rational and Specific discharge method, among others. While these methods suggest higher project capacities, during operation they often fail to generate the expected energy, resulting in unmet estimated energy targets. Consequently, the accuracy of these proposed guidelines is being questioned. Many projects fall short, producing less energy than anticipated. Moreover, with increasing global warming and climate change, the level of water is also decreasing every year.

d. Operation management and maintenance issues (internal outage):

Hydropower plants that have been operational for a long time often begin to show signs of aging, necessitating thorough maintenance and the replacement of worn-out components when necessary. A major challenge in maintaining the projected energy output is the lack of a well-structured maintenance plan. Manufacturers set maintenance requirements based on the equipment's intended use and service life, and these cannot be replaced by regulatory maintenance guidelines. However, many power plants in Nepal have failed to carry out timely maintenance, or any maintenance at all in some cases. This negligence has resulted in decreased efficiency, performance, and capacity.
For hydropower plants operating for over 5-6 years, capital maintenance becomes necessary. This process involves stripping down the entire system and replacing worn-out or defective components as needed. The plant is then re-commissioned according to the original commissioning practices. In Nepal, hydropower equipment is sourced from other countries, requiring meticulous tracking of maintenance schedules to ensure the timely availability of spare parts. However, due to the negligence of operators and developers, this tracking has been poorly managed, leading to equipment failures without available spare parts and ultimately poor performance with lower energy generation.
Additionally, Nepal has limited service providers and lacks appropriate training for operators. Many projects in Nepal are

commissioned on a "water-to-wire" basis from countries like India and China. Due to the lack of technical manpower and the manufacturing industry in this sector, many projects face maintenance challenges, resulting in power plant shutdowns for months or even years.

4. Discussion

The detailed interviews revealed critical factors such as delays in transmission line construction, transmission line outages, inadequate hydrological assessment, and internal outages due to poor maintenance practices and operation management.

The delay in constructing transmission lines exhibited a significant barrier to the optimal performance of hydropower projects. The Udipur-Markichok-Bharatpur 220 kV transmission line which was supposed to be completed by 2020 has not been completed yet due to the slow work progress of the contractor, and the delay in cutting down of trees that fall under the alignment of the transmission line. [6] The construction work of the 30 MW Khani Khola Hydroelectric Project in Dolakha is facing delays due to the incomplete construction work of the 16 km long transmission line running from Singati to the project's powerhouse which was originally set for completion in September of 2023. [7]

The transmission line outages further complicate the situation, particularly for lines with a capacity of 33 kV. According to the report published by the Ministry of Energy in 2077 BS, of 35 private small hydropower projects, projects with more than 5% outage were found to be 15, from available data, and the maximum outage recorded was 40% of Puwa Khola HEP. [8]

Hydrological assessment inaccuracies posed another substantial challenge. According to the report of MOE, 2077 BS, out of 35 only 2 projects recorded less than 10% of hydrological issues and the remaining recorded 20-30% of hydrological issues with maximum of 30.2% of Mailung Khola HEP. [8] The NEA's hydropower plants also generated only 2,930 GWh of electricity in FY 2022/23, a 10.10% decrease compared to the highest recorded annual energy of 3,259 GWh in FY 2021/22. This reduction was primarily due to the unexpected decrease in river discharge during the dry season months due to climate change.[3] This trend underscores the importance of long-term, accurate hydrological studies and adaptive planning to address the impacts of climate change on water resources.

Internal outages due to aging infrastructure and inadequate maintenance practices further exacerbate the challenges faced by hydropower plants. The MOE report indicates that 15 out of 35 projects experienced internal outage rates of 5% or less, while 20 projects had rates exceeding 5%, with Upper Hadi Khola HEP recording the highest at 13%.[8]

5. Conclusion

The investigation into the operational challenges faced by hydropower plants in Nepal reveals critical insights into the factors hindering optimal energy production. All interviewees, 100%, identified that the availability of transmission lines and substations as the predominant issue impacting energy generation. Additionally, 75% of the interviewees mentioned hydrological issues as significant, while 50% highlighted transmission line outages/non-dispatch spills, and 50% pointed to internal outages as contributory factors. These findings underscore the major need for infrastructural improvements in transmission line construction and better resource management to enhance the reliability and efficiency of hydropower plants in Nepal.

While 75% of the respondents were very adamant that hydrology contributes as a significant factor, 2 out of 8 i.e. 25% mentioned that hydrology is inherently influenced by natural phenomena and global warming worsens these challenges which are beyond our control, ultimately resulting in lower energy generation. Then 62.5% of the respondents mentioned that transmission line outage plays a significant role in insufficient energy generation. Finally, only 50% mentioned that due to the unavailability of the manufacturing industry in this sector, technical manpower lacks "know-how" resulting in unmanaged or inadequate operation management and maintenance issues.

The study's reliance on interviews with only eight participants may not capture the full range of perspectives and experiences within Nepal's hydropower sector. A larger sample size could offer a more thorough understanding of the issues. The responses are subjective and may be influenced by personal biases. Additionally, the varied expertise and focus areas of the interviewees might lead to an incomplete or unbalanced view of the factors affecting energy generation. The factors affecting energy generation are dynamic and can change over time due to policy changes, technological advancements, and environmental conditions. The insights gathered from the interviews reflect the situation at a specific point in time and may not capture future developments or past trends comprehensively.

Thus, addressing these multifaceted challenges requires a comprehensive approach that includes improving infrastructure development timelines, enhancing hydrological assessment accuracy, implementing rigorous maintenance strategies, and resolving external impediments through better policy frameworks. Only through such coordinated efforts can Nepal's hydropower projects achieve their full energy generation potential and contribute effectively to the nation's energy security and economic growth.

6. References

1. International Hydropower Association, "World Hydropower Outlook," International Hydropower Association, 2023.

2. Nepal Electricity Authority, "Annual Report 2021/2022," Nepal Electricity Authority., Kathmandu, 2022.

3. Nepal Electricity Authority , "Annual Report 2022/2023," Nepal Electricity Authority , Kathmandu, 2023.

4. S. S. R. &. D. S. Khanal, "Technical Efficiency of Hydropower Plants in Nepal: A Data Envelopment Analysis," *Energy Economics,* pp. 81, 55-67, 2019.

5. M. Shrestha, "Prospects of Hydropower in Nepal: Challenges and Opportunities," *Renewable Energy,* pp. 150, 29-37, 2020.

6. "Urja Khabar," 15 February 2023. [Online]. Available: https://www.urjakhabar.com/en/news/1502542042.

7. "RepublicaNepal," 1 April 2024. [Online]. Available: https://myrepublica.nagariknetwork.com/news/construction-delay-hits-khani-khola-hydropower-project-due-to-incomplete-transmission-line/.

8. "निजी क्षेत्रबाट संचालन भएका आर्थिक रूपले सङ्कटग्रस्थ जलविद्युत आयोजनाका समस्या सम्बन्धमा अध्ययन गर्न गठित समितीको प्रतिवेदन," २०७७ असार ३१।

Interview Questions:

1. What do you recognize as the primary factors contributing to the inability of hydropower plants in Nepal to meet their energy generation targets?
2. What is your opinion on:

a. What are the underlying causes of these challenges?

b. To what extent do you believe these issues stem from the internal management practices of the hydropower companies versus external factors such as governmental support and regulatory frameworks?

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Amit Pokhrel

Challenges of Land Acquisition for Solar Energy in Nepal

To install a solar power project of 10,000 kW or more, it is necessary to acquire sufficient land, according to related engineering guidelines. Initially, this land must be allocated to the project, as it will be the main source of energy development. The government agency should devise a policy to address the current energy deficiency, considering the land acquisition requirements for solar power development. However, there is no specific template established by government bodies to allocate land for solar power projects. Most developers face a dilemma when it comes to purchasing land, as it invites higher development costs.

In Nepal, numerous investors and developers are constructing solar projects based on the guidelines provided by the Department of Electricity Development (DOED). They receive a license and conduct a power purchase agreement with the Nepal Electricity Authority (NEA). The Government of Nepal must reconsider its development strategy as the purchase and acquisition of fertile land would lead to a decrease in food production, adversely affecting agricultural growth due to commercialization issues.

The government is developing futuristic sustainability plans. While facilitating this, a study will be conducted on government lands on a lease basis to further development through public-private partnerships (PPP). This will enable the government to issue licenses to investors willing to invest in sustainable development projects. The Government of Nepal can envisage a partnership model of 65-35% as a BOOT, benefiting the government itself. On the other hand, private investment can also be secured if these models are opened for negotiation.

In the current situation, land is a major concern. Recent climate crises have caused most countries to struggle to maintain a balance between energy security, fairness, and sustainability. The Russia-Ukraine conflict has significantly impacted global energy supply chains. During such conditions, energy supplies and infrastructure were heavily weaponized, revealing the weaknesses of the energy security structure. Developed countries with advanced energy infrastructure had to resort to emergency energy supply measures.

A highly concentrated fuel mix, reliance on few trading partners, and lack of investment in energy systems were identified as significant risk drivers. Consequently, oil and gas flows will likely be permanently redirected, resulting in the most significant re-balancing of the geopolitical landscape to date. The current energy crisis is unique due to the interconnected energy supply chains, necessitating a thorough re-evaluation of energy security strategies.

The energy crisis has significantly impacted energy accessibility. The unprecedented increase in energy prices has particularly affected poor households, forcing them to spend a greater proportion of their incomes on energy. Furthermore, the rise in food prices has caused a crisis in the cost of living for many countries. The energy market volatility has hurt the competitiveness of industries reliant on energy, leading businesses to switch to more cost-effective and reliable markets, raising questions about the sustainability of local economies.

The success of the energy transition depends on developing a strong enabling environment, including a robust regulatory framework and the capacity to attract and deploy large-scale capital. A comprehensive policy framework, energy efficiency, and access to energy must be combined with a strong, ambitious, and credible plan to reach net zero emissions, underpinned by efficient carbon pricing. An investment climate characterized by low capital costs, availability in domestic markets, and the attractiveness of foreign direct investment is essential for mobilizing increasing amounts of capital towards the energy transition. Additionally, advanced economies must ensure they mobilize $100 billion of climate finance annually for developing countries.

To ensure a timely and successful transition, it is essential to improve system performance through a balanced energy triangle and create a strong enabling environment. Recent experiences have highlighted the importance of a secure, affordable, and sustainable energy system for economic growth and a balanced transition. According to the Energy Transition Index, Nepal ranks 97th among emerging and developing countries in Asia.

Much focus has been on energy supply. However, according to the International Energy Agency's Net Zero by 2050 pathway, to meet the Paris Agreement's emissions goals by 2050, the world will need to consume 8% less energy than today. Meanwhile, the world's economies must grow sustainably to provide for 2 billion more people. This means that energy consumption as a portion of economic output and the carbon intensity of energy consumption must decline.

Financing the energy transition remains a major challenge and opportunity for financial institutions, particularly in Nepal, where most business finance is

provided by banks. However, the challenge is not insurmountable if relevant stakeholders, such as businesses, public and private sectors, and related authorities, work together to create a low-carbon, cost-effective, and reliable energy system. Many countries emphasize sustainability in their policies and programs, including energy conservation measures, renewable energy technologies, innovations in energy storage, and grid modernization.

The energy sector plays a vital role in stimulating economic growth. However, the energy transition could lead to significant costs and disparities if not managed effectively, especially for the world's most vulnerable people. This necessitates difficult decisions for leaders, especially in developing and emerging economies, to promote economic growth that optimizes social well-being while providing access to diverse energy sources at competitive prices.

Governments and economic stakeholders globally are increasingly aware of the importance of energy security, impacting supply chains, countries, and global systems. People, businesses, and nations expect reliable and uninterrupted energy supply at reasonable prices. To ensure stable energy supply and demand at national and international levels, countries must trust each other's ability to meet energy requirements. Any disruption to the global market could lead to serious economic and social instability.

As the solar power industry expands and states consider increasing solar penetration, the land needed for solar projects will increase. With careful planning, solar development can positively impact the environment and local communities. Utilizing the sun's energy to generate electricity is one of the most advanced and cost-effective ways to produce pollution-free, renewable energy. To generate electricity to meet ambitious carbon emission reduction objectives, long-term planning is necessary for the efficient and responsible development of projects. Nepal has vast potential for solar power generation, with five minutes of sunlight potentially meeting the entire electricity demand for a month.

Depending on the technology, the minimum area of a solar power plant can start from 20 bighas to generate 10 MW of electricity. Unlike fossil fuel-based power plants, developing solar power plants necessitates some land grading and vegetation removal. For instance, many Concentrated Solar Power (CSP) plants must be built on land with a slope of less than 1 percent. On the other hand, Utility-scale Photovoltaic (PV) plants can be constructed on land with a steeper slope and no access to water. By implementing federal policies to expedite the growth of Utility-scale Solar Energy, Nepal can create jobs across the country and diversify its energy portfolio, reducing carbon emissions and paving the way for a clean energy future.

The siting and permitting of a solar power plant are complex processes that must consider various factors, such as land use, transmission access, and water rights. Securing access to a suitable location is the initial step in setting up a solar power plant. Solar power plants must undergo rigorous review processes conducted by federal, provincial, and local regulatory bodies. Solar companies offer comprehensive project construction plans, perform numerous environmental assessments, and suggest mitigation strategies. This, combined with modern utility-scale solar energy technologies, ensures minimized environmental impacts. Currently, most solar power plants operate on privately owned land, and when proposed on private land, various state and local authorities must approve the project before construction. Siting and permitting can take three to five years to complete. The Department of Energy (DOE) encourages adopting best practices and policies that facilitate the permitting of eligible projects.

For solar power plants on public land, the environmental review process can take three to five years. If the plant is on private or disturbed land, it can take even less time. The ROW permits undergo rigorous review before issuance, following the Solar Energy Policy Act. Companies must provide detailed project plans, environmental impact assessments, and mitigation strategies. They also need to provide official Environmental Studies for each project before issuing an official ROW decision. Whether CSP or PV, solar power plants can produce pollution-free power with local water supply impacts similar to, and often lower than, traditional fossil power generation.

For a solar farm to be eligible for development, the land must be at least 10 bighas, or 30 bighas for utility-scale projects. For example, if one kilowatt of solar panels is installed on a 100-square-foot plot of land, the area would need to be 100 square feet. However, local municipalities may not permit the entire parcel to be used for a solar farm. A flood risk assessment is conducted before any project starts to determine if the land is subject to future flooding. If the assessment reveals a high likelihood of flooding, the project will likely not proceed. However, this does not necessarily preclude the construction of a solar farm.

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Reference:

1. Optimal-Number-of-Banks-and-Financial-Institutions-in-Nepal.pdf (nrb.org.np)
2. Renewable energy in Nepal - Wikipedia
3. Solar energy: Nepal's most sustainable resource - The Himalayan Times - Nepal's No.1 English Daily Newspaper | Nepal News, Latest Politics, Business, World, Sports, Entertainment, Travel, Life Style News
4. Solar energy with pumped storage hydro in Nepal (hydropower.org)
5. Renewable Energy and Future of Sustainable Development - myRepublica - The New York Times Partner, Latest news of Nepal in English, Latest News Articles (nagariknetwork.com)

Santosh Parajuli

As Nepal's electricity market evolves, the imperative of protecting electricity consumers grows more pronounced. In this dynamic environment, the ERC needs to assume a robust role in safeguarding the rights of vulnerable consumers within the energy sector.

Electricity Consumer Protection:
Current Issues and Way Forward

Electricity has become indispensable for daily life in the modern world, and it's hard to imagine sustaining life without it. However, as Nepali citizens, we must recall the acute electricity shortages the country faced just five years ago. During that time, the entire nation endured over 18 hours of load shedding, while certain large industrial and commercial consumers received uninterrupted electricity through the trunk and dedicated lines in a preferential manner from the sole utility provider. This practice contradicts the spirit of the Constitution of Nepal, which aimed to establish a fair and equitable society. At that time, Electricity consumers valiantly fought through the years of darkness like a soldier in battle[2].

The post-global liberalization era initiated more than two decades ago had a considerable impact on the electricity market globally. Before the global liberalization era, most of the power utility companies were organized as vertically integrated monopolies. Generally, this form of organization meant that the electricity generation, management of transmission and distribution infrastructures, and supply of electricity were done through a single entity, which was often a state-owned entity. With the global liberalization movement, this vertically integrated monopolies were disintegrated into separate utilities. Electricity supply was treated as a common social benefit that should be provided to every citizen as a public service for maximum economic and social benefit. On the other hand, such an idea has been changed in line with the change in global order. Monopolies have been disintegrated and private participation has been encouraged, which has led to an environment of competition amongst the service providers.

Similarly, Nepal's largest electricity distribution utility, Nepal Electricity Authority (NEA), was established in 1984 A.D. via enactment of the Nepal Electricity Authority Act, 1984, which entered into force on 2042.05.01 B.S. (August 17, 1985, A.D.) by a notification published in Nepal Gazette. The act, for the first time, defined the term Customer as a person who consumes electricity. Furthermore, it granted the power to the Authority to collect electricity fees and service charges from customers. NEA is responsible for providing affordable and reliable electricity services to its consumers. It is also still the vertically integrated pure "natural" monopoly. Before the enactment of the Electricity Regulatory Commission (ERC), the act granted the power to charge a monopoly price.[3] Thus, there always remains a situation where a monopoly can limit output, charge higher power than in a competitive environment, reduce consumer welfare and reduce the choice of consumer consequently restricting consumer sovereignty as well.

Thereby, it became imperative and necessary for the state (regulator) to

1 Adv. Santosh Parajuli specializes in Energy and Corporate Law.
2 https://kathmandupost.com/columns/2024/02/08/discarded-heroes
3 Nepal Electricity Authority Act 1984, section 19 (d) provisions the power of determination of electricity fees and charges as a function and duty of the NEA.

formulate a legal instrument relating to the protection of consumer rights and interests in a way that shall cover the nature of the service being delivered by these utilities. As a result, the Electricity Act 1992 A.D. envisioned forming a separate electricity tariff fixation commission to determine electricity tariff and related charges. After that, the Electricity Tariff Fixation Commission Rules established the Electricity Tariff Fixation Commission, which functioned as an ad hoc commission. Similarly, the Hydropower Policy 2001 went a step ahead in envisioning a regulatory body that would not only fix the tariff but also regulate the entire electricity sector. Almost after two decades, the Government of Nepal via the enactment of the Electricity Regulatory Commission Act, 2017 and Electricity Regulatory Commission Rules, 2018 established a fully functional commission on May 6, 2019, with a legal mandate to develop standards for consumer protection and regulation of overall electricity sector.

Categories of Electricity Distribution Utilities in Nepal

Electricity Regulatory Commission Act, 2017 defines utilities as a licensee refers to a person or corporate body licensed under prevalent law so as to generate, transmit, distribute, or trade electricity. In the context of Nepal, we can observe that currently there are three types of electricity distribution utilities, which are required to be regulated by the state. One of them is NEA (vertically integrated state-owned monopoly) which has been providing its service to around 5.13 million, an increase of 7.76 percent against 4.77 million in the previous year[4].

Secondly, there is Butwal Power Company (BPC), which is itself a generation, transmission and distributing investor-owned (both public and private) entity, providing its services to about 60,000 consumers in western Nepal. Thirdly, Community Rural Electrification Associations owned by cooperatives located in their respective districts, which provide distribution services to about 0.51 million consumers[5].

Thus, with an increasing number of consumers, rapid industrialization, and the entry of new players in the electricity markets, there is a need to protect the rights and interests of the most vulnerable. Protection of those, who are less oriented to the market-focused economy such as domestic (household), small consumers, or households with low income should be the focus of the regulator and government as well.

Lack of Safety-Centric Approach of the Distribution Utilities

It may not be premature to assert that the NEA's negligence in ensuring the safety of electricity consumers could significantly tarnish its success and reputation. Although some may argue that the NEA's role as the electricity provider in Nepal is paramount and should not be compared with consumer safety. But, having said so, the significance of consumer safety must not be overlooked. However, the present achievements of the NEA would not have been possible without the support of the public, as the NEA operates on a very foundation funded by taxpayer money.

Accidents caused by electrical-related instruments have been one of the major concerns in the post-loadshedding era. According to a recent report of the National Disaster Risk Reduction and Management Authority, a total of 18,772 fire incidents took place in Nepal from 2014 to mid-March 2023, in which a total of 769 people lost their lives.

Case Study-1:

One such incident unfolded in the heart of Kathmandu, where a humble abode turned into a blazing inferno overnight. Sunita Shrestha, a 42-year-old mother of two, recounts the harrowing experience, "I woke up to the sound of crackling flames and the acrid smell of smoke. My children and I barely managed to escape with our lives. Everything we owned; all our memories were reduced to ashes."

An employee working at Juddha Barun Yantra Office in Kathmandu said that they had to rush their fire engines for 250 to 255 days in a year and their record showed that about 70 percent of those fire incidents were caused by short circuits[6] and old connections.

Case Study-2:

On Friday evening, six members of a wedding party traveling from Dhanusha to Sindhuli were electrocuted when the bus they were traveling in touched a low-hanging high-voltage electric cable. The bus (Na 5 Kha 1752) touched the 11,000-volt transmission line at Baltiya of Sabaila Municipality-4 of Dhanusha along the East-West Highway when it was en route to Baltiya-Kothiya of Dhanusha from Jitpur, Dudhauli Municipality, Sindhuli.[7]

Similarly, data maintained by Nepal Police show that from mid-April 2018 to January 2019, a total of 518 cases of electrical accidents were reported of which 289 lost their life and 297 people were critically injured. Likewise, between mid-April 2017 to mid-April 2018, out of 520 cases of electrocution resulted in 321 deaths and 260 severe injuries. But when enquired with NEA, the blame usually is shifted to the negligence of people, electricity theft, lack of skilled manpower, lack of protective equipment and lack of awareness in public for electricity-related safety.[8] Nevertheless, it is the NEA which has been mandated to ensure safer, reliable, and resilient distribution networks as per prevailing Electricity Act and Rules.

4 Annual Report of NEA for FY 2022/23 A.D.
5 Ibid
6 https://thehimalayantimes.com/kathmandu/surge-in-electrical-short-circuit-fires-wreaking-havoc
7 https://myrepublica.nagariknetwork.com/news/electrocutions-killed-289-people-in-six-months/
8 Ibid

Prevailing laws related to electrical safety of electricity consumer

Currently, there is a noticeable absence of rules and regulations specifically addressing consumer safety related to electrical hazards. As a result, the NEA is exempt from liabilities concerning consumer losses or injuries due to electrical hazards. The existing regulations underscore the limitations of a robust energy regulatory authority and a significant oversight in protecting consumer interests. These deficiencies could impede the government's efforts to boost electricity consumption, particularly within the residential sector[9]. However, following the adoption of federalism, the Government of Nepal has enacted and implemented the Uniform Criminal and Civil Code to address the criminal liabilities of a person or a corporate body. This includes the National Penal (Code) Act, 2017, and the National Civil Code Act, 2017.

(a) The National Penal (Code) Act, 2017

Section-178 (1) of the National Penal (Code) Act 2017 provisions that "No person shall do any act, with the knowledge that, or having reason to believe that such act is, in an ordinary course, likely to cause the death of another person. Similarly, section 182 (1) of the same act provisions that "no person shall cause the death of anyone by doing a negligent act." Such offenses are liable to a sentence of imprisonment for a term not exceeding Three (3) years and a fine of up to 30 Thousand NPR.

Additionally, Section-30 of the Penal Code, 2017 also provisions that if any firm or corporate body commits or causes to commit the crime, a person responsible for committing the crime shall be liable to punishment. However, if a person who committed such a crime cannot be identified, the concerned owners and partners, the director or managing director, the general manager and even the chief executive of such body shall bear the criminal liability.

Thus, it is evident from the aforementioned provisions that any negligence by NEA (or any distribution licensee) personnel or employees resulting in death or grievous injury can be classified as a criminal offense under this clause. Furthermore, the act stipulates that any firm or corporate body can also be held liable for such crimes.

(b) Electricity Act, 1992

Section-26 of the act provisions that the security measures to be adopted in the process of generation, transmission or distribution of electricity shall be as prescribed. As such no consumer protection guarantee was realized during enactment of this legislation.

(c) Electricity Rules, 1993

Chapter-3 of Electricity Rules 1993 has provisions about the matters to be followed by distributors and consumers of electricity. Rule 38 (1) specifies that the licensee shall assign the technician to remove any danger. Further, Rule 38(2) also provides that whether or not information is received from consumers, the licensee shall timely conduct inspection and maintenance of the service line to ensure the safety of the distribution line.

Although the rules mandate that distribution licensees (such as NEA, BPC, etc.) periodically inspect and maintain distribution lines to identify and mitigate potential hazards, they lack any form of punishment or sanctions for non-compliance by the licensees.

(d) Electricity Regulatory Commission Act, 2017

Consumer protection is one of the key responsibilities of the ERC as mandated by the Electricity Regulatory Commission Act 2017. However, there is a lack of substantive provisions specifically addressing consumer rights against negligence of NEA regarding electrical safety issues.

(e) Directive related to electricity consumer rights, 2023

Recently, the ERC enacted a legal instrument to ensure the protection of electricity consumer rights and interest in the monopolized electricity distribution sector. Directive Relating to Electricity Consumer Rights, 2023 for the first time established the right of electricity consumers against any kind of exploitation from distribution licensees. Not only that, but it also further vaguely guaranteed the right to receive compensation from utilities for hazards or damages due to the fault of the licensee.

The directive obligated the distribution licensees to ensure the "Quality and Reliability" of electricity supply[10]. Clause (7) of the same directive seeks the basic infrastructural requirement for establishment of Distribution and Consumer Service (DCS) office. Similarly, clause (13) of the directive further provisions the stepwise procedure for dispute settlement of any electricity-related conflict between the distribution utility and consumer.

However, the directive lacks substantive provisions to punish or sanction distribution licensees if they fail to comply with this regulatory instrument. Clause (11) of the directive outlines penalties[11] and compensation[12] to be imposed on distribution licensees for non-compliance, but it does not specify any procedures, methodologies, or amounts.

9 https://english.onlinekhabar.com/electricity-consumption-saftey-issue.html
10 Directive relating to Electricity Consumer Protection, 2023, Chapter-2, Clause-3 to 6.
11 Clause 11 of Directive relating to Electricity Consumer Protection, 2023 states that ERC may levy penalty on distribution licensee if they fail to comply with the conditions as mentioned.
12 Clause 12 of Directive relating to Electricity Consumer Protection, 2023 states that Distribution Licensee shall make public the information incase if any compensation is required to be provided due to non-compliance of the directive.

(f) NEA Electricity Distribution Bylaw, 2021

The bylaw describes processes and methodology for the distribution or supply of electricity from NEA. However, bylaw (41) of the NEA Electricity Distribution Bylaw 2021 provisions "Every consumer shall receive an uninterrupted supply of electricity. But any damage or loss caused due to disruption of supply, NEA shall not be held liable". Similarly, bylaw 41 (2) provisions that "NEA shall inspect the wiring as distribution licensee only and if any loss or damage is incurred after such check or inspections, it shall not be held liable".

The aforementioned clauses are highly contentious and effectively exempt the NEA from any liability for damages or losses resulting from their inefficiencies. Globally, distribution licensees are held accountable to their consumers, but this is not the case with the NEA. Consequently, Clause (41) of the bylaw contradicts the spirit of the prevailing Electricity Act and Rules and should be amended immediately.

Conclusion

As Nepal's electricity market evolves, the imperative of protecting electricity consumers grows more pronounced. In this dynamic environment, the ERC needs to assume a robust role in safeguarding the rights of vulnerable consumers within the energy sector. The current scenario highlights concern about anti-consumer regulatory frameworks and a lack of consumer awareness in the electricity sector, making consumers vulnerable to exploitation. If the consumer is unaware of the rights, he/she may not be able to assert or claim his/her right. Consumer awareness reduces the chances of consumer exploitation in the marketplace. Being aware of their rights immensely helps in their protection. In developing countries like Nepal, it is often observed that consumers are unaware of their rights, consumer protection agencies, and existing redress mechanisms.

To address this, regulators like ERC, distribution utilities, and consumer advocates must prioritize consumer education about their rights. Periodic reviews of anti-consumer rules and bylaws are essential to ensure consumer protection. Negligence and reckless activities by utilities should be liable to legal consequences under the Rule of Law. By taking these steps, regulators like the Electricity Regulatory Commission can strengthen their presence and empower consumers with knowledge about their rights and responsibilities.

Storage Hydropower

Dr. Ananda Bahadur Thapa

"Unfortunately, we all, including policymakers, planners, politicians, and the intelligentsia, among others, are not seen showing even the slightest concern over the devastation of the economic potential of our water resources."

Large Storage Dams: Balancing Progress with Future Generations' Inheritance

Nepal can easily meet the country's demand for electricity for a very long time by implementing medium-sized hydropower projects in conjunction with solar and other sources of inexpensive energy generation. This can be done without resorting to costly large storage dam projects, like the Budhi-Gandaki, West Seti etc, which are often embroiled during construction in various types of disputes resulting in indefinite delay and unexpected heavy cost overrun.

Unfortunately, we all, including policymakers, planners, politicians, and the intelligentsia, among others, are not seen showing even the slightest concern over the devastation of the economic potential of our water resources that are consequent upon our failure to understand the full value of these precious natural resources. In contrast, foreign experts on water resources are surprised at our ignorance, while an expert has even straightforwardly cautioned us, *"Nepal should beware of unintentional giveaways in hydro development."*

The present institutions should be wary of giving away Nepali c

hildren's rightful inheritance.

Submergence and Taking Away Livelihood

Paul D. Terrell from Bechtel International, who was chief advisor to the Government of Nepal for the World Bank-financed Karnali Project, has expressed his concerns in an article published in the magazine HIMAL a long time ago in May 1991 about the negative impact of large storage dams on environment and economy of our country. His opinion has now become even more pertinent. The following are his opinions.

- Nepal does not have too much land. Snowfields and glaciers are not habitable, and much of the country is too steep and mountainous for terracing by the hill farmers.

- On the one hand, reservoir space is needed to harness the water, on the other, land covered by the most economic reservoirs, in terms of large storage volume is the same precious flat land needed for agriculture.

-It is impossible to create a reservoir in Nepal without inundating people's homes and taking away their agricultural livelihood.

Domestic Demand for Energy

Having huge potential in

hydroelectricity, our country can easily meet demand for energy for a very long time by implementing medium-sized hydropower projects in conjunction with solar and other sources of inexpensive energy generation without resorting to **costly large storage dam projects, like the Budhi-Gandaki, West Seti, etc. We shouldn't have to rely just on** construction of such projects which invite various types of disputes resulting into indefinite delay and unexpected heavy cost overrun. This is the view echoed by foreign experts from internationally renowned institutions like the Bechtel International of the USA.

Justification for Large Dams

Nepal's economy would greatly suffer as a consequence of the implementation of large storage dam projects earmarked exclusively for power generation at the cost of sacrificing our valuable lands and valleys in the hills and overlooking engineering, economic and environmental aspects. However, such projects could still be justified if we can reap non-power benefits.

Our country is now planning to implement large storage dam projects, like the Budhi-Gandaki storage dam project, West Seti storage projects, etc., exclusively for power generation whereas these types of projects would automatically provide India downstream benefits (irrigation, flood control, etc.), which might far exceed the power benefit. Unfortunately, our country would be **deprived of our right to a legitimate share in downstream benefits** from such projects accruing to India if we failed to reach an agreement on downstream benefit sharing before making final decision on implementation.

Irrigation Benefit Compared with Power Benefit

The detailed feasibility study of the Multipurpose Kankai storage dam project carried out under the assistance of the then Government of West Germany and completed in the 1980s shows that the annual irrigation benefit would be more than four times greater than the power benefit and such irrigation benefit would accrue entirely to Nepal. Unlike the case of the Multipurpose Kankai Project, the **vast downstream benefits accruing from the proposed West Seti, Budhi-Gandaki, Karnali Chisapani, and Tamor storage dam projects would automatically be passed on to India.**

India's Growing Demand for Water

The world population grew enormously in the 20th century. According to United Nations estimates, 1.65 billion people lived on Earth in 1900. By 1999, the world population passed 6 billion, while the UN estimates it will reach 9 billion people by 2050. **However, the annual supply of renewable freshwater will remain constant.**

In India, the demand for agricultural water dominates the total water demand. India has the second-largest population in the world. There are plentiful rains over most of the country's area, but they are received only for a few months. As a result, **India has already been experiencing severe water scarcity.** According to Mr Chaturbedi M.C., even by 2005, the total ground and surface water had already been assigned to users, and irrigation expansions witnessed restrictions.

Wisdom of Lesotho

It is quite hurting that in sharp contrast to our country's irresponsible dealings on water resources, even the most backward country in Africa, Lesotho is wise to protect its national interest to reap full benefits from its multipurpose project by reaching an agreement with South Africa on sale of regulated water flowing down after power generation to downstream country South Africa. Currently, Lesotho is receiving 56% royalty of the net benefit accruing to South Africa from using the regulated water discharged into the river after power generation.

Conclusion

Demand for water worldwide and also in India is rapidly growing, as a result, it is becoming increasingly scarce. Water has already become a valuable export item. However, Nepal is unaware of this vast economic potential. Needless to say, our proposed large storage dam projects would hurt the environment and economy of the hill region of our country. Fortunately, Nepal might not have to implement such large storage dam projects for a very long time to meet our own country's demand for electricity.

We should shelve the idea of implementing large storage dam projects providing large non-power benefits exclusively to India until we reach an agreement with our southern neighbor on downstream benefit sharing. India has already built **Sarada Shahayak and Saryu canals** in anticipation that Nepal would implement **Karnali Chisapani or West Seti storage dam projects** that would automatically provide abundant water to those canals. It has been clearly explained in the feasibility reports of those canals.

Dr. AB Thapa passed away recently on June 2024. This article was first published by the fortnightly magazine Spotlight, December 20 2019 – January 2 2020 and it has been reprinted with the kind permission of Spotlight.

Understanding Carbon Credits:

A Key Component of Climate Action

Manish Dabkara

"By ascribing a financial worth to carbon emissions, these mechanisms create economic incentives for industries to adopt cleaner technologies, spur investments in renewable energy and fund environmental initiatives that underpin a greener tomorrow."

As the global community confronts the escalating challeng es posed by human-induced climate change, the imperative to chart a sustainable and environmentally responsible development trajectory becomes increasingly urgent. Central to this transformative journey towards a NetZero carbon future lies the pivotal concept of carbon credits—innovative financial instruments that hold the potential to revolutionize our approach to climate action. In this discourse, we delve into the world of carbon credits: their essence, impact and how they constitute a critical component in shaping a sustainable future for upcoming generations.

Understanding Carbon Credits

Carbon credits epitomize a market-driven strategy to combat climate change, assigning a monetary value to greenhouse gas (GHG) emissions. They facilitate organisations and individuals in offsetting their carbon footprints by investing in projects that either reduce or remove GHG emissions from the atmosphere. These credits are typically generated through initiatives such as renewable energy projects, reforestation endeavours or energy efficiency programmes.

Each carbon credit signifies the reduction or elimination of one metric ton of carbon dioxide equivalent (CO_2e) emissions. Tradable in voluntary and compliance markets, carbon credits empower entities that exceed emission reduction targets to sell surplus credits, while those falling short can procure credits to offset their emissions.

The allure of carbon credits lies in their capacity to drive tangible change and incentivize sustainable practices. By ascribing a financial worth to carbon emissions, these mechanisms create economic incentives for industries to adopt cleaner technologies, spur investments in renewable energy and fund environmental initiatives that underpin a greener tomorrow.

Significance of Carbon Credits

1. Mobilizing Investment in Sustainable Projects

Perhaps most notably, carbon credits mobilize capital towards sustainable development initiatives. Projects supported by carbon credits often encompass renewable energy expansion, afforestation efforts, and ecological preservation schemes. The revenues generated not only accelerate the transition to a low-carbon economy but also foster socio-economic progress by reinvesting in local communities. From enhancing access to clean water to bolstering educational opportunities, carbon credit initiatives forge a symbiotic relationship between environmental stewardship and human prosperity.

2. Incentivizing Emission Reductions

Carbon credits serve as a potent incentive for businesses to curtail their carbon footprints and embrace sustainable practices. By financially rewarding emission

reduction endeavours, these credits incentivize industries to prioritize environmental sustainability, catalyzing a paradigm shift towards greener operational frameworks.

3. Encouraging Innovation and Collaboration

In their quest to attain carbon credits, organisations are motivated to pioneer cutting-edge technologies and sustainable solutions. This pursuit of carbon neutrality fosters innovation in clean energy technologies, spurs advancements in industrial processes and fosters collaboration across public and private sectors. Such synergies bolster international cooperation in addressing climate change and accelerate progress towards shared climate goals.

4. Supporting Carbon Neutrality Objectives

At its core, the utilization of carbon credits enables entities to achieve carbon neutrality - a cornerstone in the fight against climate change. By offsetting unavoidable emissions through investments in emission-reduction projects, organisations and individuals can effectively balance their carbon footprints and align with global sustainability aspirations.

5. Raising Climate Awareness

Beyond their economic implications, carbon credits elevate awareness about the environmental impacts of individual actions and consumption patterns. By supporting carbon credit projects, stakeholders signal their commitment to climate responsibility, while fostering a collective ethos of environmental stewardship.

Scope of Carbon Credit Trade in Nepal

Nepal, with its diverse landscapes and abundant natural resources, stands at a pivotal juncture where carbon credit trading can catalyze sustainable development. Carbon offset markets offer Nepal a pathway to reduce greenhouse gas emissions while attracting essential financial investments. Engaging in carbon credit trading presents Nepal with the opportunity to achieve significant emission reductions. By incentivizing projects that promote renewable energy, forest conservation and sustainable agriculture, Nepal can not only enhance its environmental profile but also stimulate economic growth. The influx of capital from carbon credit financing supports the development of green industries, creates employment opportunities and drives technological advancement.

Moreover, participating in carbon credit initiatives promises environmental co-benefits beyond emission reductions. Programmes like Reduced Emissions from Deforestation and Forest Degradation (REDD+) can safeguard biodiversity, improve water quality and mitigate soil erosion. Transitioning away from coal-fired energy sources could also help reduce air pollution while enhancing public health and quality of life.

Successful implementation of carbon credit projects in Nepal hinges on strengthening institutional frameworks and fostering private sector involvement. Building robust capacity for monitoring, reporting and verifying emission reductions is crucial to attracting international investors and ensuring transparency. Furthermore, lessons learned from carbon market engagements can enhance Nepal's overall investment climate, facilitating sustainable development across various sectors.

EKI Energy Services Ltd. is a leading Carbon Credit Developer & Supplier in the International Carbon Markets. Founded in 2008, EKI offers sustainable solutions for climate change and carbon offsets with global standards like CDM, VCS, Gold Standard, GCC, IREC, TIGR and others. EKI's offerings span Carbon Credit/Asset Management, Carbon Credit Generation, Carbon Credit Supply, Carbon Credit Offsetting, Carbon Footprint Management, Sustainability Audits, as well as Carbon Neutrality and Climate Positive initiatives. For expert advisory or consultancy services related to carbon credits, team EKI can be reached at business@enkingint.org.

Paving the Way Towards Net Zero

In the pursuit of a net-zero carbon future, carbon credits emerge as a linchpin in catalyzing substantive change. By stimulating emission reductions, spurring innovation and fostering global collaboration, carbon credits propel us closer to realizing our collective ambition of mitigating climate change. These transformative financial instruments not only bolster carbon neutrality objectives but also serve as catalysts for sustainable development investments worldwide.

As we navigate the complexities of a changing climate, let us harness the transformative potential of carbon credits to chart a course towards a greener, more resilient future - one that safeguards our planet and enriches the lives of generations to come. Together, let us embrace the promise of carbon credits as a cornerstone of our collective endeavour to forge a sustainable and prosperous world for all.

The writer of this article is Chairman & MD of EKI Energy Services Ltd, a leading Carbon Credit Developer and Supplier across the globe. ***He founded EKI (erstwhile EnKing International) in 2008 aiming to lead companies worldwide to a future of net-zero carbon emissions.***

Mahesh Paudyal

Old Tree and the Nightingale

"Hang on dear moon," said the nightingale, "for there is no light, and I am not yet decided where I would put up tonight."

It was extremely cold, though the sky looked very clear. It was twilight, but the moon was just an arc of diamond upon the head on the western mountain.

The nightingale shivered remembering the previous night. O, what a dreadful experience it had been! Someone in the south had set the whole forest on fire, and its little nest on a little willow had burnt, roasting its two little kids to death. It shed two drops of tears for the kids and flew away, and sat on a silver wire that hanged between iron poles, knowing that a silver thing would not burn. It was nightmarish, hanging on a silver wire all through the night.

"Allow me to stay here for tonight, for both of us are dying soon," said the nightingale to an old ebony tree that stood alone in a big, flat land, bare and shabby.

"How do you say so?" asked the tree.

"You know not a thing of the world, as your feet are fastened to the soil. I fly and see what is happening in the world. A devil has burnt the forest in the south. He will soon be here," said the little bird to the old tree.

> The tree dropped two big tears. The nightingale wished it a long life before the flood, and flew. It had heard that the west had trees with the sweetest figs on them.

"O, terrible!" said the tree, and shed thick drops of tears. Then it said, "I have a hole, dear nightingale; but I have rented it to a squirrel. Make it your home for tonight. You need to leave early tomorrow, for the squirrel that has gone to the Manasarobar, will come back."

"So kind of you! In the morning, I shall sing you the best of the songs I know."

By this time, the moon had almost slipped off the mountain. "Hold on," shouted the nightingale again, and said, "Give me light till I go to bed. Early at dawn tomorrow, I shall sing you the most beautiful of the songs I know."

In fact, the moon waited till the nightingale had found a cozy hole on the tree. It looked into it carefully, till it was convinced that there was no snake to try an ambush. When it had safely housed itself, the moon gave a last, parting wink and disappeared. The veil of the night covered the tree from all around.

O, what a cozy night it was! The nightingale soon fell asleep, and

dreamt of the Sleshmantak Forest, far way. Trees full of nuts bedecked the dream world, and the nightingale sang to the king's daughters sailing to Malaya on the cloud-ships in the vast blue ocean, up there in the sky. No hunter would ever come in the dreamland, and no woodcutter would ever charge his devilish axe upon the tree that gave it a home.

When the day broke, 'two-whee' sang the nightingale, and the tree woke up too. The moon—just an arc—appeared too, and 'two-whee' said the nightingale. It paid for their favor.

When the sun was fairly up, the nightingale thanked the old tree and took leave of it.

It flew over the great Bagmati River, in whose water, little naked boys dived and searched for coins devotees often threw. It also flew over burning dead bodies and trembled to remember the burnt bodies of its little kids. 'Man and birds are same,' it thought, and flew north.

Up there in the north, the returning monsoon rode on the wings of wind, and soaked the nightingale all through. A terrible rain had set the sloppy land sliding, and everything from houses to trees, chestnut or pine, were flowing down with the swelling rivers. People ran in all directions, shouting at Lord Indra, who, as they thought, had poured the whole of the Blue Sea down upon them.

"There is not a tree to hold the slide," said an old man. "Somebody dead has cleared the entire thicket. Hell be with him!"

'It's terrible,' thought the nightingale and twisted its little tail, changing its direction. 'The tree that hosted me last night is far better. Let me go back; perhaps it will allow me a stay for one more night.'

"Dear old tree, I love you better than anyone. Do allow me to put up for one more night, for both of us are dying soon," it implored.

"How do you say so?" asked the tree.

"Up there in the north, the Lord is so angry that he is emptying the entire Blue Sea upon the earth. The land is sliding, carrying all trees—big and small—down the hill. The rivers are touching the sky, and the creation is ending. I will miss you, good old tree, when you die."

"O, terrible!" said the tree, and shed thick drops of tears. Then it said, "Stay for a day, little bird, and when the day breaks, sing me a song for the leaves that have fallen off my body. O, how much I miss them!"

"So kind of you! In the morning, I shall sing you the best of the songs I know."

So, the nightingale stayed for the second day. Early next morning, it sang a sad song for the fallen leaves, and said to the tree, "Soon, you will be with your lost leaves, dear old tree."

"How?" said the tree, which was just waking up.

"For, you will lay dead upon the same leaves down there. Rain will pound upon you, and the land underneath will slide."

The tree dropped two big tears. The nightingale wished it a long life before the flood, and flew. It had heard that the west had trees with the sweetest figs on them.

The sky had cleared now after the nightlong crying, and the rays of the sun shone brightly. It flew all day long, till in the afternoon, the rays of the sun directly fell on its little, round eyes. The nightingale saw many colours—red, blue, green and violet—floating in the sky.

Far away, it saw a fat man with a yellow cap, driving a big yellow thing across the forest. It was felling all the trees that stood, and the land was being leveled.

"We will make a city here," shouted the politician. The lovers said, "Do make for us a lovely park."

"Swimming pool," shouted children, and the ladies wanted a cinema—the biggest one in the country—to come up. Brick merchants, who had come all the way from Bhaktapur said, "This soil is best suited for bricks. We will perhaps make a brick kiln here."

'The old tree is better than this,' thought the nightingale and turned back. It was afraid that if the squirrel was back, the tree would allow it no stay.

It flew past a dusty sky, full of fume and reeking odors. The air almost blinded its eyes.

"I am back, dear old tree, for I love you very much. Do allow me to stay for one more night, for both of us are dying soon."

"How do you say so?" asked the tree.

"A yellow man in the west, with a yellow thing, is clearing the forest to make a city. It is felling all trees on the way, and soon, he will reach here.

"O, terrible!" said the tree, and shed thick drops of tears. Then it said, "Stay for a day, little bird, and when the day breaks, sing me a song for my kinsmen that are killed far away in the west."

"I will," said the nightingale, and kissed the old tree on the apex of its main branch. Then it came to the hole. Thank God, the squirrel was still out.

"I think, flood in the north has killed the squirrel," said the nightingale to the tree.

"Do not say so, dear bird," said the tree. "He has stayed with me too long, and I love him more than any of my fallen leaves. I will be dead, if he dies."

"Live long, old tree," said the nightingale, feeling sour at heart.

"Good night," said the tree and started whispering to the slow breeze that had come in the dusk to fan the few leaves that still lingered on the twigs.

At dawn, the nightingale sang the most melodious of songs it knew, lamenting the death of the trees, far away in the west. The old tree heard the song, and woke up. It was the saddest song it had ever heard.

"I take leave of you," said the nightingale. "Stay well, and do not forget me."

"Sure. I hope the squirrel is coming home tonight. It has been long since the squirrel left. Ungrateful creature; it takes no name of coming home early. I feel so lonely without him."

"He must be dead in the northern flood, dear tree," said the nightingale.

"For God's sake, do not say so. For, if he dies, I shall lie dead too, broken in heart."

"I don't wish so," said the nightingale in a pathetic voice. "But if you die, I shall pray for you. Here I go, dear old tree!"

The nightingale made a quick flight, and darted eastward. East it had heard, had the best of the blackberries that grew on the banks of those long rivers that had been flowing ever since the world was created.

Far away, in the east, it saw the sky full of birds—bigger than the ones it could imagine—crossing the sky from one side to another, making terrible noises. It sat on a little willow with yellow, rusted leaves, and watched the birds dart and play. O, what a terrible game it was! Sometimes the two collided, and both fell dead, torn to pieces, into the sea.

After a long wait, the nightingale saw something it could hardly understand. A black bird, fastest of the ones it had seen so far, laid an egg while still in the air. The egg fell down with a tremendous speed, and burst with the loudest of the noise it had ever heard. Soon smoke engulfed the entire land of the east, and flames of fire ran everywhere.

Unable to bear the spectacle, it darted away. O, the fume had almost smothered its little throat to death.

On the way, a terrible vertigo besieged its head. It could not locate the direction of the kind and old tree. As night came darting, it slipped under a gutter that reeked of filth so terribly. Underneath ran sewage carrying all the dirty things of the world, and at times, it little feet touched the wet, smudgy thing. Upon the gutter ran feet, all through the night, making strange but periodic trots. It could not sleep for fear of falling into the waste.

When the night waned and the sun rose, it flew out and sat on a tree. It wanted to sing a song to the beautiful sun, but a hoarse sound escaped its strained throat. For the first time in life, it felt that it could sing no more.

But its head was clearer. It looked far and wide, till it could locate the flags of the monastery on the hill. 'The old tree is west of the monastery,' it thought, and was soon on the branch of the benevolent tree.

It sat on the branch for a long, long time without a word. It had so many things to tell to the tree, but no word would escape. It just sat on the branch outside the hole, brooding. Its head hanged low, and the eyes looked on the earth underneath.

"Ah!" shouted the nightingale all of a sudden. Its voice was no match to the songs it sang in the past.

"Are you back? Good. I missed you last night."

"You will be dead now, dear tree, and with you I will be dead."

"How do you say so?"

"Your squirrel lies dead down there. Look down there, at the foot of the red-berry shrub. There it lies, stiff and dead."

"No," shouted the tree, but the few leaves it had on the top had, with the little holes on their surface, seen the squirrel lying dead.

"It has gone," said the nightingale, and offered: "Let me fly down and see how it died."

Down flew the nightingale and keenly observed the dead body of the squirrel, even as tears kept dropping from the tree upon its wings. Yes, someone had shot it with a catapult, and the bullet had hit its little head right in the middle. Some blood clotted outside the hole on the head."

"I will die now," said the tree, sad and forlorn.

"I will die too, said the nightingale."

Then the nightingale flew up and sat on the main branch of the tree.

"Alas, alas! All's gone now. Let me sing you the swan song—the last song of my life," said the nightingale, and started singing of the saddest things. It sang of the fire in the south, flood in the north, the big yellow thing in the west, and the egg of fire in the east. Both shed tears, till the little dead squirrel under the tree was fully drenched."

"Adieu, adieu, dear old tree," said the nightingale and fell from the branch. It dropped upon the dead body of the squirrel.

"It's ebony. It gives the best wood to make seats for the theater," said a tall, fat man later in the afternoon, and the tree was sawed down.

The author of this story is an Assistant Professor at Tribhuvan University.

Electrification Always Fosters Community Empowerment

COSMIC ELECTRICAL

Corporate Talk

Cosmic Electrical Limited, a leading force in the energy sector, is proud to announce the successful completion of five major projects that significantly enhance Nepal's power infrastructure. These projects include the integration of approximately 100 MW of energy into the grid through new transmission lines, rural electrification initiatives that improve quality of life, and the modernization of substations for reliable power in the Kathmandu Valley. In this context, we had a brief discussion with ***Mahesh Mahato****, Managing Director of CEL:*

Q: The company has achieved significant milestones in a short period. How does CEL perceive its business success?

Since its inception in 2000, CEL has been dedicated to advancing electrification for the community. Our primary objective is to consistently deliver reliable and clean electricity to communities. We specialize in projects related to transmission and distribution lines, substations, and rural electrification. The company excels in engineering, procurement, and construction (EPC) services, striving to enhance quality of life through sustainability and cutting-edge technologies.

Q: How does CEL ensure the reliability of service quality?

Whether pursuing short-term or long-term goals, CEL operates on the EPC model, which ensures enhanced quality and efficiency. Our core values of sustainability, collaboration, and innovation drive us forward. These values are pivotal in upholding high standards, integrating new technologies seamlessly, and prioritizing customer satisfaction.

Q: Could you elaborate further on this ?

Our brand epitomizes progress in energy, consistently meeting deadlines. We manage project execution with strength and transparency, leveraging modern technology responsibly and skillfully to foster strong partnerships with customers and stakeholders, ensuring timely project completion.

Q: How does long-term planning contribute to project execution and management ?

Long-term planning is integral to our project operations. We prioritize environmentally-friendly practices, integrating hydro, solar, and wind energy solutions. Our commitment to reducing carbon emissions underscores our dedication to sustainable development, providing communities with clean and dependable energy sources.

Q: What distinguishes CEL from other firms in the sector ?

Our foremost priority is delivering projects on schedule, underscoring our commitment and accountability. Our strategic approach involves comprehensive project assessment within specified time and budget constraints, bolstering our reputation through enduring partnerships.

Q: What role does foresight play in project development and operation?

Foresight is pivotal in our project strategy. We emphasize eco-friendly project execution, focusing on integrating hydro, solar, and wind energy technologies. Our dedication to minimizing carbon footprints promotes sustainable growth, ensuring communities access clean and reliable energy resources.

Q: What are CEL's future aspirations ?

Our vision is to expand globally, ensuring universal access to clean and reliable electricity. We remain dedicated to pioneering advancements in technology and operational excellence, making significant contributions to global climate initiatives, and fostering sustainable, long-term growth.

Q: In conclusion ?

CEL remains steadfast in its commitment to empowering communities through uninterrupted electrification efforts.

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 (GIZ)	432,000
Wind Power	3000

Electricity Access in South Asian Country

Country	Percentage
Afghanistan	98%
Bangladesh	100%
India	99.57%
Bhutan	100%
Nepal	98%
Sri Lanka	100%
Maldives	100%
Pakistan	95%
China	100%

Power Generation Scenario (MW)

Source	Capacity
Hydropower	2985.72
Hydropower (Isolated)	4.536
Thermal	53.41
Grid Connected Solar	106.94
Co-Generation	6
Off Grid (Micro hydro, solar)	88.15
Total Generation	3244.76

South Asia Energy Scenario (MW)

S.N	Country	Installed Power	Potiential power (Hydro)	Installed (Hydro)
1	Afghanistan	1285 MW	23,000	600 MW
2	Nepal	3244.76	100,000	2985.72 MW
3	India	426140 MW	1,50,000	52117 MW
4	Sri Lanka	5024 MW	2000	1727 MW
5	Bhutan	2600 MW	36,900	2600 MW
6	Maldives	290 MW	-	-
7	Bangladesh	27515 MW	-	230 MW
8	Pakistan	46035 MW	60,000	10635 MW
9	China	2920 (GW)	6,00 (GW)	421 (GW)

Per Capita Energy Consumption (KWh)

Country	Quantity
Afghanistan	152 KWh
Bangladesh	484 KWh
India	1327 KWh
Bhutan	5550 KWh
Nepal	384 KWh
Sri Lanka	631KWh
Maldives	1125 Kwh
Pakistan	560 KWh
China	5728 KWh

Sources of Power Generation (MW)

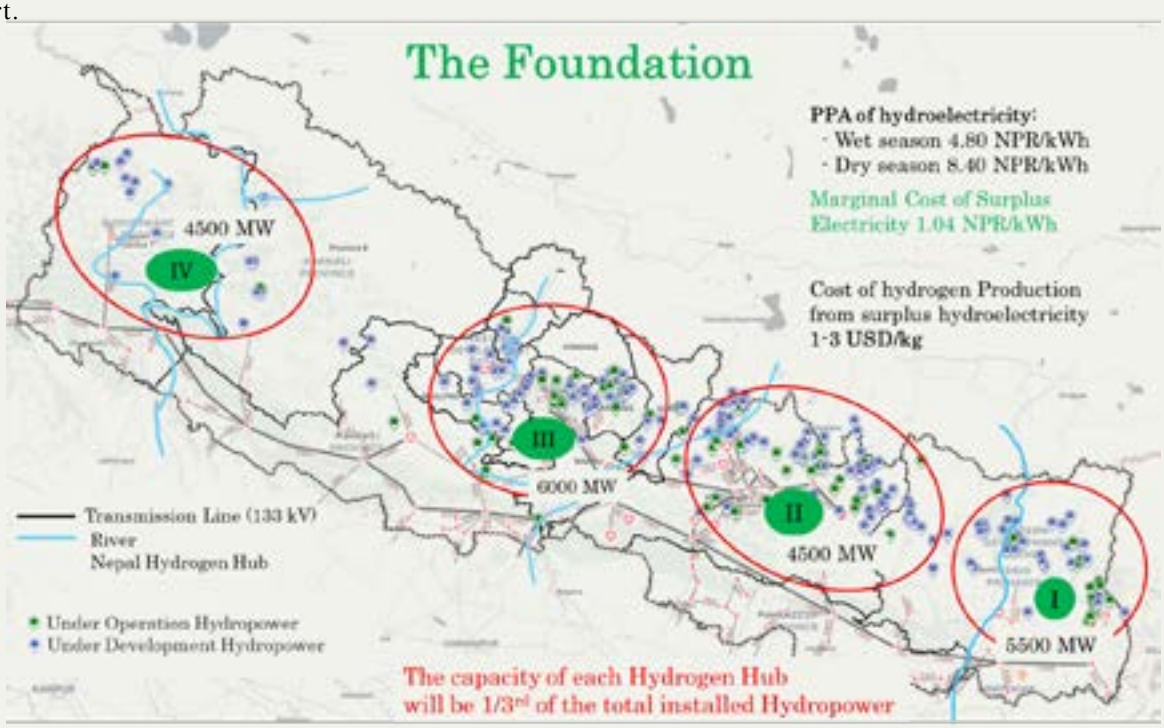
	Hydropower		Solar	Thermal	Co-generation	Micro Hydro	Total
NEA	Grid	Off Grid	25	53.41	-	-	661
	578.05	4.536					
NEA Subsidiry	492.90		-	-	-	-	492.90
IPP	1914.77		81.94	-	6	-	2002.71
AEPC	-		39.15	-	-	49	88.15
Total	2985.72	4.536	146.09	53.41	6	49	3244.76

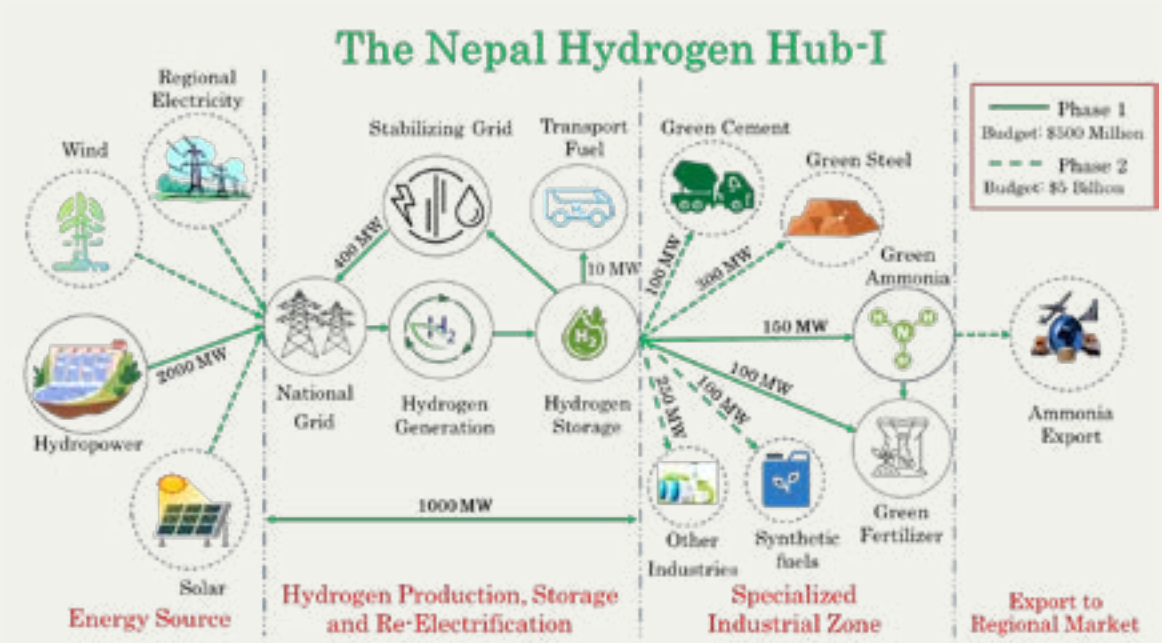
Source: 1. Nepal Electricity Authority, Alternative Energy Promotion Center and Independent Power Producers
2. Some international agency and documents.

Nepal Hydrogen Hub

Background

- Nepal Hydrogen Hubs would encompass the consolidated value chain of Green Energy and Industries centered around hydrogen production, storage, distribution, end-use applications, and export, all integrated within distributed hydropower projects.
- The Koshi basin is proposed as the site for Nepal's first hydrogen hub project development.
- The basin hosts hydropower projects with a collective capacity of 5500-6000 MW, in different stages of development. Up to 2000 MW of power can be utilized in the Hydrogen Hub.
- The hub's strategic location near major natural resources and industrial zones ensures efficient access to energy consumers.
- Koshi basin is well-connected to the national grid, facilitating seamless integration of hydrogen production and distribution. Its proximity to both the India and Bangladesh markets presents lucrative opportunities for regional export.





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Pitched at:

Nepal Investment Summit 2024

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