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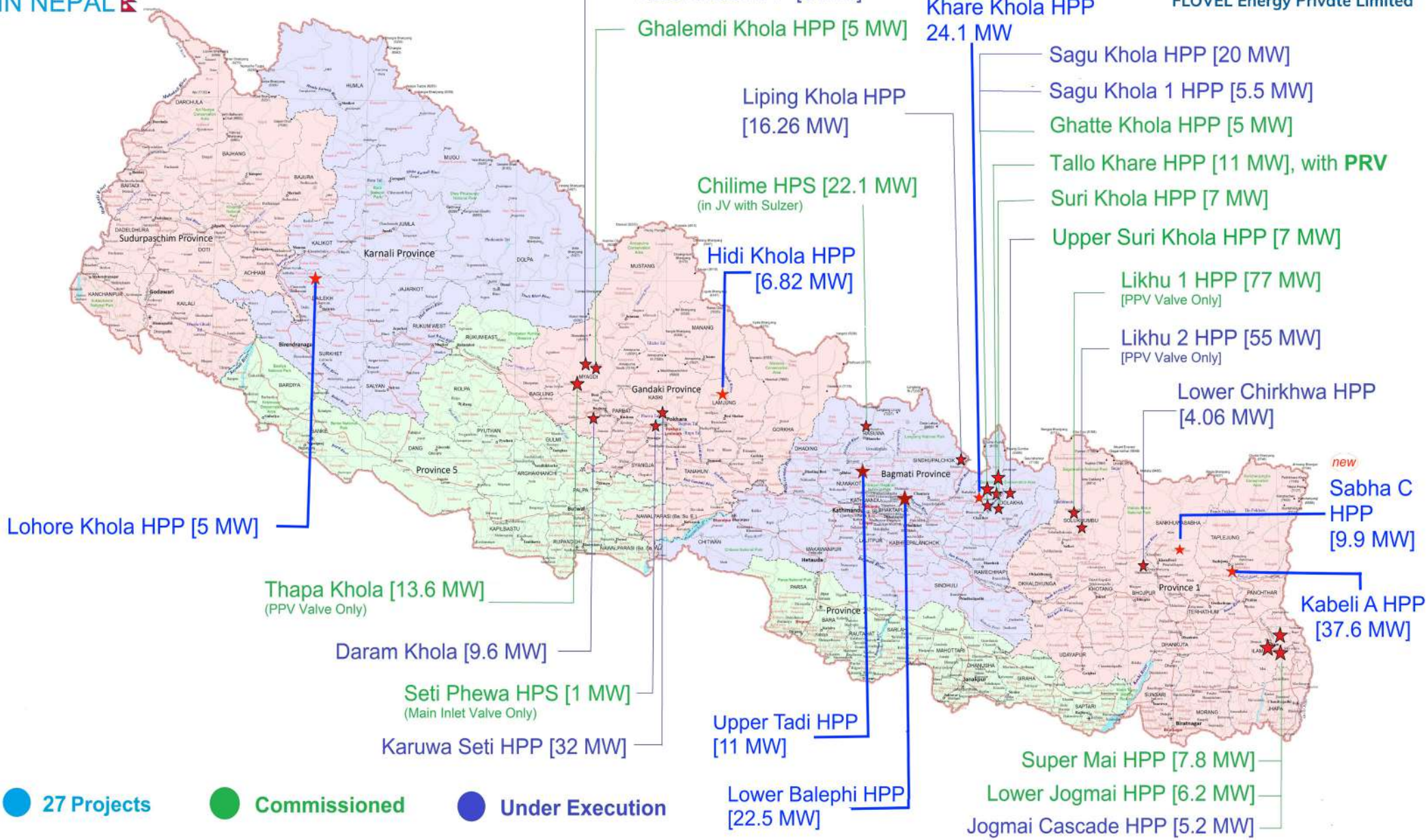

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EDITORIAL

Private developers must not only seek government privileges but also safeguard their projects from disasters by focusing on sustainable infrastructure.

Accountable Government and Responsible Private Sector

Nepal's hydropower sector has been facing increasing challenges due to natural disasters triggered by the climate change. The findings of recently conducted disaster-based studies also give inferences about the incidents. The floods and landslides that followed the heavy rains on September 26-28 caused major damage to 39 hydropower projects with a total capacity of about 1,600 MW. These include both operating and under construction projects. The affected production volume makes up almost half of the country's total installed capacity of 3,500 MW. The country's largest 456 MW Upper Tamakoshi Hydropower plant, which was damaged by the floods and landslides, resumed its partial operation only after 3 months.

The incidents however are not new in the sector, if not expected to that extent. Floods and landslides have been inflicting huge losses on the hydropower sector almost every year. The floods and landslides that occurred in June 2023 devastated 31 hydropower projects located in eastern Nepal. Moreover, projects like the 14.9 MW Hewakhola 'A' are found suffered mostly by floods and landslides. An instance of the 3 MW Bhairav Kund project, which was shut permanently with sustaining seven incidents of natural disasters in seven years between 2014 and 2021) after just one and a half months of its operation, produces a gloomy situation.

Such major disasters are the indications for alarming impacts of climate change. Due to human activities that help increase greenhouse gas emissions, global temperature is continuously rising. This has invited many changes in the climate as well as the overall weather system. As a result, events such as torrential rains, severe floods, landslides, inundations, prolonged droughts, abnormal snowmelt, snowfall, and reduced river flow are increasing. On the other hand, the possibility of dry landslides in winter is also increasing. There has been an increase in such incidents mainly after the 2015 earthquake. All these have proven to be an irony for hydropower sector of the Himalayan country.

Private hydropower developers have been demanding the government to declare such incidents as 'unforeseen circumstances' and have sought necessary privileges citing the situation. These include reducing customs duty to one percent, VAT exemption and refinancing facility on import of spare parts and equipment targeted for the maintenance of disaster-hit projects. However, the concerned government authority like the Department of Electricity Development (DoED) seems unwary to verify project design to align with impacts of natural disaster. It is not appropriate also on the ground that the government releases the benefit scheme without assessing the actual damages caused by the natural disasters. Nevertheless, the private sector alleges the government for being apathetic to the situation. In fact, the point of approach of project promoters after such disasters

should be insurance company not the government if they have taken appropriate insurance scheme considering such disasters.

Due to climate change, there has been a dramatic fall in water flow in rivers and streams in recent years. Hydropower promoters claim that the production of many projects has been limited to less than one-fourth of their actual capacities. This has led to a significant decline in revenue generation by hydropower plants. Moreover, the government has been making hydropower producers to announce their productions in advance under 'availability declaration', while the developers are subjected to pay up to 100 percent in hydrology penalty if their prediction goes wrong. This has added to the suffering of the producers. On the other hand, the projects are not able to produce as per the agreement since the very first year of their commercial operation. Similarly, promoters face allegations that their hydrology study, unknowingly or intentionally, has proved to be incredible as many of them do not meet their deemed energy even in the first year of their commercial operation.

Pushing the projects in haste to save time and costs has led to flaws in hydrology and design by private developers. The Nepal Electricity Authority (NEA) argues that climate change alone isn't to blame—developer negligence is also a factor. If energy output declines only after the initial years of operation, climate change may be the cause. NEA allows amendments to deemed energy in the Power Purchase Agreement (PPA). However, the Electricity Regulatory Commission (ERC) has recently removed hydrology penalties for projects under 10 MW.

Although the small hydropower projects have been given the cushion, the ERC maintains the cent percent hydrology penalty for projects exceeding 10 MW. NEA's role in this regard is not compatible with the law, while it also goes against the government's set plan for the overall development of energy sector. In the recently endorsed 'Energy Development Roadmap, 2024' that talks about producing 28,500 MW of electricity by 2035, the Ministry of Energy, Water Resources and Irrigation has stated to remove the provision of hydrology penalty. Private sector has also been raising their concern over the issue. It is an irony that private developers have been treated as the sole responsible factor behind climate change that they bear full charge for the huge losses from water-related disasters. Nevertheless, the Private sector should also be aware not to compromise with the quality of surveys, designs and construction of structures in the race of constructing projects at low cost and on time. NEA has been putting stress to ascertain over such issues arguing that why NEA projects are not affected by flood disasters in the same river basin where number of private projects suffer disasters if climate change was to be blamed.

What is even more contradictory is that the ERC has been approving the decision of the NEA to impose a 'hydrology penalty' in contrary to its own regulations. It is yet to see 'To what extent will the penalty provision mentioned roadmap will be implemented.' While making the private sector responsible for their quality design, it is essential to maintain and study mandatory 100-year flood data and water flow to avoid any possible accidents while developing projects. There is a need to revisit the 100-year flood design standard considering the impacts of climate change.

With rising temperatures in the Himalayan region, the number of glacial lakes is increasing. Experts on time and again have warned that these lakes are at high risk to burst at any time. Last August, a glacial lake burst in Solukhumbu destroyed many physical structures in Thame Bazaar. Meanwhile, the main cause of the floods in Sikkim last year was also bursting of a glacial lake. Now, it has become imperative for the promoters of every river-based project to conduct sufficient study from expert consultants on possible bursting and damages triggered by glacial lakes in the upper watershed area.

Sufficient study should also be done on the liquefaction tendency of the hilly terrain on the upper belt of the project construction site. On August 1, 2014, the Jure landslide of Sindhupalchok collapsed and swept away the village. Water flow in the Sunkoshi River was completely blocked. This caused huge damage to human and hydropower infrastructure in the region.

In this disaster, the 2.5 MW Sunkoshi Small Hydropower Station was submerged for days, while the 10 MW Sunkoshi downstream was shut due to water shortage. The landslide also damaged the transmission line and several private's hydro projects.

Adequate time and investment are essential for studying the geology, geography, liquefaction risks, and hydrology of construction sites. Developing projects with a short-term mindset, knowing they transfer to the government in 30 years, is detrimental. Such cases have already occurred. However, the private sector alone is not to blame for neglecting sustainable hydropower development.

Private developers must not only seek government privileges but also safeguard their projects from disasters by focusing on sustainable infrastructure. They should reflect on past work, address weaknesses, and embrace self-regulation.

Meanwhile, the government cannot simply shift blame to the private sector. Weak monitoring, inspection, and impulsive decision-making have made regulatory bodies and administrators equally responsible for disaster-related damages.

Minimizing climate change impacts requires all stakeholders to fulfill their roles responsibly. Only then can sustainable hydropower development be ensured. To achieve its 28,500 MW hydropower target, the government must enforce accountability and modernization.

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INSIDE

ERC's Digital Transformation: Paving the Way for Paperless Regulation

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Managing Transboundary Dams: Safety, Hydro-Diplomacy, and Sustainable Cooperation

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Heartfelt Condolence

Late. Amrit Man Nakarmi

We deeply mourn the sad demise of **Prof. Dr. Amrit Man Nakarmi**, a distinguished faculty member at the Institute of Engineering-IoE (Pulchowk Campus), on December 17, 2024. Dr. Nakarmi had been serving as an advisor for the Urja Khabar bi-annual magazine for the past three years, providing intellectual guidance. We remember and honor his noteworthy contributions in education, engineering and development of electricity sector in Nepal. We will miss him deeply. We extend our heartfelt tribute.

– Editor and the Urja Khabar Family

Royal Expedition: A Journey Through Majestic Destinations

Bhuwan Chand Thakuri

We had laid wooden beams on a damp wheat and installed five small diesel generators on top of them. We covered those generators (total capacity 15 KW) with a canvas roof and named this structure – Power House.

The covered with one-span-tall wheat plants, was guarded by royal soldiers armed with automatic weapons, stationed all around. Among 70 to 80 tents made from canvas that housed soldiers, royal secretaries, and courtiers, there was a tall enclosure made of the same canvas. Inside this enclosure were six additional tents. We called this enclosure the royal palace.

Among 70 to 80 tents made from canvas that housed soldiers, royal secretaries, and courtiers, there was a tall enclosure made of the same canvas. Inside this enclosure were six additional tents.

This was no joke. Inside that palace, His Majesty King Birendra Bir Bikram Shah Dev and some members of the royal family were actually residing. This was during King Birendra's first travel camp to Dipayal in Poush 2038 (January 1982).

On the left bank of the Seti River lies a steep, tall cliff. Atop this cliff is a wide flat area. This space held not just farmland but also Dipayal's airstrip. The camp was set up in the middle of the farmland. During the daytime, even in the cold month of Poush, the sun's heat made one long for an umbrella. But at night, the cold drafts from the Seti River carrying icy water made it feel as if the body would shiver uncontrollably even under two blankets.

An Unusual Problem

It was three in the afternoon. All of us responsible for operating and maintaining the powerhouse—myself, a supervisor, and an electrician—were astonished to find that the outer bodies of all the generators had become electrified. We immediately began trying to resolve the issue, but identifying the cause proved to be a challenge.

The outer bodies of the generators had been separately grounded. We had attached wires to their outer parts, burying the wires deep into the ground with a metal plate. This setup ensures that any electricity leaking to the generator's outer body would safely flow into the ground, preventing harm to humans.

The neutral line was also grounded, but disconnecting it didn't solve the problem. When we touched a tester to the generator bodies, it still lit up fully, leaving us baffled. Just an hour earlier, our electrician had been shocked while touching one of the generators. Upon inspection, we realized all the generator bodies were electrified. Since then, we had been working tirelessly to solve the issue, but with no success. The situation was growing more perplexing.

When my central office assigned me to manage the electrical systems for this camp, I had initially tried every excuse to avoid the responsibility. However, I couldn't refuse when the head of the Department of Electricity, Harshman Shrestha, personally summoned me.

"I selected you for Dipayal because of what I've heard about you," he said. "You have considerable experience with diesel generators. Moreover, since you worked during the royal camp in Pokhara, you are familiar with these operations. For this camp, you'll need to collect generators from various places, install them there, and stay on-site for one and a half months while the camp is active. Any breakdowns must be repaired immediately. That's why I've chosen you."

His tone carried more of a request than a command, so I decided to comply rather than make more excuses.

After two hours of continuous effort, we discovered that the current was coming from the ground itself—a surprising revelation. We had grounded the equipment to ensure safety, as any current leaking from the machines would flow harmlessly into the earth. But the opposite was happening: electricity was flowing from the ground to the machines.

Disconnecting the grounding wire stopped the electrification of the generator bodies, but reconnecting it made them live again. Measuring the voltage between each phase and the ground revealed slightly higher-than-normal readings in two phases, but one phase showed a significantly lower voltage. This reminded me of a similar issue I had encountered at the diesel powerhouse in Pokhara. One of the phases seemed to have an unintended connection to the ground.

The affected phase supplied electricity exclusively to the royal palace. I suspected an issue within the palace. Only three water heaters (geysers) were installed inside, apart from light bulbs. Of these, only one geyser, used by His Majesty, was active; the other two were disconnected as the King's brothers, for whom they were intended, had not yet arrived.

> Despite the resistance I faced earlier, I had to be absolutely confident in my assumptions to justify my insistence on entering the royal tent.

The active geyser's outer casing was grounded, so I suspected a potential current leak from its body. The area had seen light rainfall two days earlier, leaving the surrounding farmland and ground damp. If the King were to use the geyser to bathe, his wet body and slippers would increase the risk of an electric shock—potentially fatal.

A sense of fear gripped me. The King, who had gone out earlier, was expected to return shortly, and he might head straight to bathe upon arrival.

Although we were prohibited from entering the royal palace for maintenance—electrical work inside was handled by palace-assigned electricians or army personnel—I had been allowed to inspect the wiring before the camp began. That's how I knew about the geysers' installation.

Who Can Give Orders to the King!

Near the powerhouse, I spotted a lieutenant. I explained my concern to him and asked for a way to enter the royal palace. Unfortunately, he had no solution either.

"Why not check it tomorrow instead of now?" he suggested.

"Tomorrow might be too late. If His Majesty (King Birendra) uses the geyser, he might get electrocuted," I explained.

"Are you absolutely sure the current is leaking from the geyser?" he asked.

"It's a possibility," I replied. "But this concerns His Majesty's safety. Leaving it unresolved until tomorrow would be irresponsible."

The lieutenant picked up his walkie-talkie and spoke to a colonel. "The engineer for electricity wants to check something inside the palace. What should we do?"

The response was sharp: "Tomorrow. His Majesty is about to return from outside. Who would let him into the palace now?"

"His Majesty is likely to bathe upon his return, to wash off the dust of the day," I said.

The thought made me sweat. I insisted again that entering the palace was urgent.

"Send him to me," came the colonel's command.

The lieutenant assigned a soldier to escort me. The soldier led me to the colonel, who turned out to be the security in-charge of the travel camp. I explained everything to him again, but he refused to allow me into the palace.

"Tomorrow," he said firmly.

"In that case, please send a message asking His Majesty not to use the geyser until tomorrow," I pleaded.

The colonel gave me a peculiar look. "Who can give such an order to His Majesty? Who can stop him?" he snapped.

I walked away, muttering to myself, Even if His Majesty skips bathing tonight, he will surely bathe tomorrow morning. If the worst happens, let it not be said that I didn't warn them.

I turned back to add, "I've stated my concern. If any accident occurs by tomorrow, don't say I didn't warn you. I've fulfilled my duty. Besides, we're not responsible for the electrical work inside the palace. Goodbye!"

I left after my final words, hoping for the best but unable to shake the fear of what might happen.

How Did I Get In?

I had barely taken a few steps away when the colonel's voice called out, "Wait!"

He spoke into his walkie-talkie, communicating with the King's ADC (Aide-de-Camp): "The engineer for electricity wants to enter the palace. He says it's urgent. Let him explain himself there."

"Send him," came the immediate approval.

The colonel assigned two guards to accompany me. They escorted me a short distance before handing me over to another pair of guards, who led me closer to the palace.

As I walked, an uncomfortable feeling began to build inside me. What if nothing unusual was found? Not only would I become the subject of ridicule, but I might also face accusations of overstepping my authority. I had indirectly pressured the colonel, and if my concerns turned out to be baseless, it could result in severe consequences. There was a real risk of being expelled from the camp in disgrace the very next day. They could even question my intentions for insisting on entering the palace.

Despite the resistance I faced earlier, I had to be absolutely confident in my assumptions to justify my insistence on entering the royal tent. But now, uncertainty gripped me. With every step, I tried to prepare myself for whatever awaited me.

At the palace's main gate, the King's ADC was waiting. Dressed in an army uniform, revolver on his waist, and boots on his feet, he appeared ready for the King's imminent return from his trip.

I had met him once before, during the initial inspection of the palace's electrical system. That encounter left me with the impression that he was quick to understand matters.

I explained my suspicion to him, adding cautiously, "My assumption might be entirely wrong, but I took this step out of concern for His Majesty's safety. Please forgive me if nothing unusual is found."

I expected a thorough interrogation or at least a full-body search before being allowed entry. However, his expression changed the moment he heard my explanation. He took me straight to the spot where geyser was installed without hesitation.

A sense of fear gripped me. The King, who had gone out earlier, was expected to return shortly, and he might head straight to bathe upon arrival.

Was It a Conspiracy?

It was a small bathing cabin covered with tarpaulin, built on damp ground. Wooden planks with a rubber mat on top served as flooring. Two wooden poles supported a geyser, which was making an unusually loud noise, reminiscent of a steam engine.

"I've never heard a geyser make this kind of noise," remarked the ADC, visibly puzzled.

"Neither have I," I responded, equally astonished.

As we approached, we saw steam escaping from the geyser's outer shell with a loud hiss. Its thermostat had likely failed, as it continued heating beyond its limit. A relief valve designed to release excess steam wasn't likely functioning, the geyser had bursted.

Steam and water were dripping onto the electrical connections below the geyser, which were soaked through. Testing confirmed that the geyser's outer shell, water pipes, and even the surrounding areas were electrified. I disconnected its power supply immediately. When I asked the power house team, they confirmed the electrical leakage issue had resolved. To ensure the diagnosis, I reconnected the geyser's power, and the problem reappeared.

I cut the connection permanently and exited. Thus was averted what could have been a catastrophic accident. If I hadn't insisted, the Colonel wouldn't have allowed entry that day. He had planned to check the issue the next day during the King's outdoor schedule.

"But there's rubber matting and wooden flooring here. The King always wears slippers while bathing, doesn't he? Couldn't this prevent a shock, Engineer?" asked the ADC, seemingly more to reassure himself than to question.

"Dry conditions might not pose an immediate risk, but this is a bathing area. Once water seeps

in, everything — the mat, wood, and slippers — will get soaked. Under such circumstances..." I let my sentence trail off deliberately. He understood and didn't press further.

I inspected the other two geysers, which were new and fully functional. But what puzzled me was why the King's geyser was so old and poorly maintained while the others were brand new. Was it because the King, known for his simplicity, never complained about using subpar equipment, or was it something more sinister?

When I exited the palace, another ADC, stationed at the main gate, stopped me. "What happened inside?" he asked curiously.

All the officers had walkie-talkies, so they were all aware of my request to enter the palace, which had clearly piqued their interest. I explained the situation, and he smiled, saying, "The King had express his concern this morning that there could be an electrical leakage somewhere here. Maybe it had already given him a mild shock?"

The geyser, in its precarious state, had likely been malfunctioning since that, escalating into a severe hazard by evening. No one had taken the King's morning concerns seriously or …?

Soon after, the sound of a helicopter announced the King's arrival. I looked up to see his white helicopter approaching. The work had been completed just in time.

The next morning, a new geyser arrived via plane.

The camp lasted for one and a half months. During this time, the diesel generators ran without interruption, ensuring a steady power supply. I expected my efforts to be recognized, especially given I had safeguarded the life of the nation's highest authority.

However, when the names of awardees were announced after the completion of the camp, I was disappointed. My name wasn't even mentioned. It appeared that the incident with the geyser and my role in preventing a disaster had been kept entirely under wraps, even from the King. Why?

This historical article is taken from Atitko Poko, the book by Bhuwan Chand Thakuri, former General Manager of Nepal Electricity Authority.

Future of Nepali Hydropower
Amid Climate Change Challenges

Rajesh Khanal

Among the major hydropower projects suffered, Upper Tamakoshi Hydropower Project (456 MW) shut down due to severe damage to its dam, control rooms, and canals.

The floods and landslides on September 26-28, 2024 triggered by incessant rains have severely affected a number of hydropower plants across the country, causing a loss of billions of rupees to these power plants.

According to the Nepal National Disaster Risk Reduction and Management Authority, damage to 26 hydropower facilities has resulted in an estimated loss of Rs 3.018 billion. This loss has significant implications for energy supply, impacting both residential and industrial consumers. The Independent Power Producers Association Nepal (IPPAN) has claimed a total of 13 hydropower projects with a capacity of 626 MW were affected. In addition, another 15 projects of 1,010.29 MW also sustained major damages. A total monetary loss to these power projects amounts more than Rs 5 billion. It includes both the under construction and operating projects. Reconstruction of these projects will require substantial time and investment.

The Ministry of Energy, Water Resources, and Irrigation has reported that the floods and landslides have resulted in the shutdown of 1,100 MW of electricity production across the country, while the irrigation sector has also sustained damages amounting to NPR 1.35 billion. This has led to serious disruptions in the nation's energy supply.

Among the major hydropower projects suffered, Upper Tamakoshi Hydropower Project (456 MW) shut down due to severe damage to its dam, control rooms, and canals. The project has been non-operational for three days, and the inability to resume operations in the near future poses a serious risk to load management. This project had been a major contributor to the country's energy production. Despite expediting maintenance, the Nepal Electricity Authority (NEA) has failed to operationalize the project fully.

Likewise, Mandu Khola Hydropower Project (22 MW) sustained severe damage in its powerhouse due to flooding caused by the release of the Kulekhani Dam. Lower Hewa Khola Hydropower Project (22.1 MW) in Taplejung and Upper Trishuli 2 Hydropower Project (216 MW) in Rasuwa were among the affected projects.

The natural disasters also affected the distribution infrastructure including transmission lines in various parts of the country. The Tamakoshi River swept away Khimti-Lamosanghu Transmission Line, disrupting the flow of 200 MW of electricity to Kathmandu. Likewise, two transmission towers in the Kabeli Corridor were damaged by the floods, leading to a power outage in Ilam and Phidim in Panchthar. Among others, the Solu Corridor, Koshi Corridor, and Damak-Godak transmission lines were affected. In particular, Tower 51 of the Damak-Godak line was swept away by the flood.

Although there lacks uniformity in the data maintained by various government agencies and the IPPAN, the heavy destruction of operating and under construction projects brought about by the natural disasters cannot be undermined.

Details of damages on power plants

The September floods and landslides are reported have impacted the following projects:

SN	Project	Promoter	Capacity	Situation	District	Estimated Loss (in Rs 10 million)
1.	Hewa 'A' Small	Habitat Power	5 MW	Under-construction	Pachthar	5
2.	Upper Mai	Panchakanya Mai Hydropower	9.6 MW	Under-construction	Ilam	7
3.	Upper Mai Cascade	Panchakanya Mai Hydropower	3	Operating	Ilam	5
4.	Lower Hewa Khola	Mountain Hydro Nepal	22.1	Operating	Pachthar	25
5.	Hewa Khola 'A'	Pachthar Power Company	14.9	Operating	Pachthar	
6	Yambaling Khola	Yambaling Hydropower	7.27	Operating	Sindhupalchok	
7.	Mai Khola Small	Himal Dolakha Hydropower	4.5	Operating	Ilam	
8.	Mai Small Cascade	Himal Dolakha Hydropower	8	Operating	Ilam	
9.	Isuwa Khola	Isuwa Energy	40.1	Under-construction	Sankhuwasabha	
10.	Bagmati Small	Mandu Hydropower	22	Operating	Makwanpur	100
11.	Solu-Dudhkoshi	Sahas Urja Limited	86	Operating	Solukhumbu	
12.	Feme Khola	Khoranga Hydropower	0.995	Operating	Pachthar	10
13.	Siuri Khola	Nyadi Group Power	5	Operating	Lamjung	2
14.	Super Nyadi	Siuri Nyadi Hydropower	40.27	Under-construction	Lamjung	
15.	Ilep Khola	Jal Shakti Hydro Company	25	Under-construction	Dhading	
16.	Upper Trishuli-1	Nepal Water & Energy	216	Under-construction	Nuwakot	10
17.	Sabha Khola B	Orbit Energy	15.1	Under-construction	Sankhuwasabha	7
18.	Sabha Khola C	Orbit Energy	6.3	Under-construction	Sankhuwasabha	3
19.	Landruk Modi	Annapurna Bidhyut Bikas	86.59	Under-construction	Kaski	8
20.	Super Trishuli	Blue Energy Ltd	100	Under-construction	Dhading	25
21.	Langtang Khola	Multi-Energy	20	Under-construction	Rasuwa	
22.	Khani Khola	Khani Khola Hydropower	2	Operating	Lalitpur	10
23.	Tungun Thosne	Khani Khola Hydropower	4.36	Operating	Lalitpur	15
24.	Maya Khola	Maya Khola Hydropower	14.9	Under-construction	Sankhuwasabha	2
25.	Kabeli A	Kabeli Energy	37.6	Under-construction	Taplejung	
26.	Super Khudi	Super Khudi Hydropower	26	Under-construction	Lamjung	7
27.	Super Tamor	Crystal Power Development	166	Under-construction	Taplejung	
28.	Machha Khola	Water Energy Development	16	Under-construction	Gorkha	0.3
29.	Khimti-2	Peoples Energy	48.8	Under-construction	Ramechhap	
30.	Balephi Khola	Balephi Energy	40	Under-construction	Sindhupalchok	
31.	Super Kabeli	Snow Reverse	13.5	Under-construction	Taplejung	
32.	Kabeli-3 Cascade	Kabeli Hydropower	21.93	Under-construction	Taplejung	
33.	Super Kabeli Khola	Hilton Hydro Energy	12	Under-construction	Taplejung	
34.	Bhotekoshi-1	Electro Power Company	40	Under-construction	Sindhupalchok	
35.	Kabeli B-1	Arun Kabeli Hydropower	25	Under-construction	Pachthar	5
36.	Buku Khola	Apollo Hydropower	6	Under-construction	Okhaldhunga	4
37.	Lower Tadi Khola	Buddha Bhumi Nepal Hydropower	4.99	Operating	Nuwakot	
38.	Super Hewa Khola	Super Hewa Power	6	Under-construction	Sankhuwasabha	
	Total		1,222.80			250.30

Source: Independent Power Producers Association Nepal (IPPAN)

Recurring problems

Nevertheless, the natural disaster caused risks this year has been apparent on a relatively bigger scale, the recurring of the incidents is not unusual in the Himalayan country, particularly in recent years. This has called on the need for constructing the power plants in different modality so as to minimize the losses and to address the energy demand of the country.

Floods of June 17, 2023 hit a number of hydropower projects operating in eastern Nepal. At least 30 hydropower projects in eastern Nepal suffered damage estimated at around Rs 8.5 billion due to floods and landslides during the monsoon of 2023. The figure represented the direct loss, while the indirect ones could be multifold higher.

The data with the IPPAN shows that hydropower projects under construction in Sankhuwasabha, Bhojpur, Panchthar, Taplejung with a total capacity of 369.33 megawatts suffered damages due to floods last year.

Previously, on June 15, 2021, floods damaged 26 hydropower projects in the Madi Corridor, Dordi Corridor and Marsyangdi Corridor. At that time, 10 hydropower projects in operation and 16 under construction projects were damaged. It was estimated that the damage was more than Rs 5 billion.

Growing challenges

A World Bank report has highlighted that Nepal faces massive infrastructure losses to climate changes related events. Even with no additional warming, there is the probability of floods destroying 2.6 percent of capital stocks (plant, equipment, and other assets that help with production) in built infrastructure over 50 years, the World Bank said in the Nepal Development Update report 2022.

Nepal contributes an estimated only 0.027 percent of total global GreenHouse Gas (GHG) emissions. On top of this, Nepal has focused on renewable energy, hydropower production, targeting 12000 MW by 2030 to fulfill its growing demand of 11,500 MW. However, the Himalayan country is likely to suffer one of the highest impacts of climate change.

> According to Climate Analytics, if global temperature continues to rise as at the current pace, Nepal's GDP will be affected by about 18 percent by 2050 and more than 60 percent by 2100.

Although hydropower is considered as a renewable clean energy, dam closure, influence within the downstream river and connected ecosystems have consequent impacts on hydropower production. Nepal's topography offers more RoR types of hydropower, which is subjected to more risk of landslide, flooding and flash floods, among others.

The hydropower generated energy is still the major source of energy supply in Nepal. The river basins in Nepal sustain extensive pressure due to developmental and demographic growth. In addition, the erratic weather patterns—extreme rainfall in a short span of time, lack of rains for months, continued rain for several days and other unusual weather events—caused by climate change have become frequent in Nepal, affecting thousands of people and threatening the country's hydropower potential.

The sector's experts say that building hydel projects on the basis of 100 years' water data doesn't ensure their safety, as weather extremes have been escalating due to the effects of climate change. According to them, erratic weather patterns have become frequent in Nepal. In the past, the heavy rainfall in the high mountainous areas used to be very rare. But now, even in the mountainous areas, 100 milliliters of rainfall occur in a single day.

In the words of Climate Change Expert Manjeet Dhakal, the effects of climate change should be analyzed while building big projects. "Our infrastructures should be made compatible with possible adverse effects of climate change."

Public and Private Sector

Currently, the installed capacity of electricity generated by the government and the private sectors has reached about 3,500 MW. About 70 percent of this is generated by the private sectors. However, the risk of private sector projects is higher than that of the government run projects. A general analysis of the floods of 2023 and 2024 and their impacts on the hydropower sector shows that private sector projects sustained major damages.

Projects such as Kaligandaki 'A' and Madhya Marsyangdi promoted by the Nepal Electricity Authority were not significantly affected, but more than 200 private sector projects promoted in the central and eastern regions of the country suffered serious damage.

Energy Supply Crisis

With the cessation of 1,100 MW of power production, the NEA imported an additional 300 MW from India to maintain smooth power supply. The state-owned power utility faced additional monetary losses as it could not

export electricity to India amid peak production season. Although the Upper Tamakoshi Hydropower Project has partially resumed its operation, it is estimated to take another few months to fully operationalize its working. This created potential risks to the household sector to undergo load shedding again, while industries face inadequate power supply in their daily operations. The agricultural sector also suffers a lot due to damage in irrigation systems.

Immediate impacts

(a) Physical damage: The risk of damage to reservoirs, dams and power plants of hydropower projects due to floods and landslides following heavy rains has increased immensely of late. Landslides are also likely to affect canals, tunnels and transmission lines. The rain of June 2024 damaged transmission towers in Dang and Kailali. This disrupted the electricity supply of the national transmission line.

(b) Unbalanced water flow: As the rate of melting of glaciers increases, the availability of water increases, leading to seasonal fluctuations. Excess water during the monsoon and lack of water during the dry season will cause instability in hydropower production. In addition, the life of the project will be reduced due to the accumulation of water-borne materials such as stones, soil, silt, and gravel in the river bank areas.

(c) Delays and cost increment: When natural disasters disrupt construction work, both the time and cost of hydropower projects will be affected. These incidents are recurring at present. Additional investment will be needed in damage reconstruction and risk mitigation, which will make the project more expensive.

Long-term impacts

(a) Reduction in water resources: Global warming will reduce the number of glaciers, which is likely to pose a challenge to the sustainability of hydropower projects. Studies have shown that there will also be a significant reduction in the rate of recharge of groundwater and river systems.

(b) Impact on energy market: The Government of Nepal has projected to export 15,000 MW of electricity to India and Bangladesh by 2035. It is likely that the reduction in water resources will have a direct impact on electricity production. This is likely to be seen within the next decade. This will affect not only the external but also the domestic electricity market of the country.

The National Development Plan (NDP) prepared for the next 30 years (2021-2050) states that the decrease in rainfall compared to the past has led to a decrease in water flow in rivers and streams. This could be the reason behind the decrease in hydropower production by 6.9 percent in the fiscal year 2020/21. This will also have an adverse impact on electricity exports.

According to the Nepal Electricity Authority, nearly two billion units of electricity worth a total of Rs 17 billion was exported to India in the fiscal year 2023/24. Export of 40 MW of electricity to Bangladesh has also started since November 15, 2024. The decrease in the flow of rivers and streams is likely to have a direct impact on production and hence the export.

(c) Environmental-social impact: Floods and landslides will damage human settlements and agricultural land and increase social imbalance in the project area.

(d) Hazardous glacial lakes: Many of the hydropower projects in Nepal are situated at the lower belts of glacial lakes. Therefore, there is a risk of massive damages to hydropower projects if the glacial lakes burst. A study conducted jointly by the International Centre for Integrated Mountain Development (ICIMOD) and the United Nations Development Programme (UNDP) in 2000, indicated that 47 glacial lakes are at risk of bursting. Of these, 42 glacial lakes in the Koshi Basin in the eastern region alone are at risk. Eighteen are in different parts of Nepal, while the remaining 24 are in Tibetan territory.

According to the ICIMOD, the impact of climate change in the Hindu Kush Himalayan region is three-times higher than the global average. In the decade from 2011 to 2020, the rate of glacier melting in the region was 65 percent higher than the previous decade.

Worldwide, 15 million people are at risk of glacial lake outburst floods. One-third of them live in India (3 million) and Pakistan (2 million). In

Nepal's topography offers more RoR types of hydropower, which is subjected to more risk of landslide, flooding and flash floods, among others.

2020, a NASA research team estimated that there will be 30 to 70 percent more landslides to take place in the Nepal-China border area from 2061 to 2100. Many glaciers and glacial lakes are situated in this region.

(e) Risk to the economy: It is estimated that the contribution of clean energy to the world's gross domestic product (GDP) by 2023 was about 320 billion US dollars, which made up 10 percent of the world's GDP. According to the National Statistics Office, the energy and hydropower sector contributes the most to Nepal's GDP, accounting for about 19 percent in FY 2023/24.

Although the private sector is the largest investor in the country's hydropower sector, the government also needs to take charge. As the private sectors bear the direct losses through damages, the government faces additional financial burden for compensation indirectly. According to the World Bank, floods and other disasters will damage 2.6 percent of Nepal's infrastructure in the future.

According to Climate Analytics, if global temperature continues to rise as at the current pace, Nepal's GDP will be affected by about 18 percent by 2050 and more than 60 percent by 2100. Similarly, research by the Asian Development Bank (ADB) has shown that the impact of climate change could reduce the GDP of developing Asia and the Pacific region by 17 percent by 2070.

Restoration Challenges

The full extent of the damage is still being assessed, and significant time and resources will be needed for reconstruction. The restoration of hydropower projects, transmission lines, and irrigation structures will pose major challenges in the coming days.

> In the decade from 2011 to 2020, the rate of glacier melting in the region was 65 percent higher than the previous decade.

This disaster has profoundly impacted Nepal's hydropower production, creating immediate and long-term challenges for the nation's energy supply system. Share market was also affected adversely due to losses triggered by the natural disasters on the hydropower projects.

The private sector power producers had sought relief measures from the government in terms of tax subsidies, customs duty waiver and interest subsidies on loans, but in vain. This creates severe challenges to them to manage financial resources for reinvestment.

Insurance sector was among the suffered, due to surged insurance claims. Insurance companies have received claims of Rs 11.82 billion. But they have settled claims of slightly above Rs 1 billion till the date. Of the 1,653 claims against assets insurance, 398 were settled. Out of insurance claims related to hydropower and irrigation projects, 38 worth Rs 311.28 million were settled, according to the Nepal Insurance Authority.

Mitigation Measures

(a) Some policy recommendations:

1. As the rivers witness decline in water flow during the dry season, the promoter's income also decreases along with a fall in electricity production. In addition, the promoters have to pay 'hydrological penalty' for being unable to supply the specified electricity to the energy grid. The penalty provision has been removed in the 81-point action plan of the 'Roadmap, 2081' for the projects bigger than 10 MW. It can provide relief to promoters and investors in the coming days.
2. Since climate change-related disasters can affect any hydropower project, both the under-construction and operating projects must be made mandatory to purchase insurance policies for both property damage and income disruptions.
3. Run-of-river, semi-storage, reservoir and pumped storage projects should be promoted under the concept of production mix.
4. The government should adopt effective mechanisms in forecasting and early warning systems of climate change-related disasters.
5. Projects should be made mandatory to include the Climate Risk Assessment (CRA) while receiving permits, and to adopt the project design and strategies accordingly.
6. Make arrangements for mandatory implementation of dam safety guidelines for reservoir projects.
7. Make necessary arrangements for coordinated operation of cascade projects to mitigate impacts of floods and droughts in their project operation procedures.

8. Make policy arrangements to build climate-resilient structures during project construction and monitor whether or not they are being built.

9. Extension of production license term, by considering emerging climate change.

10. Make a legal provision for exemptions of customs duty on imported equipment that are targeted to replace damaged infrastructure and waiving 'capacity royalty' to suffered projects for specified duration.

11. Maintain provisions in new Electricity Act not to increase 'energy royalty' and 'capacity royalty' citing possible rise in costs due to climate change induced hazards in future.

(b) Reform in construction design

It is also essential to improve the design and study/research of hydropower projects. In addition, it needs to consider the impact of climate change on water resources as an integral part of the study. Similarly, while designing structures, flood assessment should be done not only based on the flow of water but also on the debris flow. The methods currently used to study hydrology for hydropower need to be extensively improved and updated. Integration of the hydrometer stations maintained by the private sector with the stations of the Department of Hydrology and Meteorology is essential while early warning systems should be improved and reliable.

Precautions should also be taken during the construction of hydropower projects. While constructing access roads, there should be no indiscriminate cutting of trees, digging, indiscriminate dumping of excavated soil, and proper management of flood water (sewage). Failure to do so, will increase the risk of landslides, which can cause more damage to the project mainly during the rainy season. Realistic flood assessments and structural design, including headworks and powerhouses, while designing important structures, and constructing powerhouses by leaving the 'right of way' of the rivers, can significantly reduce damage.

Santa Bahadur Pun

Reflecting on Nepal's Hyper-Optimistic Load Forecast and Export to India

Story of Som Sharma's Sattu?

Then in the 1990s the wave of Loktantrik democracy, globalization and privatization also came to Nepal in a whirlwind. The Multilaterals got forced to the back benches and Privatization along with Resurgent India moved to the front. Load forecast gradually passed

A. Foreword – Electricity Load Forecast

Electricity Load forecast is an important tool in preparing the country's overall power system master plan. It is, by the very name itself, a forecast based on various assumptions like the projected growth rate of the country's gross domestic product (GDP), future demands not only of rural electrification but also those of large new industries and irrigation schemes, system load factor, electricity price, per capita electricity consumption, system losses etc. etc. During the Panchayat era, Nepal's power sector was totally under the thumb of the Multilaterals. Based on their load forecasts, the Multilaterals' covenants stipulated Nepal to abide by the least cost generation expansion plan (LCGEP), transmission line expansion and even long-run marginal cost analysis. Then in the 1990s the wave of Loktantrik democracy, globalization and privatization also came to Nepal in a whirlwind. The Multilaterals got forced to the back benches and Privatization along with Resurgent India moved to the front. Load forecast gradually passed over into the hands of what the powerful financially muscular[1]Independent Power Producers' Association of Nepal (IPPAN) dictated.

B. 1990s to 2006 AD Political and Power Sector Scenarios of Nepal –

With the 1990 fall of the Panchayat regime and the advent of the much-hyped Loktantrik Democracy with constitutional Monarchy, there were heavy drum beatings about improving the quality of lives of the general Nepalese by the two major parties, Nepali Congress and the CPN-UML. However, from the very beginning in 1991, the Nepali Congress Government bogged itself down with what it called the Tanakpur MOU with India. When the Supreme Court gave the verdict that the MOU is an Agreement, the CPN-UML quickly came to rescue Nepali Congress with its grand 'out of the box' 1996 Integrated Mahakali Treaty that encapsulated the 'Sarada Barrage of Yesterday, Tanakpur Barrage of Today with Panchcheshwar Dam of Tomorrow'! On 4th February 1996, just six days after the two countries' Foreign Ministers Dr. Prakash Chandra Lohani and Pranab Mukherji inked the Mahakali Treaty at Kathmandu on 29th January 1996, Dr. Baburam Bhattarai, Chairman Central Committee/United People's Front, delivered his Party's 40 Point Demands to Prime Minister Sher Bahadur Deuba. One of the principal 40 Point Demands was 'The so-called Integrated Mahakali Treaty concluded on 29 January 1996 should be repealed immediately, as it is designed to conceal the disastrous Tanakpur Treaty and allows Indian imperialist monopoly over Nepal's water resources.' Prime Minister Deuba, turning completely deaf to Dr. Bhattarai's demands, headed instead for New Delhi and on 12th February 1996 re-initialed with Prime Minister PV Narasimha Rao the

1 Within two decades, IPPAN has grown into a large base with 400 members governed by an extremely active and powerful 17 member executive body. With Energy, Water Resources and Irrigation Minister's post presently adorned by an IPPAN member, some believe Nepal's power sector is Wagged by IPPAN and Not by Government of Nepal!

Integrated Mahakali Treaty that had already been initialed by their two Foreign Ministers. Hence, on 13th February 1996, just a day after the re-initialing of the Mahakali Treaty at New Delhi, the CPN-Maoists fired their first 'People's War Shots' by attacking the police posts[2] simultaneously in three districts: Rolpa/Holeri, Rukum/Athbiskot-Rari and Sindhuli/Sindhuligarhi. On that same day, the loan papers at the Agricultural Development Bank in Gorkha/Chyangli were looted then burnt and even the Pepsi bottling factory in Kathmandu torched. Thus began the 10 year insurgency that the Nepal Government initially, calling it to be a mere law and order issue, engaged the ill-equipped and ill-trained Police Force. Only when the 'rag-tag People's Army' of CPN-Maoists ransacked the Nepal Army barrack in Dang on November 21, 2001 carrying away truckloads of arms and ammunition, emergency was declared and the Army mobilized. The ten year 'people's war', costing over 17,000 precious Nepalese lives, finally came to a halt only when the India-brokered Comprehensive Peace Accord was signed by Prime Minister GP Koirala and Puspa Kamal Dahal 'Prachanda' at Kathmandu on November 21, 2006.

The Tanakpur MOU imbroglio, the 1996 'yesterday, today and tomorrow' Integrated Mahakali Treaty that was to 'make the sun rise[3] from the west with Rs 120 arab tinkering annually into Nepal's coffers from sale of Nepal's portion of Pancheshwar electricity to India', the rag-tag CPN-Maoists' ten year (1996 – 2006) 'People's War' and the oft ridiculous musical chair dances[4] the political parties resorted to for the much-coveted Singha Durbar throne, completely threw Nepal's power sector into the wastepaper basket! However, after the 2006 Comprehensive Peace Accord, Nepal's most attractive hydropower projects, the 300 MW Upper Karnali and 402 MW Arun III, were handed over in 2008 to the Indian companies, GMR and Satluj Jal Vidhyut Nigam– some believe for the services rendered by India for brokering the 2006 Comprehensive Peace Accord. Regarding Nepal's power sector in the dustbin, the grim and desperate scenario has been very aptly and transparently painted[5] by Dr. Prakash Sharan Mahat, Minister of Energy and Chairman of Nepal Electricity Authority, in his message to NEA's 24th anniversary:

> Harking back to that important Fifth Power Summit of IPPAN, the media reported that both India and China, the two largest stakeholders in harnessing hydroelectric potential of Nepal, agreed that the ambitious target is achievable.

'The FY 2008/09 was a challenging year for NEA. ….. in a severe supply-demand gap in the system causing NEA to resort to an unprecedented load shedding up to sixteen hours a day. …..'

C. **Birth of 10,000 MW in 10 Years and 25,000 MW in 20 Years Reports in Quick Succession** – Thus, with the country reeling under unprecedented 16 hours of load shedding per day, as recorded above by Energy Minister Dr. PS Mahat, the 2008 coalition government of the day, that of UCPN-Maoists and CPN-UML parties with Puspa Kamal Dahal 'Prachanda' as Prime Minister, constituted a 15 member Task Force[6] on Mangsir 18, 2065 (December 3, 2008) to formulate 10,000 MW of Hydropower Development in 10 years. The final report, duly endorsed and welcomed by Nepali Congress President GP Koirala, CPN-UML Chairman JN Khanal and UCPN-Maoists Chairman PK Dahal 'Prachanda', was submitted on Chaitra 18, 2065 (March 1, 2009) to the then Prime Minister Madhav Kumar Nepal's Energy Minister Dr. PS Mahat.

Some highlights of that report are:

- Bilateral investments: India (245 MW Naumure and 55 MW Sunkoshi-Kamala Diversion); China (60 MW Trishuli-3A and 400 MW Nalsyaugad) and Japan (127 MW Upper Seti storage);
- Multilateral investments: Asian

2 Deepak Thapa and Bandita Sijapati. 2003. A Kingdom under Siege. The Printhouse, Kathmandu.

3 Water Resources Minister Pashupati SJB Rana claiming the sunrise from the west and the more ebullient KP Sharma (Oli), Coordinator of CPN-UML's Mahakali Treaty Study Task Force, claiming the Rs 120 Arabs.

4 Within the 14 years' span from GP Koirala's 1991 Tanakpur MOU to King GB Shah's takeover in February 2005, the Nepal Government was headed by the following 13 personalities: 1- **Girija Prasad Koirala** 2- **Man Mohan Adhikari** 3- **Sher Bahadur Deuba** 4- **Lokendra Bahadur Chand** 5- **Surya Bahadur Thapa** 6- **Girija Prasad Koirala**7- **Krishna Prasad Bhattarai** 8- **Girija Prasad Koirala** 9- **Sher Bahadur Deuba** 10- **Lokendra Bahadur Chand** 11- **Surya Bahadur Thapa** 12- **Sher Bahadur Deuba** 13- **King Gyanendra Bickram Shah** Source: *Nepalka Mantri ra Sansadharu 2007-2075 BS* Bhairab Risal, Bharat Pokharel. Sikai Samahu Pvt. Ltd. Anamnagar, Kathmandu.

5 NEA August 2009 (Bhadra 2066) – A Year in Review Fiscal Year 2008/'09

6 Task Force members: Somnath Poudel (*former WECS Secretary*) – Coordinator, Lilanath Bhattarai– member-Secretary and other members: Ratneshwarlal Kayastha, Dr. Govinda Nepal, Balaram Pradhan, Lekhman Singh Bhandari, Saroj Upadhyay, Dr. Laxmi Prasad Devkota, Gyanendra Lal Pradhan, Anup Kumar Upadhyay, Atmaram Pande, Arjun Kumar Karki, Sunil Bahadur Malla, Uttar Kumar Shrestha and Dr. Santoshananda Mishra.

Development Bank (300 MW Dudhkoshi-1 storage and 160 MW Tamor Mewa) and World Bank (380 MW Tamor storage);

- 750 MW West Seti storage should be developed through foreign investments.
- For system balance, environment to implement storage projects like Budhigandaki (600 MW), Tamor (360 MW), Nalsyaugad (400 MW), Upper Seti (127 MW) and Dudhkoshi (300 MW) as soon as possible should be created.
- By 2020, the national target is 10,781 MW. Of this target, 22% will be provided by government/NEA, 64% by independent developers and 14% through power trading.
- Nepal-India multipurpose projects on cost/benefit basis: 6,480 MW Pancheshwar/ Mahakali, 10,800 MW Karnali/Chisapani, 3,500 MW Saptakoshi High Dam and 55 MW Sunkoshi-Kamala Diversion.

The report mentioned that, though the large multipurpose projects are not included in the Ten Year Plan, they are strongly recommended for implementation as they will have far reaching impacts on the two countries' economy. But decision must be taken based on recommendation of reputed experts after comprehensive studies, political consensus and national interests. All future treaties and agreements with neighbouring countries on multipurpose projects must assess all downstream benefits and based on that share the costs according to benefits. Also proper homework on Resource Rent should be conducted. The Task Force coined the new term Resource Rent and mentioned proper assessment of downstream benefits.

With the collapse of the two Communist Parties' coalition, another musical chair dance led to formation of another 'strange bed-fellows' coalition government of CPN-UML and Nepali Congress with Madhav Kumar Nepal as the Prime Minister. As usual to share the loaves and fishes of the poor country, Prime Minister MK Nepal and Nepali Congress President GP Koirala colluded and resorted to an unprecedented uncalled-for Caesarian operation of the 33 year old Water Resources Ministry. The two leaders delivered two wonder babies, the Ministry of Energy[7] and Ministry of Irrigation.

Not to be outdone by the previous UCPN-Maoists and CPN-UML government's 10,000 MW in 10 Years, the 'strange bed-fellows' CPN-UML and Nepali Congress coalition government of Prime Minister MK Nepal constituted another 12 member Task Force[8] on Bhadra 10, 2066 (August 26, 2009) to formulate 25,000 MW of Hydropower Development in 20 Years. To maintain uniformity and continuity in the 25,000 MW in 20 Years with the 10,000 MW in 10 Years, the newly constituted 12 member Task Force included 5 former members of the previous 15 member Task Force: Anup Kumar Upadhyay, Lekhman Singh Bhandari, Sunil Bahadur Malla, Gyanendra Lal Pradhan and Dr. Govinda Nepal.

'As the forecast through the linear analysis modal is not effective, we are planning to develop an exponential-based modality.'

The following are the essential conclusive abstracts of the 25,000 MW in 20 Years Task Force Report:

'Thus, within the twenty year period (2010 –2029) including the Pancheshwar, Karnali Chisapani and Saptakoshi multipurpose projects, total electricity generation of 37,628 MW is possible. If these three large projects are excluded, then still 20,354 MW of electricity generation is possible in the coming twenty years.' – page jha of report;

'This Report justifies the fact that, though 25,000 MW of electricity generation in the coming twenty years is very optimistic, it is not impossible.' – page ga of report;

'If Nepal's hydropower is developed properly then this region's prevailing uncertainty and mistrust would all disappear and like the South-East Asian country Laos, the South African country Lesotho and the South American country Brazil, Nepal can also become the 'hydropower centre' of South Asia.' – page gha of report;

The 25,000 MW in 20 Years (2010 – 2029) Report admits the task to be very optimistic but Not Impossible. The report says that 37,628 MW generations from Pancheshwar, Karnali Chisapani

7 When the Water Resources Ministry was caesarianed, Dr. Prakash Saran Mahat, who was the Water Resources Minister, opted to choose the Energy Ministry and Bal Krishna Khand got the Irrigation Ministry. Water Resources Secretary Shankar Prasad Koirala similarly opted to be the Energy Secretary – clearly illustrating the Energy Ministry to be the high-bred *'tagadhari'* and the Irrigation Ministry the neglected *'dalit'*! These two ministries were later combined into the Ministry of Energy, Water Resources and Irrigation.

8 With Kishore Thapa (*sitting WECS Secretary*) as Coordinator, Bhoj Raj Regmi as member-Secretary, Anup Kumar Upadhyay, Sri Ranjan Lakaul, Arjun Kumar Karki, Sunil Bahadur Malla, Dr. Jibendra Jha, Lekhman Singh Bhandari, Gyanendra Lal Pradhan, Dr. Sandip Shah, Dr. Govinda Raj Pokharel and Dr. Govinda Nepal.

and Saptakoshi multipurpose projects is possible[9] by 2029. Even if these three multipurpose projects are excluded, 20,354 MW of electricity generation is possible in 20 years. The Report concludes that, like Laos in the South-East Asian countries, Nepal can also become the 'hydropower center of South Asia.'

D. **Power Summits of Independent Power Producers' Association of Nepal (IPPAN) on the Government's 10,000/25,000 MW in 10/20 Years Reports –**

The powerful Independent Power Producers' Association of Nepal (IPPAN) has been conducting a series of Power Summits on development of Nepal's huge hydropower and extolling the virtues of exporting electricity to another huge so-called power hungry Indian market. As public memory is short and institutions have no memory at all, it is pertinent to record some of the comments of the participants at the various Power Summits organized by IPPAN.

i) Fifth Power Summit: On February 16, 2016 the then Prime Minister Puspa Kamal Dahal 'Prachanda' inaugurated IPPAN's two-day Fifth Power Summit at Soaltee Hotel. The Nepal Government had just unveiled its white paper 'National Energy Crisis Elimination and Electricity Development Decade's Concept Paper and Working Plan, 2072 BS'. Harking back to that important Fifth Power Summit of IPPAN, the media[10] reported that both India and China, the two largest stakeholders in harnessing hydroelectric potential of Nepal, agreed that the ambitious target is achievable. The following is what the three ambassadors of India, China and Bangladesh had said at the Fifth Power Summit in February 2016:

- Ranjit Rae, Indian ambassador, one of the panelists at the summit: 'Optimistic that Nepal could achieve the target in a decade. Three hydropower projects under the Indian investment – Pancheshwar, Upper Karnali and Arun III – have joint installed capacity of over 7,000 MW and gestation period of 7 to 10 years. If the development of these three projects is expedited, Nepal's goal of producing 10,000 MW in next 10 years looks very realistic. The country needs to eliminate procedural bottlenecks faced by developers of large projects'.
- Yu Hong, Chinese Ambassador: 'The government should facilitate Chinese companies in expediting the key procedures for developing hydroelectric projects in Nepal. Our government is encouraging Chinese companies to invest in energy sector in Nepal. In the past few decades, Chinese companies have gained vast experience in developing hydropower projects and Nepal can reap the benefits by ensuring right environment.'
- Mashfee Binte Shams, Bangladesh ambassador: 'Bangladesh also shows solidarity with Nepal's power goals and agree to make investments as well as import surplus energy in future. Bangladesh is in need of thousands of megawatt of electricity to fuel its high economic growth and it will import electricity from Nepal to fill the deficit if Nepal produces surplus energy.'
- To reiterate the above extremely positive statements of the ambassadors of the three countries bordering Nepal: i) Indian Ambassador Ranjit Rae called Nepal's 10,000 MW target optimistic but achievable. ii) Chinese Ambassador Yu Hong mentioned the vast experiences of Chinese companies in hydropower development and keen to invest in Nepal's energy sector. iii) Bangladesh Ambassador Mashfee Binte Shams informed

Nepal, without any quid pro quo, has readily addressed this 'burning problem' through the Indo-Nepal 2022 Joint Vision on Power Sector Cooperation!

9 The *'signed, sealed and done'* 1996 Integrated Mahakali Treaty's Pancheshwar Multipurpose Project is still (*till December 2024*) hanging in the air for the last 28 years. The 1996 Treaty stipulated the DPR to be finalized '*within six (6) months from the date of the entry into force of the Treaty*' (June 5, 1997 date of entry into force completed when the instruments of ratification exchanged during Prime Minister IK Gujral's visit to Kathmandu) and the Project '*to be completed within eight (8) years from the date of the agreement for its implementation, subject to the provision of the DPR.*'

10 Kathmandu Post, December 16, 2016 (Poush 1, 2073);

Bangladesh's need for thousands of Megawatt of electricity and agreed not only to import Nepal's surplus electricity but also invest in Nepal's hydropower. This was February 2016, the readers should kindly note the year!

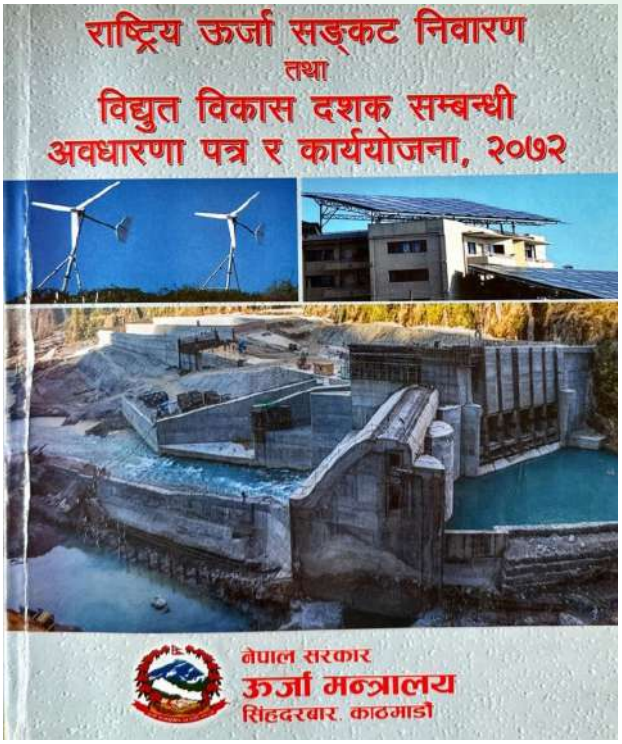
ii) At IPPAN's two-day 15th/16th December 2016 (Poush1st/2nd, 2076) '10,000 MW by Sunset!' Power Summit inaugurated by Prime Minister Puspa Kamal Dahal 'Prachanda', the following were the comments:

- Khadga Bahadur Bisht, IPPAN President –'….. Dedicated effort from all …… will help to meet the set goal of meeting 10,000 MW in ten years.'
- Gyanendra Lal Pradhan, IPPAN Adviser – '…… need to increase power consumption in the domestic market and seek export markets …..'
- Michael L Boyd, Senior Energy Adviser USAID – 'This is an optimistic target which requires serious commitments from all involved.'
- Dinesh Ghimire, Joint Secretary Ministry of Energy – 'We have set a proper background to implement the 99-point concept and target of 10,000 MW in 10 years. We are optimistic about achieving the target through collaborative effort.'
- Swarnim Wagle, Member National Planning Commission – 'One of the problems facing Nepal's hydropower was market. However, the market problem has been solved more or less after Nepal signed the PTA with India.'

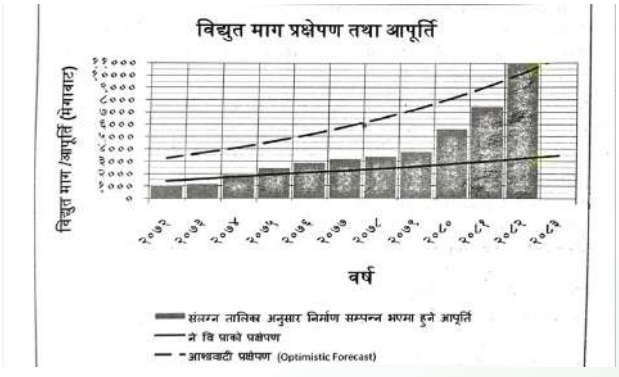
In essence, IPPAN's '10,000 MW by Sunset' Power Summit concluded that the target was optimistic but achievable requiring serious commitments from all. In particular, the NPC member, Dr. Swarnim Wagle, mentioned that the export market, according to him, has been 'more or less' solved through the 2014 Power Trade Agreement with India.

E. Nepal Government's Hyper-Optimistic Load Forecast of BS 2072:

With such quick-fire 10,000 MW in 10 Years and 25,000 MW in 20 Years Reports, and the country reeling under over 16 hours per day load shedding, the Ministry of Energy rolled out the following National Energy Crisis Elimination and Electricity Development Decade's Concept Paper and Working Plan in Falgun 2072 BS (February/March 2016 AD):

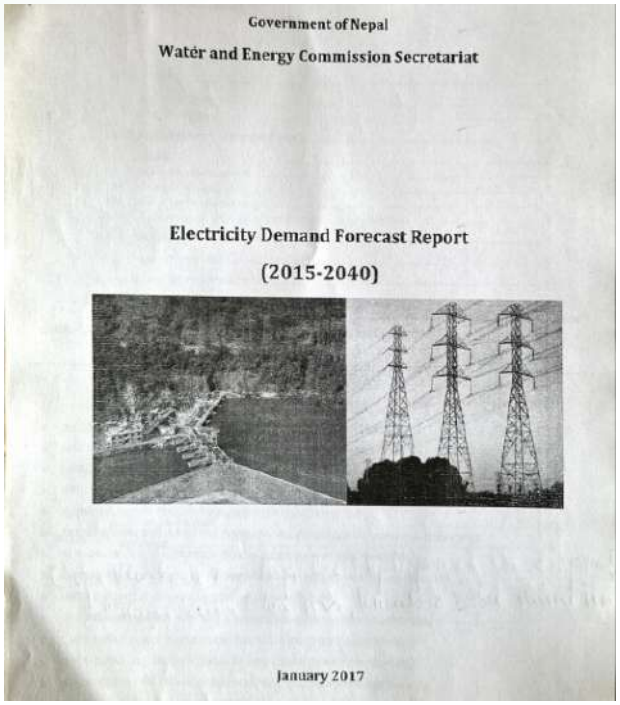


Dr. Yuba Raj Khatiwada, Vice-chairman of National Planning Commission, at the 2016 interaction on 'Facing Energy Crisis – Preparing Responsibly' organized by National Business Initiative, stated[11] that the government was working on a mechanism that forecasts electricity demand. Dr. Khatiwada said, 'As the forecast through the linear analysis modal is not effective, we are planning to develop an exponential-based modality.' The comment of Dr. Khatiwada that the 'linear model analysis is ineffective' and instead recommend 'an exponential-based modality' is difficult to comprehend. Subsequently, the board meeting of the Investment Board Nepal (IBN), chaired by Prime Minister KP Sharma (Oli), constituted[12] a high level committee with Vice-chairman Dr. Khatiwada as coordinator to 'ascertain the actual energy demand'. The government's following chart of the Forecast of 10,000 MW within a decade (2072 – 2082 BS) is the outcome of that high level committee's actual energy demand!



11 *The Kathmandu Post*, December 8, 2015
12 *The Kathmandu Post, Money,* December 21, 2015

The above hyper-optimistic Load Forecast was supported by Water and Energy Commission Secretariat's (WECS) following January 2017 Electricity Demand Forecast Report (2015 – 2040 AD) with Installed Capacity Requirement in Different Scenarios of Nepal:


Government of Nepal

Water and Energy Commission Secretariat

Electricity Demand Forecast Report

(2015-2040)

January 2017

Table 10: Installed Capacity Requirement in Different Scenarios

Year	Total Installed Capacity Requirement (MW)				
	BAU 4.5 %	Reference Scenario 7.2%	High Scenario 9.2%	@ 7.2% growth with policy intervention	@ 9.2% growth with policy intervention
2015	1721	1721	1721	1721	1721
2020	3384	3611	3794	6621	6814
2025	5787	6617	7366	9987	10803
2030	8937	11111	13296	15731	18371
2035	13242	18124	23588	23049	29231
2040	19151	29427	42228	36489	51330

F. **Energy Ministry's 2016 Load Forecast Vis-a-Vis NEA's Actual Peak Load – Som Sharma's Sattu! :**

Year MOE's Generation Capacity Requirement Forecast NEA's Actual Peak Load

With4.5% Growth Policy Intervention 9.2% Growth

2015	1,721 MW	1,721 MW	1,291 MW	
2016	-----		-----	1,385 MW
2017	-----		-----	1,444 MW
2018	-----		-----	1,508 MW
2019	-----		-----	1,320 MW
2020	3,384 MW	6,814 MW	1,408 MW	
2021	-----		-----	1,482 MW
2022	-----		-----	1,748 MW
2023	-----		-----	1,870 MW
2024	-----		-----	2,212 MW
2025	5,787 MW	10,803 MW	(Yet to Occur)	
2030	8,937 MW	18,371 MW	-----	
2035	13,242 MW	29,231 MW	-----	
2040	19,151 MW	51,330 MW	-----	

Note: The Load Forecast of Water and Energy Commission Secretariat is on a Five Yearly Basis while those (excluding export to India from 2022) of NEA's actual yearly Peak Load are from NEA's A Year in Review – Fiscal Year – 2023/2024 August 2024 (Bhadra 2081 page 171).

One thus sees NEA's actual Peak Load of only 2,212 MW in 2024 whereas the Government had forecast a Peak Load of 5,787 MW in 2025 with Business as Usual (BAU) GDP growth of 4.5% and 10,803 MW in 2025 with policy intervention and GDP growth of 9.2%! Such load forecasts of the Government is undoubtedly Som Sharma's Sattu!

G. 2023's Seventh Power Summit: Then fast forward from 2016 to 2023, Prime Minister Pushpa Kamal Dahal 'Prachanda' again had the opportunity to inaugurate IPPAN's two day Seventh Power Summit at Kathmandu's Hyatt Regency on April 18, 2023. From 2016's theme of '10,000 MW by Sunset' had now become 'Broadening Green Energy Market' at IPPAN's 7th Power Summit in 2023. Interestingly, the Embassy of India became IPPAN's Country Partner with IFC as the Strategic Partner, World Bank and USAID as Gold Sponsors and various other international and domestic partners donning the Silver, Knowledge etc. badges. But strangely, the two countries China and Bangladesh, active participants of the 2016 Fifth Power Summit, appeared neither as Country Partners nor adorned with the Strategic/Gold/Silver/Knowledge etc. badges. At the 2023 Seventh Power Summit, the powerful IPPAN, however, did not refrain from drumming[13]:

'…. 100 years to build 1,000 MW …..next 1,500 MW capacity came in no time……. pipeline suggests a cumulative capacity of 6,700 MW by 2027. Power exports are set to soar to 3,500 MW valued at 1.5 Billion US$ annually over the next five years, making it Nepal's top export commodity……. Private sector is actively constructing 134 projects with a combined capacity of 3,250 MW while another 2,000 MW are ready for construction. Furthermore, 11,700 MW projects are awaiting Power Purchase Agreements and 30,750 MW projects are under consideration. Nepal has the capability to power the region.' With 30,750 MW projects under consideration in Nepal, IPPAN

13 IPPAN's Brochure – *Power Summit '23, Broadening Green Energy Markets, 18th – 19th April 2023, Hyatt Regency, Kathmandu Nepal*

envisages Nepal powering the South Asia region!

H. Final Words – Nepal Barking Up the Right Tree?

By 2023, IPPAN's 2016 optimistic but achievable '10,000 MW by Sunset' statement and those aired by the then three ambassadors of India (Ranjit Rae), China (Yu Hong) and Bangladesh (Mashfee Binte Shams) at the 2016 Power Summit surprisingly evaporated into thin air. India's colonial British-schooled South Block mandarins at New Delhi dexterously chiseled away at what those ambassadors had said in February 2016 into the following:

- December 5, 2016 Guidelines on Cross Border Trade of Electricity - involving 'issues of strategic, national and economic importance' repealed by
- December 18, 2018 Guidelines for Import/ Export (Cross Border) of Electricity – 2018 then Formulated and Issued on
- February 26, 2021 the comprehensive 40 page PROCEDURE FOR APPROVAL AND FACILITATING IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY BY THE DESIGNATED AUTHORITY that stipulated 'Indian power trader can trade the power of a generating station located outside the country, provided that:

  (a)The generation station is located in a country, with which India has a bilateral agreement on Power Sector Cooperation.

  - Clearly aimed to bar the more competitive and technologically superior Chinese developers and contractors. Then on
- April 2, 2022 capped by the grand Indo-Nepal 2022 Joint Vision signed by Prime Ministers Sher Bahadur Deuba and Narendra Modi at New Delhi's Hyderbad House. This is the Joint Vision on Power Sector Cooperation and Not Water Resources Cooperation for – Water to Drink, Water to Produce Food and Water to Produce Energy! The Vision further capped by
- January 4, 2024 with Long-term Power Trade Agreement (signed by Gopal Prasad Sigdel, Secretary Ministry of Energy, Water Resources & Irrigation for Nepal and for India by Pankaj Agarwal Secretary of Power) that stated '… strive to increase the quantum of export of power from Nepal to India to Ten Thousand Megawatts (10,000 MW) within a timeframe of ten years …' The South Block mandarins are smart - Note the words 'strive to increase …' and not simply 'increase' also note the following 'In implementing this agreement, both parties shall abide by their applicable laws, regulations and procedures related to Cross-border Trade in Power.' Most important the 'applicable …..procedures …' – the February 2021 Procedures that bars China! Then recently, Prime Minister KP Sharma (Oli) on October 7, 2024 (Ashwin 21, 2081), harked[14] for action to generate 28,500 MW by 2035. Nepal, surely, is barking up the wrong tree when the integrated use of water first means Water to Drink, Water to Produce Food and then only Water to Produce Energy! The following is what some experts on water resources have to say:

BhimSubba[15], who once headed the Bhutan Government's Power Department, traced the fundamental flaws in Indo-Nepal water resources relationship to:

- Nepal: trying to Sell Electricity while it is Water that India Needs;
- India: pinning its hope on overcoming, by [Nepal's] default, the Impending Water Crisis through Power Projects – an extremely Short-sighted Policy [of India];
- India: refusing to concede Stored Water has Monetary Value

Salman Haider[16], India's ex-Foreign Secretary, frankly admitted: 'Mahakali is a multi-purpose project. ….. India has alternative sources of power supply. We do not have alternative sources of water supply …… the long-term interest of India in water from Mahakali outweighs our interest in power supply.'

Professor Saif Uddin Soz, India's Union Minister of Water Resources, after the Kosi River bypassed the Kosi Barrage at Kusaha in August 2008, in his interview with the BBC Nepali Service said: '…..Kosi is in focus this time in particular….Our main interest is flood control

14 Kathmandu Post – October 8, 2024 (Ashwin 20, 2081)
15 Bhim Subba in *Water, Nepal and India* in Kanak Mani Dixit and Shastri Ramachandaran edited book *State of Nepal*. 2002. Himal Books. Lalitpur, Nepal.
16 *India-Nepal Relations – The Challenge Ahead*. Observer Research Foundation. 2004. Rupa & Co. New Delhi.

and irrigation. Those are our first and second priority. If we get hydroelectricity as a byproduct, it will be a bonus for us.'[17]

Suresh Prabhu, India's Chairman of Task Force on Interlinking of Rivers and also a Union Cabinet Minister noted[18]: 'Overall, India's economic as well as human development index all depend upon the country's ability to address this most burning problem, water… To monsoon-proof India's water requirement, the need for more storage has to be urgently addressed.' And Nepal, without any quid pro quo, has readily addressed this 'burning problem' through the Indo-Nepal 2022 Joint Vision on Power Sector Cooperation!

Brahma Chellaney, India's leading strategic thinker and Professor at the Centre of Policy Research in New Delhi, has this to say[19]: 'The battles of Yesterday were fought for Land. Those of Today are over Energy. But the battles of Tomorrow may be over Water. Nowhere is that danger greater than in water-stressed Asia.'

Prime Minister KP Sharma (Oli)'s 2024 call for 28,500 MW by 2035, Water and Energy Commission Secretariat's load forecast of 51,330 MW by 2040, Prime Minister SB Deuba's Indo-Nepal 2022 Joint Vision on Power Sector Cooperation and the 2024 Long-term Power Trade Agreement of Ten Thousand Megawatts (10,000 MW) within a time frame of ten years all indicate that our naïve politicians and mandarins at Singha Durbar are totally mesmerized and enchanted[20] by Megawatts of Hydropower. They are completely oblivious of the battle for water in water-stressed India expressed above by many Indians themselves who held important posts. Unfortunately, our naïve 'leadership has no time for initiatives outside electricity. They are blinded by and too busy counting the MWs contracted with India. Nepal has 40,000 MW of hydropower potential. Most Nepalis will benefit none from it.'[21] Hydropower does not generate job opportunities unless the power is utilized by industries within the country itself. No doubt, export of hydropower to India will generate huge job opportunities for India as it already has a massive industrial base.

After pursuing Hydropower Development Decade for eight years since 2016, Nepal has finally launched a half-hearted Decade (2024–2034) of Agriculture Investment in its 2024/2025 Budget.

Agriculture is the backbone of the Nepalese economy contributing[22] 'around one-third of the nation's GDP and provides employment to two third of the population. Please note agriculture provides employment to two-third of the Nepalese population that now for lack of employment opportunities within Nepal have to go to Middle East, Malaysia and even to warn—torn Russia to keep their hearth burning. After pursuing Hydropower Development Decade for eight years since 2016, Nepal has finally launched a half-hearted Decade (2024–2034) of Agriculture Investment[23] in its 2024/2025 Budget. Though the 2024/2025 Budget has introduced 'A Decade (2024–2034) of Agriculture Investment', the ongoing '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 outweighs the miniscule investment and attention given to Agriculture.

Finally to conclude, with India's refusal to implement the World Bank initiated Kohinoor, 10,800 MW Karnali Chisapani, in the 1980s, with the 6,480 MW Pancheshwar Multipurpose Project, now downgraded to 5,000 MW, lying in the cold storage for the last 28 years since 1996, Nepal's vision of 28,500 MW by 2035 and 51,330 MW by 2040 is destined to end up in the same manner as Som Sharma's Sattu!

Mr. Pun is an energy expert and former Managing Director of the Nepal Electricity Authority.

17 Nepali Times, 19-25 September 2008, #418.

18 Suresh Prabhu. ***The Vital Links in Interlinking of Rivers in India: Issues and Concerns*** Edited by M Monirul Qader Mirza, AhsanUddin Ahmed and Qazi Kholiquzzaman Ahmad – 2008 Taylor & Francis Group, London, UK

19 Brahma Chellaney. *Water Asia's New Battleground.* 2011 Harper Collins Publishers India

20 Bishal Thapa, a writer with a Master's degree from University of Maryland, wrote the following interesting article in **Kathmandu Post December 5, 2024**: *Nepal has always maintained that **hydropower electricity exports will lead to economic growth and development of its people.** ….. This narrative has become **so all-consuming that Nepal's leadership is now measured in megawatts (MW).** …. **Foreign Minister Arzu Rana Deuba** is currently **at 251 MW** … from 12 hydro plants ….. **Energy Minister Dipak Khadga** is **at 40 MW** after he symbolically inaugurated Nepal's export to Bangladesh …. **Kulman Ghising,** Managing Director of Nepal Electricity Authority (NEA), is **at 941 MW** because India's commitment to purchase up to this level has come under his watch…..*

21 Bishal Thapa, **Kathmandu Post December 5, 2024**

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

23 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

ERC's Digital Transformation:
Paving the Way for Paperless Regulation

Dr. Ram Prasad Dhital

Despite its pivotal role, the ERC has encountered persistent challenges inherent to its nascent stage, including limited resources, dependence on manual processes, and the absence of comprehensive digital infrastructure.

Sneha Shakya

The Electricity Regulatory Commission (ERC) of Nepal, established under the Electricity Regulatory Commission Act, 2017, serves as an independent regulator for equitable growth in the energy sector. Its primary mandate is to maintain a balance between the demand and supply of electricity while simplifying the generation of electricity, transmission and distribution or trade, which ensures reliable, accessible, high-quality, competitive and safe electricity services, protecting the rights and interests of the electricity consumers.

Despite its pivotal role, the ERC has encountered persistent challenges inherent to its nascent stage, including limited resources, dependence on manual processes, and the absence of comprehensive digital infrastructure. These constraints have impeded operational efficiency and transparency, stressing the necessity for modernization.

The ERC has embarked on an ambitious digitization initiative recognizing the increasing demands of a dynamic energy market. This transformation aims to streamline operations, enhance transparency, and build stakeholder trust, thereby enabling the Commission to fulfill its mandate more effectively. The digitization efforts are anticipated to facilitate better regulatory oversight, improve service delivery, and support the sustainable development of Nepal's electricity sector.

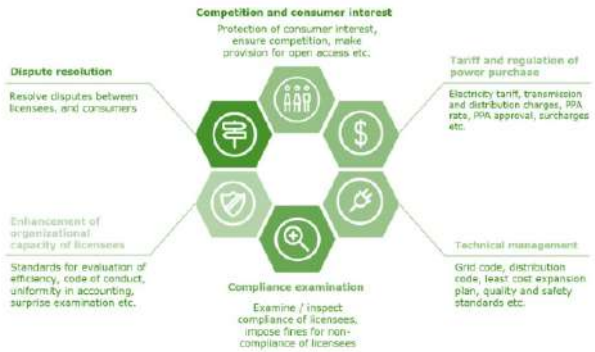


Figure 1 Key Functions and Duties of the Commission

The Legacy of Paper-Based Systems

At the core of ERC's operational challenges lies its reliance on manual, paper-based workflows - a necessity born of its current circumstances. Each petition filed by a licensee embarks on a meticulous journey through ERC's procedural framework, designed to ensure thorough review and regulatory compliance.

The process begins with an applicant submitting hard copies of their petition to the ERC office, where it is registered and assigned a unique identification number. For instance, an applicant applying for initial public offerings (IPO) is required to submit at least five

copies of physical documents to the commission. From there, the petition is carefully routed to the appropriate department. Junior officers are tasked with the vital role of verifying the completeness of documentation and ensuring that all service charges have been paid in accordance with ERC's regulatory instruments. This initial review is no small task, requiring cross-referencing documents against established checklists and preparing preliminary analyses that serve as the foundation for further evaluation.

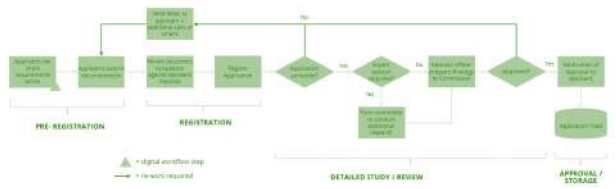


Figure 2 Current State Workflow

Once this stage is complete, the petition progresses up the chain to supervisors, line managers, and ultimately the ERC Secretary, each conducting their own layer of scrutiny. These reviews, while repetitive, reflect ERC's commitment to due diligence and accountability. The Secretary, then, prepares the petition for presentation at an ERC Board meeting, where it undergoes collective deliberation before a decision is made by the Commission.

This is a painstaking process for both the Commission and the applicants, and even though it is effective in ensuring thoroughness, it is inherently time-intensive. With no centralized tracking system in place, the movement of files between departments is a manual effort. This results in delays that are largely unavoidable under the current framework. Applicants, understandably eager for updates, often resort to follow-ups, which add to the workload of already overstretched staff.

Incomplete applications are a common occurrence, further complicating the workflow. When documents are missing or fail to meet prescribed formats, ERC must notify the applicant, often in writing, leading to additional back-and-forth exchanges. Staff members dedicate a significant portion of their time to scanning, filing, and managing these documents - a necessity in a system that lacks the digital infrastructure to automate such tasks. ERC has no choice but to adopt this labor-intensive process given its limited staff members constrained by physical infrastructure.

While stakeholders may sometimes view the system as slow or opaque, it is important to recognize the challenges that ERC faces as an emerging regulator working within its means. The current system reflects a conscientious effort to maintain procedural rigor and ensure fairness despite significant constraints.

ERC is not alone in grappling with the challenges of manual systems. For instance, prior to its digitization efforts, the Office of the Company Registrar (OCR) in Nepal faced significant operational inefficiencies due to its reliance on manual processes. The traditional paper-based system resulted in prolonged delays in company registration, inconsistent record-keeping, and challenges in document retrieval. Entrepreneurs often had to make repeated visits to the office, endure lengthy queues, and navigate cumbersome bureaucratic procedures, which discouraged business growth and innovation. These inefficiencies eroded stakeholder trust and made regulatory compliance a time-consuming task. On a similar note, the Central Electricity Regulatory Commission (CERC) of India, prior to digitization, faced significant delays in processing petitions due to its reliance on physical documentation. [1] This paper-based approach not only slowed decision-making but also resulted in frequent errors during record-keeping and retrieval processes. Licensees often voiced frustration about inconsistent communication and sparse updates, which forced them to rely on persistent follow-ups through phone calls or office visits. Over time, these operational inefficiencies risked undermining trust in the institution, weakening its ability to effectively govern and support the electricity sector. Such challenges emphasize the urgent need for digital transformation to streamline operations, improve transparency, and restore stakeholder confidence.

The Imperative for Digitization

Digitization offers a clear pathway to address these inefficiencies and transform the regulatory framework into one that is agile, transparent, and capable of handling increasing demands. For the ERC, adopting a digital approach promises to reduce cumbersome processing times, streamline communication with stakeholders, and optimize resource allocation across its limited workforce. ERC has made it clear in its Five-year Roadmap that digitization is one of the priority areas for developing its internal systems, and it resonates clearly with ERC's five guiding principles of becoming a regulator that is transparent, impartial, accountable, proactive and responsive.

Globally, the adoption of digital systems by regulators has resulted in groundbreaking improvements in efficiency and credibility. A case study of The Georgian National Water & Energy Supply Regulatory Commission (GNERC) serves as a prime example. [2] Prior to digitization, GNERC struggled with a paper-based system that bogged down workflows, delayed decision-

1 CERC backlog a drag on power projects (2015). http://timesofindia.indiatimes.com/articleshow/48230841.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

2 This case study is a part of the ERC Digital Strategy and Implementation Roadmap: Final Report (2021) authored by Deloitte under the ENR Call 62: Technical Assistance for the Power Sectors of South Asia. This work was funded by the U.S. Department of State, Bureau of Energy Resources, Power Sector Program.

making, and left stakeholders with limited visibility into regulatory processes. The implementation of a centralized digital document management system revolutionized their operations. GNERC now efficiently tracks compliance, facilitates faster decision-making, and provides stakeholders with a user-friendly interface for submitting and monitoring applications. This transformation has reinforced GNERC's standing as a trusted and forward-thinking regulator.

Similar is the case of CERC. CERC launched its e-Court platform in 2017, which revolutionized operations by enabling stakeholders to file petitions and replies online, eliminating delays caused by physical submissions. It introduced real-time status tracking, offering stakeholders greater visibility into the progress of their applications. At the same time, digitized judicial proceedings and systematic queuing significantly reduced the time required for hearings and decisions. Moreover, the platform facilitated remote participation in hearings, an innovation that proved indispensable during the COVID-19 pandemic. [3] These examples emphasize the transformative power of digital systems in enabling regulators to meet stakeholder expectations while maintaining efficiency and accountability.

ERC's Initial Steps: DMS

The ERC, with the development of its preliminary Document Management System (DMS), has initiated an important step toward digitization. The ERC recently signed a Memorandum of Understanding with Nepal Telecom (NT), a government-owned telecommunications utility, which established the terms and conditions under which NT will provide NT Cloud Server Resource for ERC to host its web-based software and application. Furthermore, ERC has also received authorization from the Integrated Data Management Center, Singha Durbar for the creation of a subdomain within its website (www.erc.gov.np) for housing access to the DMS and for providing further technical assistance for the seamless facilitation of the DMS.

The online DMS platform represents a pivotal shift from manual, paper-based workflows to a centralized digital interface, allowing licensees to submit applications and supporting documents electronically, thereby eliminating the need for physical submissions and reducing administrative overhead.

Currently, the DMS has been designed to support applications related to pre-approval of Initial Public Offerings (IPOs), Further Public Offerings (FPOs), Right Shares, Power Purchase Agreements (PPAs), share structure changes, and mergers and acquisitions. The system can track the time taken at each stage, ensuring greater accountability. Applicants can monitor the status of their submissions in real time, significantly reducing the need for follow-ups.

The current DMS involves the following steps:

1. **Application Submission**: Licensees log in to the DMS platform, where they are guided through an intuitive interface to upload required documents, complete forms, and submit applications for processes such as pre-approval of IPOs, FPOs, Right Shares, PPAs, share structure changes, and mergers and acquisitions. The application can only be submitted if all required documents are uploaded.
2. **Preliminary Validation**: An authorized officer validates the application against a standard checklist of requirements, flagging incomplete or non-compliant submissions for correction. Any communication with the applicant is taken up through the DMS platform.
3. **Assignment to Officers**: Assignment of the application to an ERC officer or a designated committee for review is taken up within the DMS by the ERC chair. The system sends notifications to the responsible parties, ensuring timely handling of the application.
4. **Digital Review and Comments**: ERC-designated officers review the submissions directly on the platform. They can annotate documents, provide comments, and request additional information or clarifications from the applicants.
5. **Approval Workflow**: Once the review process is complete, the application is routed through automated workflows to the relevant decision-making authority within the ERC. If approvals are granted, they are digitally recorded and stored.
6. **Real-Time Status Updates**: Throughout the process, applicants receive real-time updates on their application status via the platform. This transparency is expected to significantly reduce the need for repeated follow-ups or physical visits to the ERC office.
7. **Final Notification and Record Storage**: Upon approval, the applicant is notified electronically and the decision is archived in the system, ensuring secure, retrievable records for future reference.

3 This case study is a part of the ERC Digital Strategy and Implementation Roadmap: Final Report (2021) authored by Deloitte under the ENR Call 62: Technical Assistance for the Power Sectors of South Asia. This work was funded by the U.S. Department of State, Bureau of Energy Resources, Power Sector Program.

Figure 3 DMS Workflow

Future of Digitization

While the preliminary DMS marks a promising start, ERC's ultimate vision is the development of a fully integrated Regulatory Information Management System (RIMS). This system is envisioned to be a transformative tool, serving as a centralized database for all regulatory documents and processes while offering capabilities for real-time data analysis and seamless decision-making.

The RIMS will incorporate several advanced features designed to modernize ERC's operations and address critical pain points. Online payment gateways, for instance, will enable applicants to process payments directly through a secure digital platform, eliminating the cumbersome need for in-person transactions and notarized receipts. E-signatures and e-notarization will further expedite approval workflows, replacing physical document exchanges with streamlined, authenticated digital transactions. Secure data storage will ensure compliance with data protection protocols, safeguarding sensitive regulatory and stakeholder information. These enhancements collectively promise to increase ERC's efficiency and ability to communicate effectively with stakeholders while reducing bottlenecks caused by manual processes.

A key component of RIMS will be its workflow management module. This module is expected to automate routine tasks, such as task assignments, deadline reminders and the logging of actions taken by staff at each stage of the approval process. According to Deloitte's ERC Digital Strategy and Implementation Roadmap: Final Report (2021), automating these processes could free up ERC's limited workforce for more strategic regulatory functions, ultimately increasing productivity by as much as 40 percent . Additionally, RIMS will include real-time dashboards for data visualization, enabling staff to analyze performance metrics, track application progress, and identify potential delays or compliance risks immediately.

The success story of GNERC offers a compelling glimpse into what ERC could achieve through a well-designed RIMS. [4] GNERC's transition to a digital platform included web-based applications for data submission, a centralized compliance monitoring system, and intelligent automation for analyzing operational metrics. By investing in digital tools and skilled IT personnel, GNERC not only improved its workflow efficiency but also gained the ability to enforce regulations effectively by using real-time data analytics to monitor compliance. This approach reduced administrative burdens significantly and improved customer satisfaction.

ERC's Five-Year Roadmap, as outlined in the ERC Digital Strategy and Implementation Report (2021), follows a similarly ambitious trajectory. The system will initially prioritize core functionalities such as application submissions, document management, and payment processing, which can be developed within 15 months under a bespoke software solution. Later phases will include advanced modules for public engagement, analytics-driven decision-making, and data interoperability with other government systems.[5]

ERC is setting the stage for a regulatory framework that is not only efficient but also transparent and future- ready by embracing comprehensive RIMS. This digital transformation will enable ERC to meet its growing mandate while establishing itself as a model for innovation and accountability in Nepal's electricity sector.

Global Insights for Nepal's Digital Shift

The journey toward digitization is not without challenges. Cultural norms deeply embedded in manual, paper-based processes, resistance to change among both staff and stakeholders and significant capacity-building requirements present formidable challenges. However, insights from global success stories offer valuable lessons that can help ERC navigate these hurdles effectively and tailor solutions to its unique context. For instance, the PSC's phased approach to digitization, involving stakeholder engagement and pilot testing, ensured the smooth implementation of its e-Docket system. Similarly, GNERC's decision to outsource certain functionalities while developing others in-house allowed for cost-effective and tailored solutions. ERC can similarly leverage stakeholder feedback to fine-tune its system during development, ensuring the digital transition is both effective and widely accepted. Additionally, strategic outsourcing of certain components, such as cloud infrastructure (which has been done by the ERC) or payment gateway integration, could help the ERC manage its resource constraints while focusing internal efforts on regulatory innovations.

The proposed digital system emphasizes scalability,

4 This case study is a part of the ERC Digital Strategy and Implementation Roadmap: Final Report (2021) authored by Deloitte under the ENR Call 62: Technical Assistance for the Power Sectors of South Asia. This work was funded by the U.S. Department of State, Bureau of Energy Resources, Power Sector Program.

5 Five-Year Roadmap for ERC (2024-2029) (2024). https://erc.gov.np/storage/contents/July2024/1QedMrw33f9aIKJNommp.pdf

ensuring future modules that can be added as ERC's responsibilities evolve. For instance, the envisioned Regulatory Information Management System (RIMS) will not only accommodate current functions such as application submissions and fee processing but will also expand to include advanced analytics, real-time compliance monitoring and public engagement tools.

Furthermore, the focus on user-friendliness is central to ERC's vision. Plans for mobile compatibility and multilingual support aim to make the system accessible to a diverse group of stakeholders, from Independent Power Producers (IPPs) to the general public. Such inclusivity reflects ERC's commitment to meeting the needs of all users, irrespective of their technical proficiency or language preferences.

Toward a Digitized Era

ERC's digital transformation represents a strategic initiative to modernize Nepal's electricity sector and address its evolving complexities. Anchored in ERC Rule 20, which empowers the chairperson to enhance the regulator's credibility, and Rule 38, which ensures alignment with government-approved policies, this initiative reflects ERC's commitment to transparency, accountability, and responsiveness.

These principles make sure that the ERC's technological advances not only make operations run more smoothly, but also meet its legal obligations and fit with the priorities of state government. This balanced approach positions ERC as a credible and adaptive regulator, ready to tackle emerging challenges in the energy sector.

As the global energy landscape evolves, ERC's digitization journey highlights its proactive approach to regulatory excellence and stakeholder collaboration. These efforts not only reinforce trust and accountability but also set the foundation for a more efficient and transparent regulatory framework, serving as a model for Nepal and beyond.

In a time when digital tools are redefining governance, ERC's transformation is a decisive step toward shaping a future where regulation becomes synonymous with innovation and trust.

Dr. Dhital is the Chairman of the ERC, and Mrs. Shakya is a Techno-Economic and Regulatory Affairs Specialist

UPPER TAMAKOSHI
HYDROPOWER LIMITED

Salient Features	Upper Tamakoshi Hydropower Plant	Rolwaling Khola Hydroelectric Project
Type of Development	Peaking Run-of-River (PRoR)	Run-of-River including Diversion
Location	Dolakha District, Bigu Rural Municipality- 1	Dolakha District, Bigu Rural Municipality-1 & Gaurishankar Rural Municipality-9
Headwork's Location	Bigu Rural Municipality-1, Lamabagar	Gaurishankar Rural Municipality-9
Powerhouse Location	Bigu Rural Municipality-1, Gongar	Bigu Rural Municipality-1, Lamabagar
Installed Capacity	456 MW	22 MW
Annual Energy	2,281 GWh	317 GWh including diversion
Gross Head	822m	207.18m
Design Discharge	66.0 m3/sec	13.4m3/sec
Settling Basins	2 Nos. L=225m	110mx9.0mx9.7m
Headrace Tunnel	8.4km (Cross Sectional Area =32.14m2)	6.2km
Power House (Underground)	142.0m x13.0 mx25.0m (LxBxH)	35x11.85x22m
Number of units	6	2
Tailrace Tunnel	2.9km (Cross Sectional Area =35.0m2)	740m
Access Road from Charikot of Dolakha District	68.0km	68.0km
Transmission Line	220Kv Double circuit, 47.0km (Gongar to Khimti Substation)	8.35km Length, 33kV

Essential Insights from India's Power Sector Regulations

Saroj Koirala

In Nepal also, the Electricity Regulatory Commission Act 2017 provided the statutory framework to establish the independent regulator. However, the extent of the independence of the regulator is always a matter of debate.

I was privileged with the opportunity to participate in the *Intensive Course on Regulations & Policies in the Indian Power Sector* co-organized by the Independent Power Producers' Association of India (IPPAI) and Idam Infrastructure Advisory Pvt. Ltd. in Belgundi village, located in Karnataka, India, on October 17-19, 2024. The three-day program, as the name suggests, was focused on building the capacity of power professionals working in India. However, I was particularly intrigued by the opportunity to understand the rationale behind one of the most comprehensive electricity laws governing and regulating one of the world's largest power systems, which motivated me to participate. To my good luck, the event was attended by representatives of the Central Electricity Authority (CEA), employees of financial institutions, representatives of distribution companies, state transmission utilities (STU), generation companies, investors, etc. As trainers, the program was graced by notable personalities, Dr. Pramod Deo (Ex-Chairperson - Central Electricity Regulatory Commission, India), Mr. Ashok Kumar Rajput (Member - Power Systems - CEA), PK Agrawal (Former Director - Power System Operator, India), Mr. Balawant Joshi (Managing Director, Idam Infrastructure Advisory Pvt. Ltd.) and Advocate Divya Sood, PHD, (Head of Regulatory Affairs, IPPAI).

As an engineer with a business degree and a strong interest in the legal aspects of electricity, the course sessions offered me a valuable learning opportunity. I was able to confirm many of my own conclusions about electricity policy and governance issues, deepen my understanding of familiar concepts, and explore entirely new ideas—most of which hold significant relevance for Nepal as well. In this article, I discuss some relevant issues that were discussed in the course.

a. Extent of the Independence of Regulator

By the turn of the 21st century, countries in South Asia had begun adopting the concept of independent regulation, which was prevalent in the United States as a form of regulation of public utilities such as drinking water, gas, electricity, telecommunications, etc. In 1997, the National Electric Power Regulatory Authority (NEPRA) Act, 1997 was enacted to establish an independent regulator of electricity in Pakistan. Similarly, in India, the Electricity Regulatory Commissions Act, 1998 was enacted to provide for central and state regulators of electricity. Although some states already had constituted a State Electricity Regulatory Commission before the enactment of the 1998 act also. In Nepal also, the Electricity Regulatory Commission Act 2017 provided the statutory framework to establish the independent regulator. However, the extent of the independence of the regulator is always a matter of debate. Although regulatory institutions are also a part of the state mechanism, they are bound by state policies. While it is a generally agreed principle that the regulators are free to exercise their independence on how they do what they do while following state

policies, the executive body or policy institutions sharing regulatory powers or sometimes overreaching to the regulatory jurisdiction is also sometimes observed. Sections 107 and 108 of India's Electricity Act 2003 state that in the discharge of its functions, the Central and State Commissions shall be guided by such directions in matters of policy involving public interest as the Central Government and State Government, respectively, may give to it in writing. This written statute may instinctively go against the concept of independence as it seems to bind the regulator to the will of the government. However, in the course of discussion, it was made clear that a recent judgment by the Supreme Court of India ruled that the state commission shall only be 'guided' by the directions issued by the state or central government and is not automatically bound by them [1]. It is a groundbreaking judgment that sheds light on the nature of the independence that the regulators have, while it has a significant persuasive value in Nepal's context also.

b. Unlegislated Regulations

The issue of power trading remains unsolved within Nepal's electricity sector even today. Although power trading is a critical component of any electricity market—and despite Nepal's policy and statutory indications from the state to move toward a regime that facilitates energy trade—no significant breakthroughs have been achieved in decades. A frequently cited explanation is that Nepal's Electricity Act of 1992 does not explicitly recognize electricity trading as a licensed activity. Nevertheless, a step towards enabling power trading is urgently needed to safeguard the Nepal Electricity Authority (NEA) from the unsustainable burden of Power Purchase Agreements (PPAs) and to enable private-sector direct participation in market development and business development of electricity.

Reflecting on the journey, it becomes evident that despite challenges, India's experience with open access has allowed it to refine its mechanisms, fostering the growth and development of the power sector.

In discussions during the training, it was highlighted that India's Electricity Act of 2003 does not explicitly address provisions for energy storage, which has become increasingly relevant with the advent of Battery Energy Storage Systems (BESS). However, the lack of an explicit statutory provision did not bar the Central Commission from considering energy storage systems in its tariff regulations or general network access regulations. Accordingly, the establishment of a power exchange in India was not a direct outcome of the Electricity Act, 2003 but was rather contingent on a policy of the Central Government. This demonstrates that the principle of necessity can supersede a written law, which in fact is defined according to the need of the hour.

Nepal's Electricity Regulatory Commission Act 2017 has already envisioned power trading, but there is no such provision in the Electricity Act 1992 that explicitly forbids power trading. Notably, under Section 14 of the Act, the Commission is mandated to promote competition in the electricity sector—a goal that cannot be achieved without facilitating power trading. It is also worth highlighting that India established and operationalized the Power Trading Corporation of India Limited (now PTC India Ltd.) well before its electricity legislation licensing power trading, demonstrating that practical action can precede legislative clarity.

c. India's Open Access Journey

Open access lies at the heart of competitive electricity markets. It aims to offer more choices to both consumers and generators, which can stimulate investment and foster the development of innovative business models. The Central Electricity Regulatory Commission (CERC) first enacted its open access regulations for interstate transmission networks in 2004, which opened doors to more competition and even laid the foundation for the operationalization of power exchanges in 2008. Reflecting on the journey, it becomes evident that despite challenges, India's experience with open access has allowed it to refine its mechanisms, fostering the growth and development of the power sector.

In 2022, the CERC notified the Connectivity and General Network Access (GNA) Regulations 2022, marking a significant shift in access to the transmission network[1]. Under the previous open access regime, access to the interstate transmission network in India was granted on the basis of power purchase. Power would then be injected from a specific point and drawn at another, as stipulated in the terms of access. However, the new regulations separate access to the transmission network from power purchase and instead, the required access is determined based on historical data. The GNA

1 https://cercind.gov.in/regulations/175-Notification.pdf

regulations also eliminate the need to pre-specify the exact injection and withdrawal points.

Additionally, the new regulations introduce the concept of Temporary General Network Access (TGNA). Open access to the interstate transmission network was previously classified into long-term, medium-term and short-term categories. The GNA regime removes these classifications, offering only GNA or Temporary GNA (TGNA). The transition from Open Access to General Network Access aligns with India's current electricity market, which sees a greater proliferation of non-dispatchable renewables, supports more short-term electricity trading and promotes better utilization of available transmission infrastructure. However, this transition requires a more resilient and dynamic system, along with greater vigilance from system operators.

d. Disputes Resolution in Power Sector

Most regulators are granted quasi-judicial functions to resolve disputes within their respective industries. Since electricity regulators oversee nearly all aspects of the electricity business, they are well-positioned to both understand and adjudicate disputes, as well as enforce the resulting judgments. This not only saves time and resources for the judicial system but also accelerates the dispute resolution process.

However attending the event made me understand that there is still some room for improvement in the electricity dispute resolution mechanism in India. There are constructs such as the Consumer Grievances Redressal Forum and Ombudsman, which help to remove smaller consumer disputes from the Commission's jurisdiction, allowing the commission to focus on more complex matters that require greater resources and sections 79 and 86 provide sufficient mandate to adjudicate disputes involving generation and transmission companies in regards to their tariffs. However, the Electricity Act 2003 is silent on the authority of state and central regulators to adjudicate disputes between two licensees, which has been identified as a significant gap in the electricity laws.

In Nepal, however, the Electricity Regulatory Commission, although unable to provide licenses, retains the authority to resolve disputes between licensees. But, given that the Electricity Regulatory Commission of Nepal is statutorily mandated to resolve disputes of all kinds, either between licensees or between licensees and consumers, it may be wise for future legislation to establish a mechanism, similar to the Consumer Grievances Redressal Forum, to alleviate the Commission's burden of handling thousands of minor consumer disputes, such as domestic consumers' billing errors.

Additionally, it was discussed that issues regarding the management of used lithium-ion batteries and old solar panels could become a significant issue in the future, potentially leading to disputes. In the future, Nepal's electricity legislations and subsequent frameworks should address the issue and create a just, realistic and practical mechanism for the management of old batteries and solar panels.

e. Resource Adequacy

Resource adequacy planning ensures that there is always enough generation capacity to reliably meet demand under various conditions. The increasing share of variable renewable energy sources combined with unpredictable weather events presents a challenge to consistently supply electricity in the required quantities, underscoring the growing importance of resource adequacy. While traditional generation planning focused on forecasting electricity needs for the future, resource adequacy now addresses the need for ensuring reliable supply across a range of scenarios. This is achieved through the efficient use of appropriate generation resources, sufficient generation and transmission capacity, energy storage, reserve margins, and demand-side management.

To strengthen resource adequacy in India, the Electricity (Amendment) Rules 2022 mandated that the Central Government develop a resource adequacy guideline. Based on this, state regulatory commissions are tasked with framing their own regulations. Additionally, the Indian Electricity Grid Code, 2023, issued by the Central Electricity Regulatory Commission (CERC), outlines specific planning and reporting responsibilities for grid participants related to resource adequacy[2].

Nepal currently boasts impressive electricity access, with 96% of the population connected to the grid[3]. With the challenge of access nearly resolved, the country must now focus on improving the quality and reliability of electricity and this includes continuity of reliable electricity service under all conditions. Recent disasters in Nepal, likely driven by climate change, have exposed the vulnerabilities in Nepal's energy security. As the country increases its renewable energy generation and explores small, scalable energy storage solutions, along with its abundant hydropower potential, it is essential for Nepal to begin prioritizing resource adequacy in its energy planning.

Mr. Koirala is the Founder/Principal Consultant of Mrigasheera Consulting & Training Services.

2 https://cercind.gov.in/Regulations/180-Regulations.pdf
3 https://npc.gov.np/images/category/240607021743 सोह्रौं%20योजना.pdf

One Stop Solution

for Hydropower Projects and Construction Industries

- Explosives & Bailey Bridge
- EM Equipment & Spare Parts
- Transmission Line & Substation
- Safety Equipment & Solution

The principles and standards of Tactical Solution/Synex Power have made the company one of the reputed trading organizations in its sector and we are able to satisfy all our clients who are based in Nepal.

Our main business scope is as follows

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   - Approval, supply and daily/monthly management of explosives.
   - Supply and erection for bailey bridge.
2. **For EM Equipment, Transmission Line and Substation**
   - Turbine generator design and manufacture (1MW~100MWs),
   - Installation, commissioning and testing in site.
   - Spare parts supply, maintenance and overhaul (by JV company in Nepal).
   - Construction supervision of transmission line & substation
   - Supply of substation and transmission line equipment
   - Supply of transformer and accessories (CRGO, Roll Core Silicon Steel etc.)
3. **For Safety Equipment & Solution**
   - Ensure safety in mining and tunneling as well as on motor sports tracks, in industry and in test facilities
   - Slope stability
   - Rockfall protection
   - Monitoring and alarm systems
   - Flood protection system

Our Objective

Our objective is to become one of the leading market share holder in one of the most competitive market in Nepal.

Our Goal

Customer satisfaction is the ultimate goal of our company.

Mission

We are committed to provide the products at the right time at the right place with zero tolerance.

Vision Statement

To be referred as the most trusted company for Explosive, Bailey Bridge, EM Equipments, Transmission Line, Sub Station and Safety Equipment for Hydropower Projects and Construction Industries.

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Chongqing Wangbian Electric (Group) Corp. Ltd., China

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Carbon Financing and Renewable *Energy Opportunities in Nepal*

Dr. Mukesh Ghimire

The 1992 General Assembly in Rio de Janeiro, Brazil, the United Nations Conference on Environment and Development, emphasized the urgency of immediate international action on the environment, including climate change.

KEY HIGHLIGHTS:

1. Global Climate and Carbon Agenda: Pre and Post-Paris Agreement
2. Global Climate Funds and Mechanisms
3. Regulatory and Compliance-based Carbon Markets
4. Overview of Nepal's Renewable Energy-based Carbon Projects
5. COP 29's Implications for Climate Financing for Least Developed and Developing Countries
6. Future Perspectives of Carbon Projects under Article 6

1. Global Climate and Carbon Agenda: Pre and Post-Paris Agreement Era

The awareness of the effects of climate change was further advanced at the second World Climate Conference held in Geneva, Switzerland, from 29 October to 7 November 1990. The conference stated that climate change was a global problem for which an international response is required. The 1992 General Assembly in Rio de Janeiro, Brazil, the United Nations Conference on Environment and Development, emphasized the urgency of immediate international action on the environment, including climate change. *The Earth*

Summit set a new framework for seeking international agreements to protect the integrity of the global environment in its Rio Declaration and Agenda 21, which highlighted global consensus on development and environmental cooperation. The most significant event during the conference was the opening for signature of the United Nations Framework Convention on Climate Change (UNFCCC); by the end of 1992, 158 states had signed it. It entered into force in 1994, and in March 1995, the first Conference of the Parties (COP) was held in Berlin, launching talks on a protocol or other legal instrument containing stronger commitments for developed countries and those in transition.

The major milestone of climate change action was initiated in December 1997 with the Kyoto Protocol to the UNFCCC, the most influential climate change action so far taken. It aimed to reduce the industrialized countries' overall emissions of carbon dioxide and other greenhouse gases by at least 5 percent below the 1990 levels in the commitment period of 2008 to 2012. The Protocol, which opened for signature in March 1998, came into force on February 16, 2005.

To make climate action more ambitious, voluntary, and open to global participation, 196 parties at COP 21 in Paris on December 12, 2015, signed a legally binding international treaty on climate change, which is known as the *Paris Agreement*. The main goal of this agreement is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate-neutral world by mid-century. The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.

The Paris Agreement works on a 5-year cycle of increasingly ambitious climate action carried out by countries. The countries submit their plans for climate action, known as nationally determined contributions (NDCs), by 2020. In their NDCs, countries communicate actions they will take to reduce their greenhouse gas emissions in order to reach the goals of the Paris Agreement. Countries also communicate in the NDCs actions they will take to build resilience to adapt to the impact of rising temperatures. To detail the efforts towards the long-term goal, the Paris Agreement directs the countries to formulate and submit by 2020 long-term low greenhouse gas emission development strategies (LT-LEDs). It provides the long-term horizon to the NDCs but is not mandatory. For the tracking of the progress, the Paris Agreement has established an enhanced transparency framework (ETF). Under ETF the countries will report transparently on actions taken and progress in climate change mitigation, adaptation measures, and support provided or received. This reporting as per ETF started in 2024, and every country has to submit it to the UNFCCC. The information gathered through the ETF will feed into the Global Stocktaking, which will assess the collective progress towards the long-term climate goals. Further, this will lead to recommendations for countries to set more ambitious plans in the next round.

Many countries, regions, cities, and companies are establishing carbon neutrality targets. Zero-carbon solutions are becoming competitive across economic sectors. Currently, the trend is most noticeable in the power and transport sectors and has created many new business opportunities. The Paris Agreement 2015 formulated three different carbon trading avenues. They are

- Article 6.2: Accounting guidance for reporting of "internationally transferred mitigation outcomes" (ITMOs) with "corresponding adjustments."
- Article 6.4: An emissions mitigation mechanism to issue units for programs or activities, building on existing Kyoto mechanisms (CDM).
- Article 6.8: Work program for non-market approaches to advance cooperation that does not involve ITMOs.

2. Global Climate Funds and Mechanisms

Climate finance is the mobilization of financial resources to help implement mitigation and adaptation in developing countries to minimize the impacts of climate change. The fund can be of public climate finance commitments by developed countries under the UNFCCC or through bilateral, as well as through regional and national climate change channels and funds. In the 2009 Copenhagen Accord, developed countries guaranteed to deliver climate finance of USD 30 billion between 2010 and 2012. The Paris Agreement repeats that developed countries should take the lead in mobilizing climate finance "from different sources, instruments and channels," and COP21 in 2015 agreed to set a new collective goal by pledging USD 100 billion by 2025. Many countries have highlighted the need to increase international support in implementing their National Adaptation Plans (NAPs) and Nationally

To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate-neutral world by mid-century.

Determined Contributions (NDCs). Figure 1 provides a synopsis of the worldwide climate financing mechanism. The different types of climate finance available are in the form of grants, concessional loans, guarantees, private equity and technical assistance.

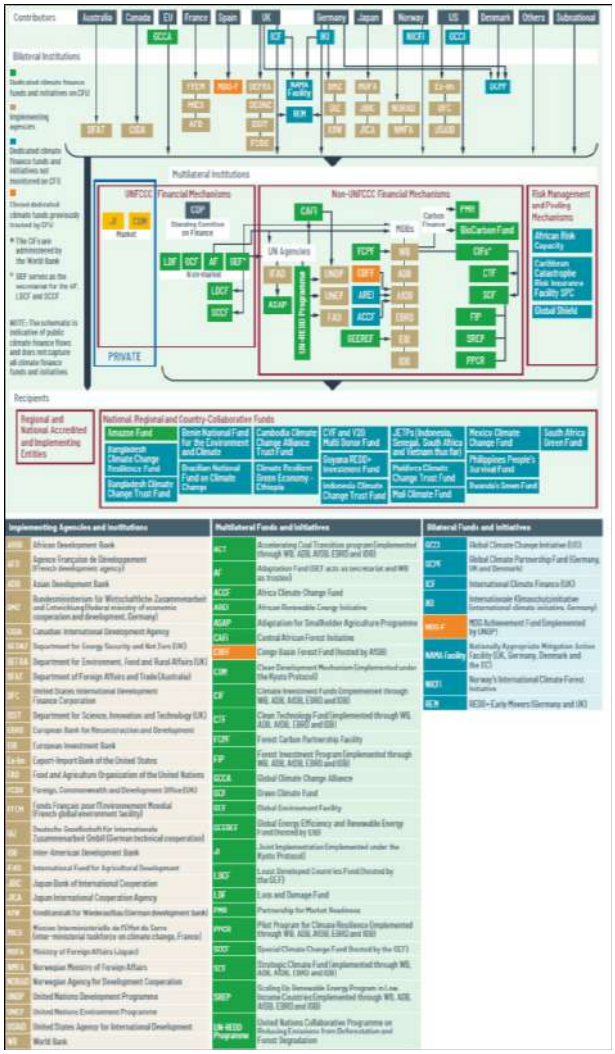


Figure 1: Global Climate Finance Architecture (Source: ….)

3. Carbon Markets: Regulation & Compliance

Two types of carbon markets exist: regulatory compliance and voluntary markets. The compliance market is used by companies and governments that, by law, have to account for their GHG emissions. It is regulated by mandatory national, regional, or international carbon reduction regimes. On the voluntary market, the trade of carbon credits is carried out voluntarily. The size of the two markets differs considerably.

3.1 Regulatory Compliance Market:

The International Regulatory Compliance Market is established by the Kyoto Protocol that implemented three mechanisms, namely the International Emission Trading, Joint Implementation (JI) and Clean Development Mechanism (CDM).

Summary of International Regulatory Compliance Markets under Kyoto Protocol (KP)

Mechanisms	Units
Emission Trading (ET) - Article 17 of KP • Allow the Annex 1 countries to sell the excess capacity to those countries that are over their targets.	Assigned Amount Units (AAUs)
Joint Implementation (JI) - Article 6 of KP • Project-based mechanism to use emission reduction from any projects among Annex 1 countries • Joint implementation offers flexible and cost-efficient means of fulfilling a part of their commitments, while the host party benefits from foreign investment and technology transfer.	Emission Reduction Units (ERU)
Clean Development Mechanism (CDM) – Article 12 of KP • Project-Based Mechanism and projects must be hosted by developing countries. • Two objectives: (a) assist Annex I countries in meeting their targets through offset mechanisms and (b) assist non-Annex I countries in achieving sustainable development.	Certified Emission Reduction (CER)
1 Unit = 1 tCO_2eq	

Under International Emission Trading, parties with commitments under the Kyoto Protocol (Annex B Parties) have accepted targets for limiting or reducing emissions. These targets are expressed as levels of allowed emissions, or assigned amounts, over the 2008-2012 commitment period. The allowed emissions are divided into assigned amount units (AAUs). Emissions trading, as set out in Article 17 of the Kyoto Protocol, allows countries that have emission units to spare - emissions permitted them but not "used" - to sell this excess capacity to countries that are over their targets. Thus, a new commodity was created in the form of emission reductions or removals.

The mechanism known as "joint implementation," defined in Article 6 of the Kyoto Protocol, allows a country with an emission reduction or limitation commitment under the Kyoto Protocol (Annex B Party) to earn emission reduction units (ERUs) from an emission-reduction or emission-removal project in another Annex B Party, each equivalent to one tonne of CO_2, which can be counted towards meeting its Kyoto target.

The Clean Development Mechanism (CDM) defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn

saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, which can be counted towards meeting Kyoto targets. The mechanism stimulates sustainable development and emission reductions while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.

3.2 Voluntary Carbon Market:

The voluntary carbon markets function alongside compliance schemes and enable companies, governments, non-profit organizations, universities, municipalities, and individuals to purchase carbon credits (offsets) voluntarily. Currently, the majority of Voluntary Carbon Credits (VCCs) are purchased by the private sector, where corporate social responsibility goals are typically the key drivers.

Market participants use carbon credits to offset emissions that are caused by their activities and cannot or have not yet been eliminated. Firms across the globe either utilize VCCs that are sold by registries (primary markets) or enter into VCC derivatives contracts (secondary markets). The global nature of voluntary carbon markets allows investments to be made anywhere in the world to develop new, innovative sequestration technologies or to preserve critical habitats or forests by creating a market-based incentive through the growing demand for carbon offsets.

Some of the Voluntary Market Registries are:

American Carbon Registry (ACR): https://americancarbonregistry.org

Gold Standard Registry: https://www.goldstandard.org/resources/impact-registry

Climate Action Reserve (CAR): https://www.climateactionreserve.org/

Social Carbon Registry: http://www.socialcarbon.org/developers/registry/

Plan Vivo Registry: http://www.planvivo.org/plan-vivo-certificates/markit-registry/

Verified Carbon Standard (VCS) Registry: https://verra.org/project/vcs-program/

Climate, Community, & Biodiversity Standards (CCBS) Registry: https://verra.org/project/ccb-program/

4. 4. Overview of Nepal's Renewable Energy-based Carbon Projects

The Alternative Energy Promotion Centre (AEPC) succeeded in registering its first Clean Development Mechanism (CDM) project as early as December 2005. Simultaneously, two bundled CDM projects on biogas (Biogas Support Program-Nepal Activity-1 and Biogas Support Program-Nepal Activity-2) were registered with UNFCCC on the same day. This was a landmark portal for Nepal in the international carbon markets, and since then, the AEPC has been capitalizing on the carbon opportunities. Being an apex institution for renewable energy and energy efficiency promotion in Nepal and citing the contribution of renewable energy for climate change mitigation and adaptation, the AEPC realizes that the scope needs to be expanded beyond the horizon of mitigation, which also encompasses the adaptation in its domain.

So far, a total of eight carbon PAs/PoAs have registered in the UNFCCC CDM registry, of which five domestic biogas projects and three projects are of Micro Hydro Promotion, Improved Cooking Stove and Improved Water Mill. Details of projects are shown in the table below.

SN	CDM Projects/PoA	Reg. date	Systems	Remarks
1	Biogas Support Program - Activity-1	27 Dec. 2005	9692	CDM and GS
2	Biogas Support Program -Activity-2	27 Dec. 2005	9688	CDM and GS
3	Biogas Support Program - Activity-3	13 Dec. 2011	20254	CDM and GS
4	Biogas Support Program Activity-4	13 Dec. 2011	20318	CDM and GS
5	Micro-hydro Promotion	18 Oct. 2010	450 (15 MW)	CDM
6	Nepal Biogas Support Program-PoA	31 Jan 2013	10 CPAs: 182,000	CDM and GS
7	Promotion of the Improved Cooking Stove (ICS) – Nepal-PoA	27 Mar. 2015	15 CPA (22000 per CPA)	CDM
8	PoA for Promotion of the Improved Water Mills (IWM) in Nepal	9 Sep 2015	2 CPAs (3300)	CDM
9	Developing Large Size Biogas as Carbon Programme in Nepal	Proposed for ITMO under article 6.2 of Paris Agreement		

The maximum emission reduction capacity of these eight projects is 810,633 Certified Emission Reduction (CER) per year. The details of emission reductions from the AEPC CDM projects are as follows:

	CDM Projects	Emission Reduction
Biogas PA	Biogas PA 1	35,607
	Biogas PA 2	35,357
	Biogas PA 3	74082
	Biogas PA 4	75,307
	Total	146,271

	CDM Projects	Emission Reduction
Biogas PoA	CPA 1	65,103
	CPA 2	64,868
	CPA 3	64,973
	CPA 4	65,009
	CPA 5	64,592
	CPA 6	61,565
	CPA 7	61,191
	CPA 8	64,565
	CPA 9	57,134
	CPA 10	38,731
	Total	607,731

Project	Emission Reduction
Micro Hydro Projects	34,336

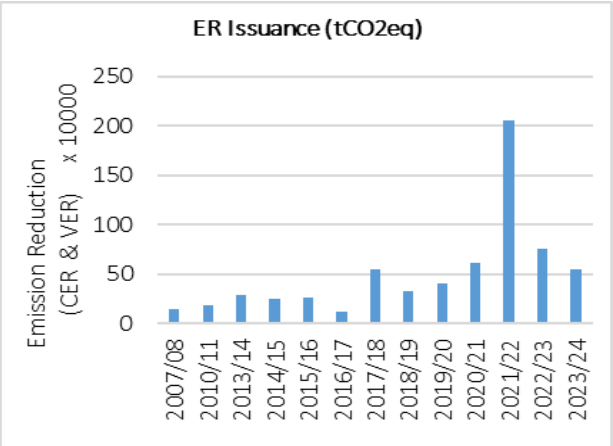
IWM	Projects	Emission Reduction
	CPA 1	11,022
	CPA 2	11,273
	Total	22,295
Project		Emission Reduction
Improved Water Mill		34,336
Total CDM Emission Reduction Per Year		*810,633 CERs*

Total CDM Emission Reduction Per Year	*810,633 CERs*

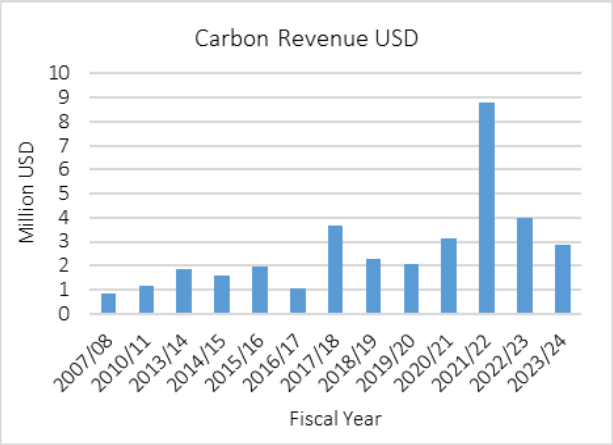
Source: (AEPC,2024)

AEPC biogas projects are also registered in the Gold Standard registry. The Biogas PoA was registered as the first AEPC project in Gold Standard on January 31, 2013, followed by Biogas PA on August 1, 2018.

As per the Annual Progress Report, around 5.94 million units of Emission Reduction (ER) have been generated and an additional 542,866 ERs verifications are under Gold Standard Registry Review (A total of 6.5 million units of Emission Reductions); and around 6.48 million units of ERs have been sold. The total earnings from carbon revenue are around USD 35.27 million.



Year-wise issuance of ERs (CERs and VERs)



Year-wise carbon revenue earning

Source: (AEPC, 2024)

Nepal has minimal carbon projects compared to the other countries in the world. In the clean development mechanism registry, the activity projects that are requested for the transition to Article 6.4 are eight government projects and are operated by AEPC. Similarly, AEPC projects are active in the gold standard registry, which is about 0.2 million biogas plants. From other institutions, 114 carbon projects are registered in the Gold Standards, most of the projects are biomass-related projects. Out of these, 23 carbon projects are listed and are in process of getting registration in the Gold Standard registry. Under the Verra Registry, there are eight projects registered at the Government of Nepal, which are mostly biomass projects. During COP 29, Nepal's government has signed an agreement with the Swedish Energy Agency (SEA) to develop the carbon project under Article 6.2. SEA is interested to developing the large biogas project with the AEPC. Some level of preliminary preparation has been done for the large biogas project development by SEA.

5. COP 29: Climate Finance for LDC & DC Countries

The recent COP 29 was held in Baku, Azerbaijan, from 11th November 2024 to 22nd November 2024 and emphasized establishing a new climate finance goal, reducing greenhouse gas emissions, building resilient communities, ensuring means for stronger climate action in countries, and guiding the country to develop NDCs. The major achievements of COP 29 in relation to climate financing for developing countries are:

- Triple financing to developing countries, from the previous goal of USD 100 billion annually to USD 300 billion annually by 2035.
- Secure efforts of all actors to work together to scale up finance to developing countries, from public and private sources, to the amount of USD 1.3 trillion per year by 2035.

A notable achievement in mobilizing Article 6 is that countries have agreed on the final building blocks, which set out how carbon markets will operate under the Paris Agreement, making country-to-country trading and a carbon crediting mechanism fully operational. Similarly, in the case of Article 6.2, COP 29 has shown clarity on how countries will authorize the trade of carbon credits, and tracking of registries will be done. Further, it has emphasized assuring the environmental integration prior to the project implementation.

The countries agreed on standards for a centralized carbon market under the UN (Article 6.4 mechanism). The developing countries will benefit from new flows of finance, and particularly the least developed countries will get the capacity-building support to move

ahead in the market. Moreover, the parties have handed over the to-do list for 2025 to set up the new carbon crediting mechanism.

6. Future of Carbon Projects under Article 6

With the Article 6 mechanism, the country can now access carbon financing through carbon trading through Article 6.2 (cooperative approach) and Article 6.4 (market mechanism). This has widened up the opportunities to access more carbon financing in the country. With the ambitious NDCs of the developed countries, it is expected to increase investment in clean/renewable/energy-efficient technologies and increase the demand for emission reduction units in the future. Understanding the beneficial side of carbon trading, the participation of public and private entities in the Article 6 mechanism will increase in coming years. In the future, more innovative projects and clean technology projects will be developed in the developing countries. This Article 6 mechanism will attract investment from private sectors and banking sectors in clean technology, renewable energy, and energy-efficient technologies.

The author is currently working as deputy director at the Alternative Energy Promotion Center (AEPC), under the Ministry of Energy, Water Resources and Irrigation, Government of Nepal. The opinion expressed in this article is solely based on the author's personal views and does not represent the author's organization.

Accelerating Nepal's Green Mobility through Retrofitting

Kushal Gurung

While electric vehicles (EVs) represent a clean and efficient solution, the economic and logistical hurdles of replacing the existing fleet of internal combustion engine (ICE) vehicles with new EVs remain significant.

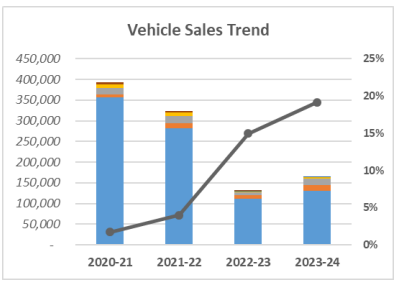
Aastha Dhungana

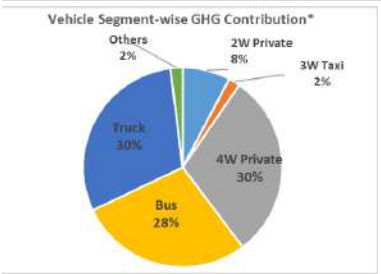
Introduction

Nepal, a country characterized by its unique topography and ecological diversity, faces significant challenges from climate change while also grappling with an urgent need to reduce its reliance on fossil fuels. The transport sector, a major contributor to greenhouse gas (GHG) emissions, necessitates urgent action to transition to sustainable alternatives. While electric vehicles (EVs) represent a clean and efficient solution, the economic and logistical hurdles of replacing the existing fleet of internal combustion engine (ICE) vehicles with new EVs remain significant. As a cost-effective and resource-efficient solution, retrofitting ICE vehicles to EVs offers immense potential for accelerating Nepal's transition towards sustainable transportation.

This article explores the potential of converting ICE vehicle to EVs in Nepal, examining the benefits, opportunities, challenges, and strategic measures required to establish retrofitting as a cornerstone of Nepal's green mobility agenda.

Current Transport Landscape in Nepal



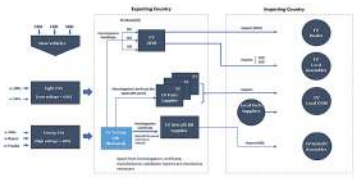


Source: Department of Customs and NADA

Nepal's vehicle fleet has grown exponentially, with over 4.5 million registered vehicles till now. Two-wheelers (2Ws) dominate in numbers, followed by four-wheelers (4Ws), three-wheelers (3Ws), and light commercial vehicles (LCVs). Despite their lower numbers, 4Ws, trucks, and buses contribute a staggering 88% of GHG emissions from the sector[1]. Public transport systems, including buses and microbuses, often rely on outdated ICE technologies, exacerbating fuel inefficiencies and emissions.

In recent years, a notable rise in EV adoption in Nepal has been driven by supportive government policies, rising fuel costs, and increasing environmental awareness. The government's ambitious EV targets under its Nationally Determined Contributions (NDCs) include achieving 25% EV penetration by 2025 and 90% by 2030[2]. These goals highlight the urgency for innovative solutions like retrofitting to complement the introduction of new EVs.

Further, the "Vehicle Conversion Policy Advice Paper, Nepal" outlines detailed strategies to support such initiatives by providing clear guidance on vehicle conversion processes and regulations.



Structural Framework of Nepal's EV Ecosystem

Source: pManifold Business Solutions

1 https://medium.com/@dipesh.official2022/electric-vehicle-conversion-in-nepal-b52a1ff92317
2 https://kathmandupost.com/money/2023/05/15/changing-policy-is-hurting-nepal-s-plan-to-switch-to-evs-experts-say?utm

The diagram outlines the ecosystem for converting internal combustion engine vehicles (ICEVs) to electric vehicles (EVs) in Nepal, highlighting key stakeholders, processes, and certification pathways[3].

- **EV Types**: Includes light EVs (e-2Ws, e-3Ws under 60V) and heavy EVs (e-4Ws, e-buses, e-trucks over 60V).
- **Retrofit Process**: Certified retrofit kits, paired with donor vehicles, undergo homologation at the National EV Testing Lab, ensuring compliance with safety and performance standards.
- **Stakeholders**:
  - OEMs & Retrofit Kit Suppliers: Provide certified models and parts.
  - Local Assemblers & Parts Suppliers: Facilitate local assembly and component sourcing.
  - Retrofit Assemblers: Convert ICEVs to EVs, creating an efficient transition pathway.
- **Imports & Distribution**: CKD/SKD kits and components complement local production and assembly, enabling EV deployment via dealers and assemblers.

This structured approach leverages local manufacturing and retrofitting opportunities to advance EV adoption in Nepal.

Why Retrofitting?

Retrofitting involves replacing the ICE drivetrain with an electric one, utilizing conversion kits comprising motors, batteries, controllers, and chargers. This process extends the lifespan of vehicles, reduces reliance on fossil fuels, and offers significant environmental and economic benefits:

- **Cost-Effectiveness**: Retrofitting costs significantly less than purchasing a new EV. In Nepal, converting an ICE vehicle to an EV costs between NPR 700,000 and NPR 1,200,000, depending on battery capacity and motor specifications[4]. In addition, studies such as the "Cost Analysis of Owning Four-Wheel Electric Vehicles in Nepal" demonstrate favorable total cost of ownership (TCO) for retrofitted vehicles.
- **Environmental Impact:** Retrofitting reduces tailpipe emissions, including GHGs, particulate matter (PM), and nitrogen oxides (NOx), thereby improving air quality and contributing to climate change mitigation.
- **Resource Efficiency:** By extending the lifecycle of existing vehicles, retrofitting reduces the demand for raw materials and manufacturing energy. Historical data, such as the early efforts in ICE vehicle conversions dating back to 1981, further showcase the practical feasibility of this approach.
- **Regulatory Compliance:** Retrofitting offers a viable means for vehicle owners to meet increasingly stringent emission standards.
- **Customization:** Kits can be tailored to different vehicle types and operational needs, enabling flexibility across various use cases.

Key Segments for Vehicle Retrofitting Conversion

Retrofitting opportunities in Nepal span across several vehicle categories, which can be seen in the chart given below:

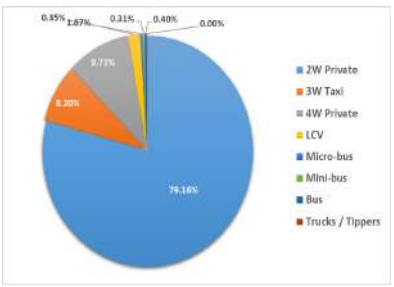


Figure 1: Prominent Vehicle Segments with EV penetration

Source: pManifold Business Solutions

1. Two-wheelers (2Ws)

- **Market Share:** 79.16% (Dominant segment in Nepal's vehicle landscape)
- Retrofitting Potential:
- Two-wheelers represent a significant opportunity for retrofitting with low-voltage systems (<60V).
- Retrofitting is cost-effective, operationally simple, and affordable, ensuring high adoption rates.
- Electrification of 2Ws can significantly reduce fuel dependency and operational costs while aligning with Nepal's sustainable mobility goals.

2. Three-wheelers (3Ws)

- **Market Share**: 8.20%
- **Retrofitting Potential**:
- Indian homologated retrofitting kits are well-suited for Nepal's imported three-wheeler fleet.
- Electrification reduces maintenance costs and enhances cost savings for operators, particularly in urban areas.
- Given their role in urban public transport and last-mile connectivity, retrofitting 3Ws can drive urban e-mobility.

3. **Light Commercial Vehicles (LCVs)**

- **Market Share:** 1.87%
- Retrofitting Potential:
- LCV retrofitting meets the operational demands of last-mile delivery and intra-city logistics.
- Cost-effective solutions from India's retrofitting market offer reliability and ease of implementation.
- Electrification of LCVs supports decarbonization in Nepal's urban freight and

3 Viability Assessment for the Conversion of Internal Combustion Engine Vehicles to Electric or Hybrid Vehicles by pManifold
4 https://www.researchgate.net/publication/371158771_Cost_Analysis_of_Owning_Four-Wheel_Electric_Vehicles_in_Nepal

logistics sectors.

4. Microbuses and Buses

- **Market Share:** 0.75% (Microbuses: 0.35%, Buses: 0.40%)
- Retrofitting Potential:
- Retrofitting public transport vehicles supports Nepal's vision of electrified urban and intercity mobility.
- Successful retrofitting initiatives in India have demonstrated both economic viability and operational efficiency.
- Converting existing fleets provides an immediate pathway to reduce emissions and enhance urban transit sustainability.

5. Trucks and Tippers

- **Market Share:** 0.31%
- Retrofitting Potential:
- Electrification of heavy-duty vehicles, such as trucks, offers significant potential for reducing emissions in freight transportation.
- California's successful truck retrofitting programs provide valuable insights into feasibility and impact.
- Retrofitting these vehicles is essential for achieving broader emissions reduction targets in Nepal's freight sector.

6. Vintage and Specialty Vehicles

- Retrofitting Potential:
- Retrofitting vintage or specialty vehicles (e.g., utility or classic cars) ensures their preservation while meeting modern environmental standards.
- Global examples, such as retrofitting programs in France, demonstrate the potential to retain aesthetic and functional value while transitioning to cleaner energy sources.
- This niche segment offers opportunities for heritage conservation alongside environmental compliance.

Technological Advancements in Retrofitting

Recent advancements have bolstered the appeal of retrofitting:

1. **Solid-State Batteries:** With higher energy density, faster charging capabilities, and enhanced safety features, these advanced batteries are becoming a cornerstone of modern retrofitting kits.
2. **Wireless Charging Systems:** Inductive charging technology eliminates the need for physical connectors, simplifying infrastructure for retrofitted vehicles.
3. **Lightweight Materials:** The use of carbon composites and aluminum alloys in conversion kits reduces the overall weight of vehicles, enhancing performance and energy efficiency.
4. **Smart Control Systems:** Advanced controllers enable better energy management, optimizing battery usage and extending the range of retrofitted EVs.

Challenges in Promoting Retrofitting in Nepal

While retrofitting holds immense promise, several challenges need to be addressed to unlock its full potential:

1. **Regulatory Barriers:**
   - Nepal lacks homologation standards and certification mechanisms for retrofit kits.
   - Retrofitted vehicles currently face legal ambiguities regarding roadworthiness.
   - Initial efforts, as noted in "Nepal Allows Combustion Vehicles' EV Conversion,[5]" have enabled ICE-to-EV conversions, but a comprehensive framework is needed for technical standards, certification, and legal clarity.
2. **Economic Constraints:**
   - High import duties on retrofit kits and components increase costs for end-users.
   - Limited financial incentives and subsidies hinder large-scale adoption.
3. **Technical Limitations:**
   - The absence of skilled professionals in retrofitting technologies poses a bottleneck.
   - Compatibility issues between older ICE models and EV kits require extensive R&D.
4. **Consumer Awareness:**
   - Public skepticism about the safety, performance, and durability of retrofitted vehicles hinders adoption.
5. **Infrastructure Gaps:**
   - Insufficient EV charging stations, especially in rural areas, pose a logistical challenge for retrofitted EV operations.
   - Battery-swapping networks for specific vehicle types are still in nascent stages.

Nepal's transport sector is at a crossroads, with retrofitting ICE vehicles to EVs offering a practical and sustainable solution to decarbonize mobility.

Policy and Strategic Pathways

Nepal's "Green Mobility Roadmap," launched in 2023, emphasizes retrofitting as a

5 https://english.onlinekhabar.com/nepal-allows-ev-conversion-what-next.html?utm

core strategy for sustainable transportation. This initiative aligns with Nepal's commitment to achieving carbon neutrality by 2050 and positions retrofitting as a cost-efficient alternative to importing new EVs. Also, the government, in collaboration with international organizations, has initiated pilot programs to assess the feasibility of large-scale retrofitting projects.

To establish retrofitting as a cornerstone of sustainable transportation, Nepal must adopt a comprehensive strategy that includes the following key components:

1. **Policy and Regulatory Frameworks:**
- Develop national standards for retrofitting, focusing on safety, performance, and environmental compliance.
- Establish certification centers and testing facilities to streamline approvals.
- Draw from resources like "Promotion of Electric Vehicles in Nepal" for policy structuring and standard development.

2. **Economic Incentives:**
- Provide tax exemptions and subsidies, and reduce import duties for retrofit kits and batteries.
- Introduce financing mechanisms, such as low-interest loans, to make retrofitting more accessible.
- Create public-private partnerships to support R&D and reduce costs through economies of scale.

3. **Infrastructure Development:**
- Expand EV charging infrastructure, particularly in urban, semi-urban and highway areas.
- Promote battery-swapping stations for commercial vehicles.
- Collaborate with the private sector to ensure affordable and accessible charging solutions.
- Strengthen the electricity grid to support increased EV operations and integrate renewable energy sources.

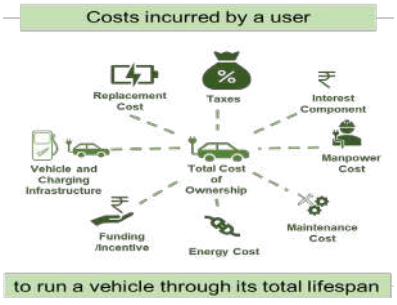
4. **Capacity Building:**
- Collaborate with technical institutes to train engineers and technicians in retrofitting technologies.
- Facilitate knowledge sharing and technology transfer through collaborations with international retrofitting experts.
- Establish vocational training centers dedicated to EV technologies.

5. **Awareness Campaigns:**
- Conduct public outreach programs to highlight the economic and environmental benefits of retrofitting.
- Engage with community organizations to address misconceptions.
- Use social media and local events to showcase successful retrofitting projects.

6. **Incentivizing Private Sector Participation:**
- Encourage local entrepreneurs to enter the retrofitting market through startup grants and business development support.
- Partner with international organizations to provide technical expertise and funding.

Economic Viability and Environmental Impact

1. **Total Cost of Ownership (TCO):**
- TCO analysis offers a comprehensive view of lifecycle costs, including purchase, maintenance, and operational expenses.
- Retrofitting outperforms new EVs in TCO comparisons, providing long-term savings and faster payback periods.



For example, retrofitted 3Ws in India deliver a 45% lower TCO as compared to ICE 3Ws, offering faster payback periods and long-term savings. Similarly, Rwanda's battery-swapping model highlights operational cost savings, which could be replicated in Nepal[6].

2. **Environmental Benefits:**
- Retrofitted EVs reduce lifecycle emissions, including manufacturing-related GHGs, making them a greener alternative.

3. **Energy Security:**
- Utilizing Nepal's renewable energy resources for retrofitted EVs reduces reliance on imported fuels and stabilizes foreign exchange reserves.

4. **Job Creation and Local Industry Growth:**
- The retrofitting industry could create significant employment opportunities for engineers, technicians, and assembly workers.
- Encouraging local production of retrofitting kits can stimulate industrial growth and reduce dependency on imports.

5. **Technological Advancements:**
- Investment in battery technology and lightweight materials can further enhance the efficiency and appeal of retrofitted EVs.

The Way Forward

Retrofitting ICE vehicles presents Nepal with an effective and transformative pathway toward sustainable mobility. By addressing barriers, building capacity, and

6 Rwanda National Climate Change Policy, 2021.

fostering collaboration, Nepal can unlock the vast potential of retrofitting to accelerate EV adoption.

Collaboration Among Stakeholders:

Government initiatives must integrate with private sector innovation and international support to develop a robust retrofitting ecosystem. Key actions include:

- Launching public-private partnerships to reduce the cost of retrofit kits and promote research and development.
- Engaging academic institutions to enhance engineering solutions and provide training.
- Coordinating with international retrofitting leaders for technology transfer and knowledge sharing.

Public Awareness Campaigns:

- Educate the public on retrofitting benefits and dispel misconceptions through targeted outreach.
- Conduct community demonstrations, workshops, and financial literacy programs to boost confidence in retrofitting solutions.

Strengthening Policy Support:

- Align retrofitting initiatives with Nepal's broader climate and transport policies to ensure coherence and sustainability.
- Leverage international funding and expertise to build infrastructure and expand market reach.

Conclusion

Nepal's transport sector is at a crossroads, with retrofitting ICE vehicles to EVs offering a practical and sustainable solution to decarbonize mobility. By addressing regulatory, economic, and technical challenges, Nepal can harness the full potential of retrofitting, achieving its climate goals while promoting economic and social equity.

As Nepal embarks on this journey, a collective effort involving government agencies, private enterprises, and civil society will be crucial to unlock the full potential of retrofitting. The road ahead is challenging but promising, offering a unique opportunity, which also requires a concerted effort from policymakers, industry players, and the public to embrace retrofitting as a cornerstone of Nepal's transition to a green and sustainable transport system. With strategic interventions and global lessons, Nepal can lead by example, transforming its transport landscape into a cleaner, more resilient model for other developing nations to follow.

Mr. Gurung serves as the Director of the Alternative Energy Promotion Center.

Ms. Dhungana is associated with WindPower Nepal, a renowned company specialized in Nepal's renewable energy sector.

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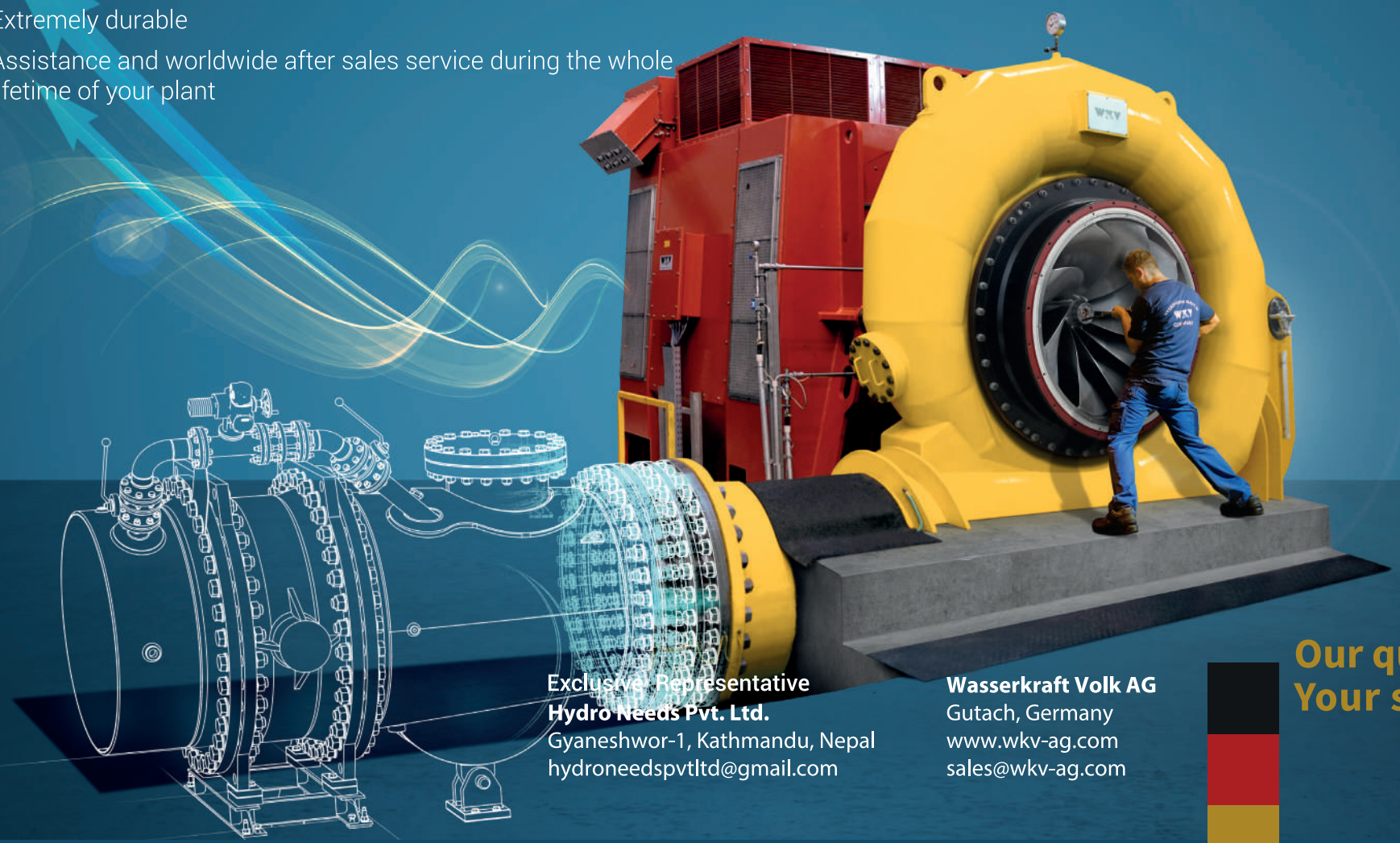

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Global Insights on Hydrogen Regulation for Nepal's Blueprint

Dr. Biraj Singh Thapa

The history of global warming awareness dates back to 1938 when Guy Callendar, a British engineer and amateur meteorologist, first observed that the Earth's temperature had risen by 0.3 degrees Celsius over the previous 50 years.

As the global community struggles with the severe implications of climate change, the transition to Clean Energy (CE) has emerged as a critical priority. Among the myriad of CE options, hydrogen stands out for its potential to revolutionize the energy landscape. This article explores the historical context of global warming, the rise of CE, the benefits and challenges of hydrogen, the global shift toward hydrogen, and the role of regulatory bodies in governing its development. Finally, it proposes establishing a regulatory framework for hydrogen in Nepal, drawing on best practices from around the world.

Global Warming and Shift to CE

The history of global warming awareness dates back to 1938 when Guy Callendar, a British engineer and amateur meteorologist, first observed that the Earth's temperature had risen by 0.3 degrees Celsius over the previous 50 years. This discovery marked the beginning of a scientific journey that would reveal the profound impact of human activities on the Earth's climate. By 2023, studies showed that the planet had warmed by approximately 2.45 degrees Fahrenheit (1.36 degrees Celsius) since the late 19th century. This temperature rise is largely attributed to increased greenhouse gas emissions from industrial activities, deforestation, and other human activities.

The consequences, including melting ice, rising sea levels, and intense heat waves, have become increasingly severe. Despite their minimal contribution to global emissions, small economies like Nepal are highly vulnerable to these impacts, facing challenges like glacial retreats and extreme weather events.

In response to the climate crisis, global initiatives have been launched to address the growing threat. The 1992 Rio Earth Summit marked a significant milestone with the introduction of the United Nations Framework Convention on Climate Change (UNFCCC), which unites countries through the Conference of the Parties (COP). This was followed by the Kyoto Protocol, which operationalizes the UNFCCC by committing industrialized countries and economies in transition to limit and reduce greenhouse gas emissions per agreed individual targets; the Paris Agreement, where 196 nations committed to limiting global warming to below 2°C; and various other initiatives. These collective efforts reinforce global commitments to reduce carbon emissions and strive to limit the rise in global temperatures to 1.5 degrees Celsius.

On a national level, countries are aligning with these commitments by advancing renewable energy policies and reducing dependence on fossil fuels. Nepal has also set ambitious renewable energy targets under its Nationally Determined Contributions (NDCs) and actively engages in international initiatives, including the United Nations Climate Change Conferences, with COP-28 being the most recent.

In recent years, the global drive to limit greenhouse gas emissions and reduce dependence on fossil fuels has significantly accelerated the growth of renewable energy. Technological advancements and decreasing costs have made renewable energy more accessible and economically viable, leading to substantial global investments. Among these developments, hydrogen has emerged as a key CE source with the potential to decarbonize various sectors. However, to fully harness hydrogen's potential, strong regulatory frameworks, adequate infrastructure, and effective market mechanisms are necessary to ensure its safe and efficient application.

Hydrogen: Benefits and Challenges

The potential of hydrogen as an energy carrier has been recognized for over a century. In the early 19th century, scientists discovered that hydrogen could be used to produce energy and that it has the highest energy content by weight among the general fuels, making it ideal for energy-intensive applications. However, it wasn't until the 1960s that hydrogen found widespread use, notably in NASA's Project Gemini, where fuel cells powered probes, satellites, and space capsules.

Despite these early applications, the development of hydrogen as an energy source stalled due to the high cost of production, storage, and transportation, as well as safety concerns. Hydrogen's highly reactive and flammable nature presents safety risks that require careful management, and early research faced setbacks from incidents related to its storage and transportation. These safety challenges, combined with the availability of cheaper fossil fuels, led to a period of stagnation in hydrogen development.

As the country embarks on this journey, it must prioritize safety, innovation, and inclusivity, ensuring that the benefits of hydrogen are realized for all its people.

Moreover, environmental concerns also posed a significant challenge. The majority of hydrogen is currently produced from fossil fuels, resulting in substantial carbon dioxide emissions. Although green hydrogen, produced using renewable energy sources, offers a cleaner alternative, its development has been hampered by high costs, technical barriers, and the lack of necessary infrastructure and regulatory support.

The Global Shift Towards Hydrogen

In recent years, there has been a resurgence of interest in hydrogen, driven by advancements in technology, decreasing costs of renewable energy, and growing concerns about climate change. The development of electrolysis technology, which uses electricity from renewable sources to split water into hydrogen and oxygen, has made green hydrogen a more viable option. Governments and industries are now investing heavily in hydrogen research, development, and deployment, recognizing its potential to decarbonize sectors that are difficult to electrify.

Governments worldwide are implementing policies to advance hydrogen production, infrastructure, and market development. Countries like Japan, Germany, and South Korea are leading the way in developing hydrogen strategies and roadmaps. These efforts are supported by international collaborations, such as the International Energy Agency (IEA), Hydrogen Council, International Renewable Energy Agency (IRENA), International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), among others, which bring together governments and industries to promote hydrogen as a key element of the global energy transition.

Public-private partnerships and technological innovation are also fueling the hydrogen revolution. These are essential for scaling up hydrogen production, reducing costs, and creating sustainable markets. Advances in electrolysis, fuel cells, and hydrogen storage are enabling more efficient and cost-effective hydrogen production and utilization. As these technologies continue to mature, the cost of green hydrogen is expected to decline, making it competitive with fossil fuels and other renewable energy sources.

Regulatory Frameworks Across Different Countries

Globally, countries have instituted diverse regulatory bodies and institutional frameworks to govern the development and integration of hydrogen within their energy systems. These entities are pivotal in ensuring the safe production, storage, transportation,

and utilization of hydrogen. Below is an overview of these regulatory bodies:

Australia

Australia's hydrogen regulatory framework is led by the Australian Renewable Energy Agency (ARENA), which ensures that the private sector has access to the tools, technology, and business models necessary to deliver secure and reliable renewable energy. ARENA also researches to inform policy decisions and fosters collaboration across the energy sector, government, startups, and universities. The Clean Energy Finance Corporation, established by the Clean Energy Finance Corporation Act, provides financial support to advance the hydrogen sector. Additionally, the Clean Energy Regulator, established by the Clean Energy Regulator Act 2011, administers the Australian Government's carbon abatement schemes, including the Guarantee of Origin, which tracks and verifies emissions associated with hydrogen production.

Egypt

Egypt's National Council for Green Hydrogen, chaired by the Prime Minister and comprising various key ministers and officials, coordinates the country's hydrogen strategy. The Council aims to unify state efforts to stimulate investment in green hydrogen, aligning with sustainable development goals and enhancing Egypt's international competitiveness. The Council is responsible for implementing and updating the national strategy, approving necessary policies, and ensuring coordination among relevant ministries and authorities.

India

India's hydrogen regulatory framework is managed by the Ministry of New and Renewable Energy (MNRE), which oversees the coordination and implementation of the Green Hydrogen Mission. The MNRE collaborates with other concerned ministries, departments, agencies, and institutions to execute India's hydrogen strategy, ensuring comprehensive regulatory oversight.

Japan

Japan's regulatory framework for hydrogen is overseen by the Ministry of Economy, Trade and Industry (METI) and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). These ministries are responsible for developing policies to promote the supply and use of low-carbon hydrogen under the Hydrogen Society Promotion Act. Approved business plans can receive subsidies and regulatory exemptions. Several other bodies, such as the Industrial and Product Safety Policy Group and the Japan Organization for Metals and Energy Security, also play roles in administering safety regulations, environmental protection, and infrastructure development through various laws and subsidy programs.

In recent years, the global drive to limit greenhouse gas emissions and reduce dependence on fossil fuels has significantly accelerated the growth of renewable energy.

South Korea

In South Korea, the Ministry of Energy is responsible for issuing licenses and registrations for hydrogen-specialized businesses under the Hydrogen Act and instructing facility owners to develop hydrogen fuel supply facilities. The Hydrogen Economy Committee, comprising the Ministry of Energy and seven other government bodies, spearheads the coordination and implementation of the country's hydrogen strategy. Chaired by the Prime Minister, the Committee oversees and deliberates on key policies and plans for advancing the hydrogen economy. The Korea Testing Certification Institute and the Korea Testing & Research Institute, designated by the Ministry of Trade, Industry, and Energy, are responsible for certification testing and evaluation under the Clean Hydrogen Certification procedure.

United Kingdom

In the UK, the Hydrogen Delivery Council, co-chaired by a Department for Energy Security and Net Zero Minister and an industry representative, leads the regulatory efforts. The Council serves as the primary forum for collaboration between the government and the hydrogen sector, promoting the deployment of low-carbon hydrogen across the UK energy system. The Office of Gas and Electricity Markets (OGEM) regulates the gas network, including hydrogen, under the Gas Act 1986. The UK Vehicle Certification Agency approves hydrogen transport vehicles, while the Oil and Gas Authority regulates new pipelines and decommissioning activities.

United States

In the United States, the Hydrogen and Fuel Cell Technologies Office, under the Department of Energy, leads efforts to advance hydrogen and fuel cell

technologies. The Federal Energy Regulatory Commission (FERC) may regulate the transportation of hydrogen if blended with natural gas, though an Act of Congress is required to define FERC's scope. The Pipeline and Hazardous Materials Safety Administration oversees the regulation of hydrogen transportation, ensuring compliance with safety standards.

Comparative Analysis

A study of the hydrogen regulatory bodies reveals that their primary functions include setting safety standards, developing and enforcing regulations, facilitating research and development, and promoting market development. These institutions also develop policies and frameworks to support the growth of the hydrogen economy, including setting targets for hydrogen production, offering financial incentives for hydrogen projects, and creating regulatory pathways that integrate hydrogen into existing energy systems by removing regulatory barriers. Additionally, they play a crucial role in fostering innovation by funding research and pilot projects that advance hydrogen technologies and applications.

On the other hand, a comparative analysis of regulatory approaches reveals that while there is no one-size-fits-all model, several best practices can be identified. For instance, in Australia, the focus is on integrating the private sector into the energy transition through collaboration and knowledge-sharing facilitated by the Australian Renewable Energy Agency alongside rigorous regulatory frameworks enforced by bodies like the Clean Energy Regulator. Japan's strategy is notable for its detailed regulatory exemptions and subsidy systems under the Hydrogen Society Promotion Act, showcasing a multi-agency collaboration to address sector-specific challenges. In contrast, the USA adopts a technology-driven approach focused on research and development, with an evolving regulatory landscape that could expand to include broader hydrogen governance.

These varied approaches demonstrate that effective hydrogen regulation requires a combination of strong leadership, clear policy frameworks, and collaboration between government, industry, and academia. As Nepal considers establishing its hydrogen regulatory framework, it can draw on these lessons to create a model that aligns with its unique context and priorities.

Proposal for Nepal: Establishing Nepal Green Hydrogen Development Commission

Justification for a Regulatory Framework: Aligning with Global Trends

Nepal's energy landscape is at a crucial turning point. As the world moves towards CE and net-zero carbon emissions, Nepal and the South Asian region remain heavily dependent on fossil fuels, necessitating a strategic shift towards sustainability. Green hydrogen, an emerging key element in global energy transition strategies, offers Nepal a unique opportunity to align with global sustainability efforts. With its abundant CE resources, strategic position for power system stability, and ample water availability, Nepal is well-positioned to become a leader in green hydrogen production. Establishing a dedicated regulatory framework by drawing inspiration from the global practices for green hydrogen is essential to unlocking its potential as a CE source and positioning Nepal as a regional leader in CE innovation.

India's hydrogen regulatory framework is managed by the Ministry of New and Renewable Energy (MNRE), which oversees the coordination and implementation of the Green Hydrogen Mission.

A regulatory framework would provide the necessary guidelines for the safe and efficient production, storage, and utilization of green hydrogen. It would also create an enabling environment for investment in hydrogen infrastructure and technology, fostering economic diversification through hydrogen-derived products in the global market.

Institutional Structure

The proposed Nepal Green Hydrogen Development Commission (the "Commission") will serve as the central regulatory body for green hydrogen in Nepal. Established by the Green Hydrogen Policy 2024, the Commission is envisioned as an intermediate institution that will operate until a permanent entity is institutionalized by the relevant statute. The Commission will be responsible for developing and implementing strategies exclusively dedicated to green hydrogen, recognizing its potential to become a mainstream energy solution shortly.

The Commission will work closely with other government agencies, industry stakeholders, and international partners to promote research, innovation, and investment in green hydrogen technologies.

Objectives:

- Policy Frameworks and Regulations: The Commission

will develop and implement policies, strategies, and regulations necessary to introduce green hydrogen as a key energy carrier and industrial commodity in Nepal. This includes establishing frameworks for subsidies, taxation, and project development.

- **Market Development and Investment:** The Commission will build a foundation for national and international commercial opportunities in green hydrogen, attracting investments in infrastructure and business development. The goal is to develop a domestic hydrogen supply chain that can eventually integrate into the global market.
- **Research, Innovation, and Safety:** The Commission will promote research and development, set safety standards, and ensure compliance with policies and regulations. It will involve continuous monitoring of green hydrogen projects and fostering innovation through pilot projects and international collaborations.

Strategic Action Plan:

The Commission will implement its mission through a phased approach:

- Phase I (2081-2082): Establish regulatory frameworks, policies, and institutional setups, benchmarking against global standards.
- Phase II (2082-2087): Focus on licensing innovative green hydrogen projects and pilot projects to encourage technological advancements.

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- Phase III (2087-2091): Expand Nepal's global presence in the green hydrogen market, facilitating large-scale commercial projects and attracting foreign direct investments.

Governance and Structure

The Commission will include members appointed by the Government of Nepal, including experts in economics, commerce, management, law, and engineering. This structure ensures that the Commission is equipped with the necessary expertise to guide Nepal's green hydrogen sector.

Resource Generation and Sustainability

The Commission will prioritize minimizing the financial burden on the government by relying on grants from domestic and international sources. It will also seek public-private partnerships and corporate sponsorships to share costs and risks.

Exit Strategy

The Commission is designed to operate for up to 10 years. After this period, it is expected to be succeeded by a permanent national entity, with all developed infrastructure and ongoing activities transferred to government ownership.

Conclusion

The shift to CE is a global imperative, driven by the urgent need to mitigate climate change. Hydrogen, with its potential to decarbonize multiple sectors, plays a crucial role in this transition. However, the successful application of hydrogen requires robust regulatory frameworks, supported by strong institutions, clear policies, and international cooperation.

For Nepal, the establishment of the Nepal Green Hydrogen Development Commission offers a unique opportunity to align with global trends, leverage its renewable energy resources, and build a sustainable and resilient energy future. By drawing on best practices from around the world, Nepal can create a regulatory framework that not only supports hydrogen development but also contributes to the global effort to combat climate change. As the country embarks on this journey, it must prioritize safety, innovation, and inclusivity, ensuring that the benefits of hydrogen are realized for all its people.

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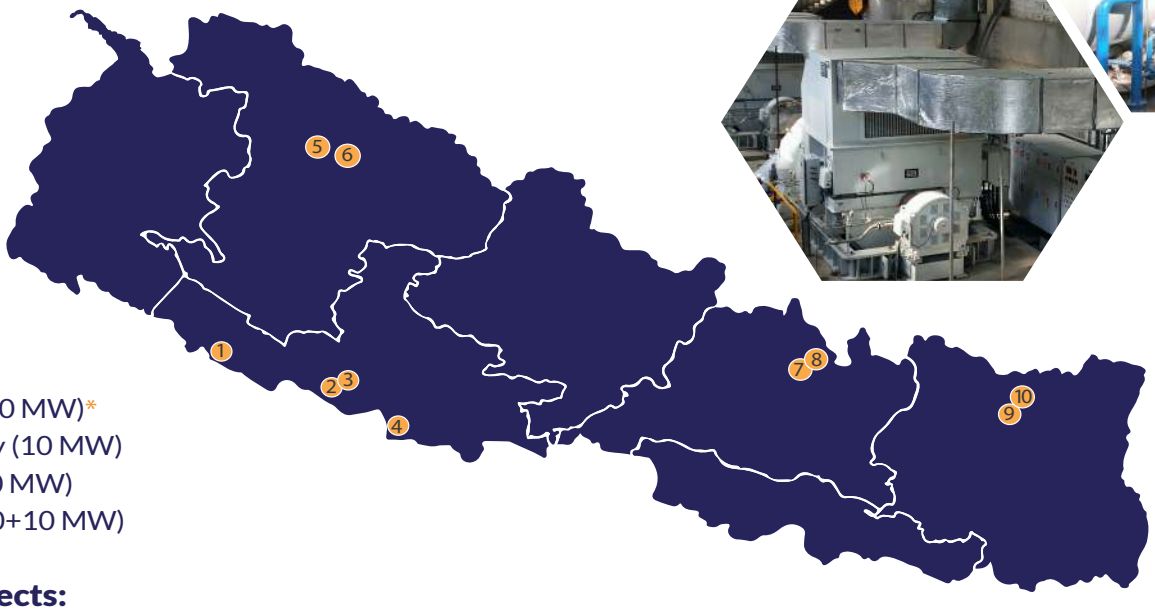
GOLYAN

TOWARDS A CLEAN & GREEN FUTURE



Solar Projects:

1 Pure Energy (10+10 MW)*
2 Progressive Energy (10 MW)
3 Pioneer Energy (10 MW)
4 Positive Energy (10+10 MW)

Hydropower Projects:

5 Upper Mugu Karnali Hydropower Project (306 MW)
6 Namlan Khola Hydropower Project (135 MW)
7 Upper Balephi A Hydropower Project (36 MW)*
8 Upper Balephi Hydropower Project (46 MW)
9 Lower Apsuwa Hydropower Project (54 MW)
10 Isuwa Khola Hydropower Project (97.2 MW)

Harnessing Hydro & Solar Power for Sustainable Development of Nepal.

Note: The above projects are in different phases of construction with more projects in the pipeline.
* These projects are under operation.

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Expanding Solar Energy

While Preserving Nepal's Agriculture

Dinesh Dulal

Given the fragmented nature of land ownership in Nepal, this land will likely need to be bought or leased from numerous landowners, displacing them from their primary agricultural activities and threatening their livelihoods.

Nepal is primarily an agricultural country, with agricultural land making up approximately 28 percent of its total area. Of this, around 53 percent, or 2.2 million hectares (roughly 15 percent of the country's total land), is classified as arable, while the remaining is used for permanent meadows or pastures. Agriculture remains as the backbone of the Nepalese economy, providing livelihoods for about 62 percent of the population and contributing around one-fourth of the nation's gross domestic product (GDP).

However, the area of arable land has been steadily declining, with a loss of about 300,000 hectares in the past decade. According to the Seventh National Agriculture Census of 2021, the country cultivates 2.2 million hectares of land, a decrease from the 2.5 million hectares recorded in the 2011 census. Expanding urbanization along with pinning up houses on the land that was once used for cultivation have been seen as major causes for the declining size of arable land. Despite this reduction, agriculture continues to support a large portion of the population, highlighting the challenge to feed the nation with shrinking land resources.

Meanwhile, solar power has become a global leader in cost-competitive energy generation due to significant reductions in its cost over the past decade. Utility-scale solar power is now more affordable than many newly established conventional power generation sources. This trend is reflected in recent development in Nepal's solar energy sector. The Nepal Electricity Authority (NEA) initially planned to award contracts for 800 MW grid-connected solar power projects but allocated 960 MW across 63 projects due to overwhelming interest. The NEA received proposal for 3,600 MW, far exceeding its call for 800 MW. The bidding process followed a reverse auction model, with a benchmark power purchase agreement (PPA) rate of Rs 5.94 per kilowatt-hour. Ultimately, NEA awarded contracts for 960 MW at competitive PPA rates ranging from NPR 4.99 to 5.54 per kilowatt-hour. The power generated from these solar projects will be sold to the NEA under a 25-year PPA, with successful bidders responsible for supplying the energy.

These solar projects will require approximately 2,000 hectares of land, while the large section of these is cultivable in nature. Given the fragmented nature of land ownership in Nepal, this land will likely need to be bought or leased from numerous landowners, displacing them from their primary agricultural activities and threatening their livelihoods. In absence of provisions to integrate agricultural activities under the solar panels, it could result in the loss of another 2,000 hectares out of already limited size of arable land. This presents a significant challenge in a country where food security is more critical than energy security. Solar projects on arable land could also negatively influence land sustainability, affecting soil stability, water retention, carbon sequestration, and biodiversity. Additionally, the competition for land use between food production

and energy generation could create a conflict of interest.

Given these challenges in place, why not combine agriculture with solar energy production on the same land? The concept of agrivoltaics—using land for both agricultural production and solar power generation—has been discussed for decades, however it has gained momentum for large-scale projects only in recent years. A few solar energy project developers in the country have already piloted agricultural initiatives such as goat farming, turmeric, and ginger cultivation, while others are planning to explore medicinal herb farming. These efforts show how agricultural components can be integrated into solar farms. However, a thorough study is needed to assess the agricultural potential of solar farms, along with a financial evaluation of these agricultural activities. Additionally, an incentive mechanism should be developed to promote agrivoltaics in the country. Without proper policy guidance and economic incentives, the voluntary adoption of agriculture in solar farms may yield disappointing results, ultimately failing to maximize the land's potential fully.

Nepal needs more renewable energy, while solar energy serves as one of the key parts of the solution. However, this should not come at the expense of the country's agricultural potential. Therefore, the NEA and project developers should prioritize integrating agriculture with solar energy development to ensure land use supports both food and energy security.

If the project developers begin developing solar power projects sustainably, it will pave the way for the future expansion this type of renewable energy in the country. If we don't stick to this approach, we will eventually need to restrict the use of arable land for solar energy projects citing the scarcity of land. This would limit the country's potential for low-cost renewable energy generation and hinder the achievement of energy security through a balanced energy mix. Recent innovations in energy storage systems have further enhanced the potential for integrating solar energy with battery energy storage systems (BESS), opening up significant future opportunities for solar energy generation.

In addition to large-scale solar projects, rooftop solar systems are gaining increasing importance within the solar energy spectrum, as they can be installed on existing rooftops, eliminating the need for land to build solar energy projects. Recently, there has been significant traction in promoting rooftop solar energy, especially among commercial and industrial customers, as these systems help reduce electricity costs. Banks and financial institutions are financing rooftop solar systems through both capital expenditure finance models and renewable energy service company models. Moreover, government agencies and development partners have been supporting rooftop solar promotion by offering risk-sharing facilities, generation-based subsidies, and interest buy-down options. The NEA should place equal emphasis on harnessing rooftop solar potential by providing the necessary support to customers and addressing bottlenecks. If rooftop solar promotion is planned more aggressively and systematically, it can significantly increase the adoption of renewable energy at a competitive cost, without requiring arable land for solar farms or additional transmission infrastructure.

Sustainable and systematic planning for solar energy will also facilitate energy storage in our peaking run-of-river projects during the daytime, allowing for the full utilization of their potential in managing peak energy demand. Additionally, this approach could generate higher tariffs by exporting energy to neighboring countries during peak hours when there is excess generation. On the other hand, an unsystematic and ad-hoc approach could undermine the solar energy potential in the country. Therefore, it is crucial to adopt a smart and well-coordinated approach among all stakeholders when developing the upcoming 960 MW solar projects recently awarded by the NEA and aggressively promoting the rooftop solar energy project in the country.

Conclusion:

Nepal faces the challenge of expanding solar energy without compromising its agricultural land, which is vital for food security and the overall economy. Utility-scale solar projects require significant land, often arable, risking the displacement of agriculture and livelihoods. To address this, integrating agriculture with solar energy—through agrivoltaics—offers a sustainable solution. This approach allows land to serve dual purposes, maximizing its potential without sacrificing food production.

Rooftop solar systems also provide a promising alternative, utilizing existing structures and avoiding the need for arable land. By promoting rooftop solar through financial incentives and policy support, Nepal can increase renewable energy adoption while preserving agricultural resources.

In conclusion, careful planning, coordination, and the integration of agriculture and energy production are essential for Nepal's solar energy expansion. A balanced approach will ensure both energy and food security, supporting the country's sustainable development, ensuring *Happy Nepali and Prosperous Nepal.*

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Nepal-Bangladesh Power Trade: Opportunities and Challenges

Dr. Ramhari Poudyal

In keeping with this global trend, Bangladesh and Nepal have recently made significant strides in their power trade through India, creating opportunities for both economic integration and energy security.

Guru Prasad Neupane

Introduction

The idea of cross-border energy trade is not new; the recent advancements in the power exchange between Bangladesh and Nepal demonstrate this. There are notable examples of this technique all across the world. In the European energy market, for instance, where countries like France, Germany, and Switzerland exchange power through interconnected networks to maximise extra energy, cross-border electricity trading has long been successful. European countries trade cross-border electricity most extensively – imports accounted for 9.1% of total electricity supplied in 2018, compared to 4.5% in Africa, 2.2% in the Middle East, 1.9% in the Americas and 0.6% in Asia.

Similarly, Canada's hydropower may make a substantial contribution to the United States' energy balance thanks to the robust power trade agreements that exist between the two countries in North America. According to the IEA report Global, cross-border electricity trade, measured by gross imports in each country, was 728 TWh in 2018 or about 2.8% of total electricity supply, an increase from 588 TWh in 2010 (24%, or 2.7% per annum).

Utilising contemporary clean energy sources is crucial in countries with expanding populations and rising energy demand in order to lower harmful emissions from the power sector and achieve a low-carbon economy. Many nations still have difficulties adopting renewable technology, despite the fact that its costs are rapidly declining. How can nations with limited access to renewable energy sources, for instance, aspire to power themselves sustainably? How can the sporadic nature of solar and wind energy be addressed?

In keeping with this global trend, Bangladesh and Nepal have recently made significant strides in their power trade through India, creating opportunities for both economic integration and energy security. Building on this momentum, Nepal has the potential to emulate the shared resources and cooperative spirit that have enabled Europe and North America to become significant energy exporters in South Asia and a key contributor to the energy stability of the region.

In recent years, there has been a notable increase in the trade of electricity between South Asian countries, with collaboration between Bangladesh, India, and Nepal receiving particular attention. Nepal has been steadily increasing the amount of hydropower it can produce, with the lofty target of 28,500 MW by 2035. 10,000 MW of energy would be exported to India, 5,000 MW will go to Bangladesh, and 15,000 MW will be used locally. The prospects and difficulties of selling electricity between Bangladesh and Nepal are examined in this article, which also suggests ways to enhance transmission lines

and promotes the use of Public-Private Partnership (PPP) models for generation, transmission, and trading.

Despite having a wealth of clean, renewable energy resources, South Asia and Southern Africa are examples of locations where many nations (including Bangladesh, India, and South Africa) nevertheless rely heavily on indigenous resources like coal or natural gas to provide the majority of their electricity. As the world works to reach climate objectives, this reliance on fossil fuels runs the danger of locking in to technology that will probably become outdated. These areas need long-term, competitive renewable energy supply for strong economic growth.

Electricity Trading in Nepal and India

Nepal's hydroelectric resources and geopolitical alliances with its neighbours, particularly India, are strongly linked to the country's history of energy trade. India is a transit and trading partner for power exports, and bilateral agreements have governed cross-border electrical commerce with India. Nevertheless, Nepal has not yet completely tapped into its potential to increase trade in power with Bangladesh.

The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), which aims to improve energy cooperation among member states, including Bangladesh, India, and Nepal, is one of the leading frameworks for regional power cooperation. Furthermore, regional energy commerce in South Asia is facilitated via the South Asia Regional Initiative for Energy Integration (SARI/EI). Both paradigms encourage the development and integration of sustainable energy.

Revamping Transmission for Nepal-Bangladesh Power Trade

The present 650-kilometer, needlessly lengthy, and inefficient energy transmission line connects Bangladesh and Nepal via India's Muzaffarpur to Bangladesh Bheramera. The transmission and distribution losses along this route are larger, which lowers the total efficiency of the power commerce between the two nations. The excessively complicated path that electricity follows through this transmission line is jokingly described by the expression "Kashi Jane Kutiko Bato."

Proposed Electricity trading route India's Muzaffarpur to the Bangladeshi border of Bhramara

Transmission Losses

In order to enable the required electricity billing and monitor the power flow, an electric meter has been placed in Muzaffarpur, India. The two nations will split the transmission losses. While Bangladesh will cover the damages beyond Muzaffarpur to the Bangladeshi border of Bhramara, Nepal would cover the losses up to Muzaffarpur. Since the route is quite long and the loss will be greater for this cross-border commerce, an alternate route that uses the shortest path from Jhapa, Eastern Nepal, to Fulbari should be taken into consideration going forward in order to reduce those enormous losses as mentioned in the figures.

To explain the transmission losses for the proposed Nepal-Bangladesh electricity trading route, let's break down the key factors involved:

Proposed Transmission Route: Nepal via India's Muzaffarpur to Bangladesh Bheramera

Transmission Line Length: 650 KM

The proposed route from Jhapa district in Eastern Nepal to Phulbari in Bangladesh is approximately 65 km.

Transmission losses occur due to the resistance in the electrical conductors, which causes energy to be dissipated as heat. These losses are typically expressed as a percentage of the total transmitted power.

For high-voltage transmission lines, losses can range from 2% to 6% depending on the distance, quality of the infrastructure, and the voltage level.

Efficiency Improvement:

The current route via Muzaffarpur (India) to Bheramara (Bangladesh) is about 650 km long, with higher transmission losses estimated at around 6%.

The proposed route significantly reduces these losses by shortening the transmission distance to 65 km. Assuming a similar infrastructure quality, the losses could be reduced to approximately 2-3%.

Calculation Example

Current Route: 650 km with 6% loss

If 40 MW is transmitted, the loss would be 2.4 MW, leaving 37.6 MW delivered.

Proposed Route: 65 km with 2-3% loss

If 40 MW is transmitted, the loss would be 0.8 MW, leaving 39.2 MW delivered.

Benefits of Reduced Transmission Losses

Increased Efficiency:

Reducing transmission losses means more of the generated power reaches the end users, improving overall efficiency.

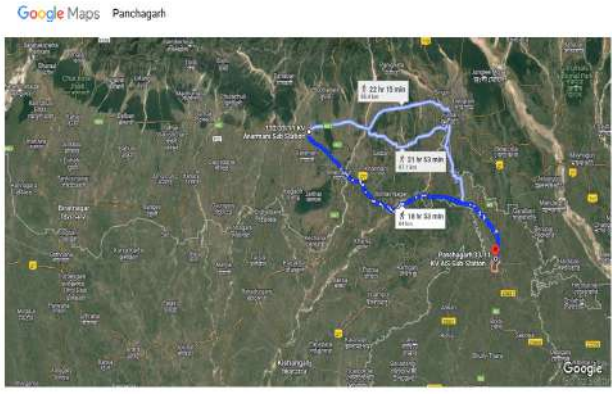
Cost Savings:

Lower losses translate to cost savings for both the producer and the consumer, as less energy is wasted.

Environmental Impact:

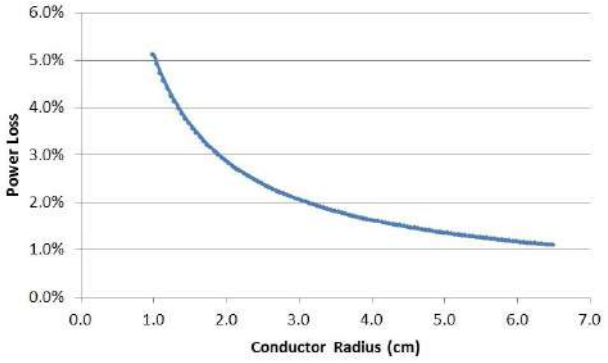
Improved efficiency reduces the need for additional power generation, which can lower the environmental impact associated with energy production.

By optimizing the transmission route, Nepal and Bangladesh can enhance the efficiency and profitability of their electricity trade, making it a more viable and sustainable option for both countries.



Aarmani, Nepal Substation to Panchgarh, Bangladesh

Establishing a transmission link from Jhapa district (Anaarmani) in Eastern Nepal to Phulbari 25, Bangladesh's closest border, will be a more effective and quicker route. With a transmission line length of around 65 km in Panchagarh, Bangladesh, this alternative is more practical than the Muzaffarpur line. Nepal and Bangladesh might increase efficiency and profitability by reducing transmission losses by rerouting the transmission line through Jhapa-Birtamode-Phulbari.



Public-Private Partnership (PPP) Model for Electricity Trading

Government-to-government (G2G) models now control the bulk of the power trade within the area. On the other hand, switching to a Public-Private Partnership (PPP) model may encourage innovation and draw in additional capital for the electrical industry. A PPP strategy promotes more involvement from foreign businesses and investors by allowing the public and private sectors to share risk and accountability.

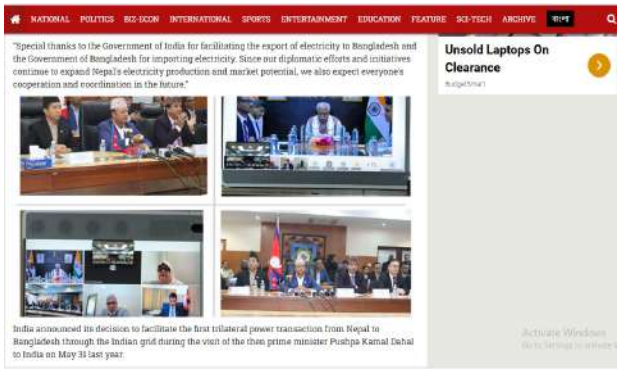
The Adani Group of India has already set a precedent by exporting 1,000 MW of coal-generated energy to Bangladesh through the Muzaffarpur transmission line. With an extra 40 MW of transmission capacity available, Nepal may use this infrastructure and begin exporting power to Bangladesh via this current route.

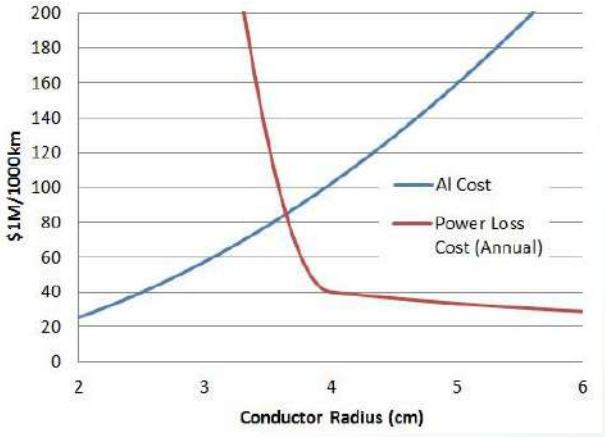
Regional Cooperation: A Future Vision

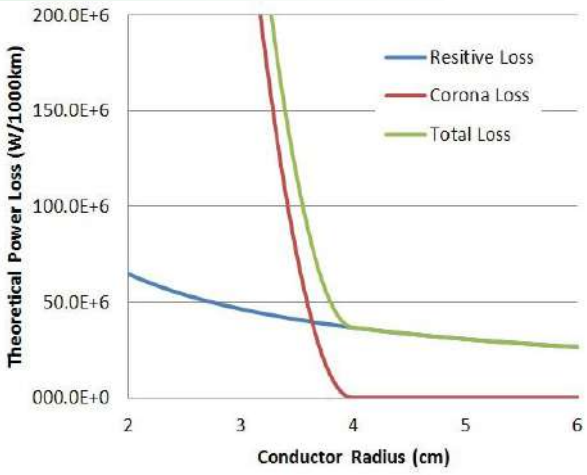
Regional integration has to be the main goal of Nepal's power trading strategy. Although trilateral and bilateral agreements are good, Nepal would have much more potential to export power if it had more regional access to electricity markets, particularly China and Tibet. The SARI Initiative, BIMSTEC, and SAARC frameworks all encourage regional collaboration, which has to be prioritised to make South Asia's energy market more robust and interconnected.

Depending on the available transmission infrastructure, a substantial reduction in demand in one nation might have an impact on the whole market and, therefore, lower market prices.

Moreover, due to Nepal's increasing hydropower-producing capability, it is imperative to investigate energy trading agreements with surrounding nations outside India and Bangladesh. By forging strong regional ties, Nepal can become a significant exporter of power and support sustainable development and economic progress.







Here are some examples of cross-border energy trade, presented in a tabular format with referencing:

Example	Description
Europe	European countries like France, Germany, and Switzerland exchange power through interconnected networks to maximize extra energy.
North America	Canada's hydropower significantly contributes to the United States' energy balance through robust power trade agreements.
South Asia	Bangladesh and Nepal have made significant strides in power trade through India, enhancing economic integration and energy security.
Africa	Cross-border electricity trade in Africa is facilitated by regional power pools like the Southern African Power Pool (SAPP).
Asia	Japan and South Korea engage in cross-border energy trade to balance supply and demand, particularly during peak seasons.

These examples illustrate the diverse approaches and benefits of cross-border energy trade across different regions.

Conclusion

Nepal has a great deal of potential for energy commerce with Bangladesh; nevertheless, in order to maximise the efficiency of this trade, it is imperative that transmission routes be reevaluated and transmission losses be precisely computed, as indicated by the statistics above. Investigating Public-Private Partnership (PPP) options is also necessary to open up fresh investment prospects. Nepal can greatly increase its capacity for power export and support regional energy security by taking a regional strategy and making use of hubs like BIMSTEC and SARI. Shorter lines, like the Jhapa-Birtamode-Phulbari corridor, can reduce transmission losses and provide more economical and efficient commerce.

The PPP model has the potential to stimulate innovation and attract investments so that Nepal can properly utilise its rich hydropower resources. The energy minister of Nepal has also highlighted efforts to investigate the possibility of trading power with China. If this plan is implemented, Nepal's network of cross-border power traders will grow even further, improving regional energy security and establishing Nepal as a major participant in South Asia's energy sector.

Mr. Neupane is a renowned energy entrepreneur in Nepal & Mr. Paudyal is a PhD at Swansea University in the UK on how to sustainably manage Nepal's energy development.

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Managing Transboundary Dams: Safety, Hydro-Diplomacy, and Sustainable Cooperation

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However, dams built on transboundary river basins - where water resources are shared by two or more countries - pose distinct engineering, political, and socio-economic challenges.

Abstract

Freshwater resources are crucial for human well-being, economic development, and ecological balance. In an era of intensifying climate pressures and growing demands for clean energy, dams have become essential in water resource management. However, dams built on transboundary river basins - where water resources are shared by two or more countries - pose distinct engineering, political, and socio-economic challenges. Climate change, population growth, aging infrastructure, and environmental pollution magnify these challenges, raising the risk of conflict. Over 126 shared river basins currently contain dams with cascading failure potential, urgently highlighting the need for enhanced transboundary cooperation.

This paper explores the complex nature of conflicts over shared water infrastructure, offering historical perspectives, a seven-level taxonomy of water-related disputes, and emerging threats such as the impact of climate change and environmental concerns. It demonstrates how risk assessment methodologies, contemporary dam safety frameworks, and hydro-diplomacy can foster collaboration and mitigate tensions. Through case studies spanning North America, the Himalayan region (Nepal-India), Spain-Portugal, and the Eastern Nile Basin, this study underscores both the risks of unilateral governance and the benefits of coordinated approaches. Concluding with best-practice recommendations, the paper emphasizes integrating dam safety, emergency management, and hydro-diplomacy protocols into existing and future transboundary treaties. This strategy helps nations enhance security, protect lives, and preserve vital ecosystems while leveraging the power of hydro-diplomacy for mutual stability and resilience.

Keywords: Hydro-Diplomacy, Dam Safety Management, Transboundary Dams, Water Governance, Climate Change Adaptation, Risk Assessment, Conflict Resolution

1. Introduction

Freshwater resources underpin agriculture, energy production, and industry worldwide (Schilling et al., 2020). Dams serve critical functions—regulating water supply, generating hydropower, controlling floods, and supporting ecosystems. However, governance becomes substantially more complex when these dams lie on

transboundary river basins shared by multiple nations. McCracken and Wolf (2019) note at least 2,924 large dams in 40% of the world's 310 transboundary basins, with 1,416 more under construction or planned in 57 shared basins, collectively affecting over 3 billion people in 151 countries (Acharya et al., 2024).

Despite the existence of more than 800 treaties, agreements, and memoranda of understanding (MoUs), most lack modern considerations - such as the protection of indigenous rights, integrated approaches to dam safety and emergency management, mechanisms for environmental protection, the flexibility needed to address climate change, risk-informed dam safety decision-making, and effective processes for conflict resolution. In these circumstances, inadequately planned dam construction and operation can intensify geopolitical tensions, particularly as climate change alters hydrological cycles and amplifies extreme events (Farinosi et al., 2018; Schilling et al., 2020). Furthermore, outdated or insufficient water governance frameworks frequently lag behind fast-evolving challenges, rendering downstream and upstream communities susceptible to unintended consequences.

Key Stressors on Transboundary Dams

1. **Potential Impacts of Climate Variability** Changing precipitation patterns exacerbate droughts and floods, challenging traditional stationary design assumptions (Cooley & Gleick, 2011; Tian et al., 2020).
2. **Rapid Population Growth** Escalates needs for water, food, and energy, stoking competition among riparian states.
3. **Aging Infrastructure** Many older dams require costly upgrades to maintain structural integrity and reliable operations, a process complicated by inter-country cost-sharing negotiations (Marcus et al., 2020).
4. **Environmental Degradation & Sedimentation** Pollution and sediment accumulation reduce dam capacity and water quality, spurring disputes over who is responsible for mitigating these losses and restoring the original capacity and quality.
5. **Data Asymmetry & Transparency Gaps** Upstream states often have superior flow and storage data, while downstream states operate at a disadvantage, eroding trust and sparking conflict (Farinosi et al., 2018).
6. **Exclusion of Indigenous Rights and Environmental Protection in Existing Treaties** Many older agreements overlook the rights of local communities and the necessity to protect vital ecosystems.
7. **Poor Implementation of Transboundary Instruments** Even where treaties exist, inadequate enforcement mechanism leads to persistent tensions and undercut the potential for cooperation.

By illustrating how integrated dam safety management and hydro-diplomacy can address these stressors, this paper proposes a roadmap for policymakers, engineers, local communities, and international organizations to harmonize water resource management across borders. Drawing on historical analysis, engineering best practices, and legal frameworks, it outlines a comprehensive approach - from early dispute detection to institutionalized long-term collaboration - supported by a seven-level conflict taxonomy. A central premise is that technical solutions must be complemented by robust diplomatic and institutional capacity-building to ensure that transboundary dams evolve from potential conflict flashpoints into opportunities for regional cooperation.

2. Transboundary Issues: History and Modern Realities

2.1 Water as a Weapon and a Lifeline

Water's dual identity as both a life-sustaining resource and a strategic asset underpins numerous historical conflicts (Birkett, 2017). From the ancient poisoning of wells to the 2023 Nova Kakhovka Dam breach in Ukraine, water infrastructure remains vulnerable to geopolitical tensions (Acharya et al., 2023). Yet, shared rivers also often prompt diplomatic engagement, sometimes resulting in treaties that outlast larger political disputes (Wolf, 2009).

2.2 Transforming Tensions

While transboundary water disputes can be contentious, most do not escalate into overt violence (Wolf et al., 2003). Classic examples include:

- **Indus Waters Treaty (1960)**: Survived wars between India and Pakistan, effectively allocating water among the Indus tributaries.
- **Columbia River Treaty (1961)**: Marked a milestone in Canada-U.S. cooperation for flood control and hydropower generation.

However, these older pacts often need updating to address climate adaptation and Indigenous rights. The following section introduces a conceptual framework - spanning seven levels of conflict - to clarify how localized disagreements over dam operations can escalate if unaddressed.

3. Seven Levels of Transboundary Water Conflict

Conflicts evolve along a spectrum from mild tensions to full-

scale armed confrontations (Wolf, 2009). This taxonomy, often used in describing the level of transboundary conflicts, aids in recognizing early warnings and guiding de-escalation strategies:

1. **Disputes and Tensions (Level 1)**

- Minor, non-violent, localized disagreements about water use or access (e.g., downstream farmers protesting reduced irrigation flows due to an upstream hydropower project).

2. **Verbal Conflict (Level 2)**

- Escalation in rhetoric, public accusations, or inflammatory statements by politicians, media, or community leaders. (e.g., politicians publicly condemning upstream operators and threatening "reprisals" if reservoir releases are not adjusted).

3. **Legal and Institutional Conflicts (Level 3)**

- Formal legal complaints or arbitration and invocation of treaty mechanisms (e.g., Ethiopia, Sudan, and Egypt bringing their dispute over the Grand Ethiopian Renaissance Dam).

4. **Political and Economic Pressure (Level 4)**

- Imposition or threat of sanctions, trade restrictions, or use of diplomatic leverage to alter dam operations and water-sharing arrangements (e.g., a nation suspending a bilateral trade agreement unless upstream dam operations are modified or withholding development aid to force changes in reservoir management).

5. **Localized Violence (Level 5)**

- Physical sabotage or armed protests at dam sites around dam infrastructure, typically confined to the immediate area (e.g., local insurgent groups damaging gates or canals to protest perceived water inequities).

6. **Armed Conflict (Level 6)**

- Coordinated attacks by state militaries or insurgents targeting dams for tactical gains (Gleick, 2006) (e.g., armed forces seizing a major dam to induce downstream or upstream flooding or breaching dams to flood downstream territories as seen in Ukraine's Nova Kakhovka Dam breach, using dam destruction as a weapon of war).

7. **War Over Water (Level 7)**

- Full-scale interstate war, driven by acute water scarcity or strategic control. Historically rare, this remains a risk in severely water-stressed regions with fragile diplomacy (e.g., an upstream nation invading a downstream neighbor to secure key headwaters after negotiations collapse).

This framework underscores the importance of promptly addressing low-level disputes before they intensify. Early intervention helps prevent small tensions from spiraling into larger confrontations, underlining the value of robust dam safety management practices and reliable conflict-resolution mechanisms.

4. Dams in Transboundary River Basins

4.1 Defining Transboundary Dams

A dam is considered transboundary if its operation or potential failure affects communities in at least two sovereign states (McCracken & Wolf, 2019). These structures might be newly planned or decades-old dams needing modernization. They confront unique complexities, like shared operational protocols to existing multilateral treaties that may or may not address current hazards and modern dam safety practices. These complexities may range from different legal jurisdictions and divergent safety standards to questions of ownership and joint financing (Acharya et al., 2022).

4.2 Factors Amplifying Conflict

Following are the examples of some factors amplifying transboundary water-related conflicts:

- **Socio-Economic Inequalities**: Poverty and limited institutional capacity compound the fallout of water disputes, particularly in developing nations.
- **Lack of Data Sharing**: Upstream parties often hold exclusive access to hydrological data, fostering mistrust among downstream stakeholders (Farinosi et al., 2018).
- **Aging Infrastructure**: Many older dams require retrofits or expansions to meet modern standards, raising the question of cost-sharing responsibilities (Marcus et al., 2020).
- **Inadequate Legal Instruments**: Agreements fixated solely on water allocation overlook dam safety, emergency preparedness, Indigenous rights, and environmental considerations or climate adaptation strategies (Acharya et al., 2024).
- **Political Tensions**: Historical animosities can amplify disputes over new dam projects or reservoir operations (UNEP-DHI & UNEP, 2016).
- **Dam Ownership and Control**: One-sided control provisions - the Koshi Barrage Treaty, for instance, assigns control to India despite the barrage being on Nepalese territory (Acharya et al., 2022).

4.3 Potential for Cooperation

Not all transboundary dam operations spark conflict. Effective management frameworks such as the concept included in the friendship dams, and proper implementation of such framework can yield benefits for all parties:

- **Friendship Dams as Model of Cooperation**: Friendship dams are joint infrastructure projects between nations that symbolize international cooperation through shared water resource management. These projects provide hydroelectric

power, irrigation, flood control, and water supply while fostering diplomatic goodwill and sustainable development. They demonstrate how nations can collaborate to address common challenges and strengthen regional ties.

Projects like the Afghan-India Friendship Dam (Salma Dam) exemplify how shared infrastructure can transcend geopolitical tensions. The dam not only provides irrigation and hydroelectric power but also serves as a symbol of an enduring partnership, showcasing how equitable resource sharing can build trust and strengthen diplomatic ties.

- **Joint Hydropower Projects**: Sharing both electricity production and revenue, as seen in the **Doosti (Friendship) Dam** between Iran and Turkmenistan, highlights how collaboration can address shared energy and water needs while strengthening bilateral relations.
- **Coordinated Flood Control**: Joint emergency data sharing and resource pooling can mitigate flood risks, benefiting all parties.
- **Enhancing Regional Resilience**: Upgrading dams against climate shifts can stabilize broader water supply and agriculture.
- **Interrelated dam Safety and Emergency Management Plan**: Joint risk assessments and stakeholder engagement reduce the probability of conflict while helping to institutionalize best practices in dam safety (Acharya et al. 2023).

When water storage, flood control, and hydropower benefits are distributed equitably, Friendship Dams can significantly enhance bilateral relations and contribute to regional development. However, their success hinges on critical factors such as political stability, inclusive negotiations involving all stakeholders, and comprehensive planning that addresses technical, environmental, and social considerations. By meeting these conditions, transboundary dams can evolve from potential points of contention into powerful symbols of cooperation and catalysts for socio-economic growth and regional stability.

5. Evolution of Water Conflicts and Cooperation

5.1 Historical Lessons and Success Stories

Early conflicts, like the sabotage of canals in 18th- and 19th-century North America (Steinberg, 1990), spurred the creation of formal treaties and commissions. The 1909 Boundary Waters Treaty between Canada and the U.S. established the International Joint Commission (IJC), a pioneering model for equitable water use and conflict resolution (Wolf et al., 2003).

5.2 Barriers to Cooperative Behavior

Despite documented successes, many transboundary basins remain vulnerable to conflict due to many factors like

- **Mismatched Political Timelines:** Short electoral cycles can disrupt sustained dam planning and operations (Marcus et al., 2020).
- **Imbalanced Negotiating Power**: Dominant upstream nations or militarily stronger ones may impose unfavorable terms such as impose unilateral solutions, heightening hostilities on weaker downstream partners (De Stefano et al., 2017).
- **Colonial Legacies**: Older treaties shaped under colonial rule can entrench inequities and unresolved sovereignty issues (Wilder et al., 2020).
- **Outdated Legal Instruments**: Many treaties omit contemporary dam safety provisions, indigenous rights, or climate adaptation measures (Acharya et al., 2024).

5.3 Water Allocation and Conflict Potential

The link between water scarcity and conflict is often non-linear. Moderate scarcity can sometimes spur cooperation, while extremes in availability (very high or low water availability) can worsen disputes (Dinar et al., 2011). Schilling et al. (2020) emphasize the critical role governance failures and power asymmetries play in fomenting conflict - further justifying the need for a stable, flexible transboundary institutional mechanism.

6. Dam Safety Management in Transboundary Contexts

6.1 Importance of Dam Safety Measures

Traditionally, dam safety focuses on structural resilience such as spillway design for flood handling, and seismic resilience. Yet in transboundary settings, dam safety expands to encompass political and socio-economic dimensions, given potential cross-border impacts.

- **Aging Infrastructure & Design Deficiencies**: Many existing dams do not meet modern design flood or seismic criteria, particularly in developing regions.
- **Emergency Preparedness Plans (EPPs)**: Cross-border coordination is often lacking, leaving downstream communities unprepared for sudden failures or releases (Acharya et al., 2023).

6.2 Case Snapshots

1. **Nepal-India**

o **Context**: The two countries share multiple dams under several controversial treaties, most notably the Koshi and Gandak Agreements.

o **Issues**: These agreements are frequently criticized for

granting one-sided control and lacking adequate cross-border emergency planning.

- **Consequence**: India maintains primary authority over operational decisions, for example, the Koshi Barrage, leading to recurrent flooding in Nepal's Terai region and highlighting insufficient reservoir management as well as limited transboundary coordination (Acharya et al., 2022).

2. **North America (Canada-U.S.)**

- Treaties: Boundary Waters Treaty (1909), Columbia River Treaty (1961).
- Challenges: Modernizing agreements to include Indigenous rights and climate-change considerations (Acharya et al., 2024).

3. **Spain-Portugal**

- Joint initiatives around the Tagus and Douro Rivers include dam safety programs and data sharing.
- Impact: Reduced flood risk and stronger bilateral ties (Marcus et al., 2020).

6.3 The Need for Integrated Risk Assessment

Modern dam safety management practice demands integrating technical analyses - like Bayesian networks, fuzzy logic and multi-criteria decision-making - with geopolitical and socio-economic factors (Rai et al., 2014). For instance, high-level machine learning models can project climate-induced changes in river flow, estimate sediment buildup rates, and calculate risk probabilities, aiding in proactive policy decisions (Ghoreishi et al., 2022). State-of-the-art risk assessments integrate:

- **Engineering Parameters**: Design flood estimates, earthquake load cases and reservoir drawdown rates.
- **Environmental & Socio-Economic Factors**: Sediment management, water quality, local livelihoods.
- **Political Dimensions**: Treaty obligations, conflict histories, and power imbalances.

These multi-layered evaluations enable stakeholders to identify not only the probability of structural failures but also the potential for social and diplomatic fallout so that necessary proactive measures can be taken.

7. Hydro-Diplomacy as a Pathway to Resolution

Hydro-diplomacy applies diplomatic methods such as mediation, conflict resolution, and consensus-building to the realm of shared water resource management (Schmeier & Shubber, 2018). By combining negotiation strategies, conflict-resolution frameworks, and scientifically grounded water management, hydro-diplomacy seeks to convert potential "zero-sum" disputes into opportunities for cooperation, using international river basin organizations (IRBOs) as impartial forums. Its goal is to avert conflicts or defuse tensions by promoting a common understanding of hydrological realities (Milman & Gerlak, 2020). Increasingly, river basin organizations (RBOs) like the Mekong River Commission and the International Commission for the Protection of the Danube River are adopting this integrated approach. Key elements and practical aspects of hydro-diplomacy include:

1. **Adaptive Governance**: Focuses on flexibility, social learning, and evolving regulations that respond to changing climate and demographic conditions (Wilder et al., 2020).
2. **Science-Policy Interface**: Encourages transparent, evidence-based discussions that build trust and highlight shared risks and benefits (Cooley & Gleick, 2011).
3. **Institutional Capacity**: Depends on well-resourced River Basin Organizations (RBOs) capable of enforcing treaties and adapting to new challenges (De Stefano et al., 2017).
4. **Technical Data Exchange**: Involves sharing real-time reservoir levels, inflow forecasts, and sediment load data to improve overall decision-making (Acharya et al., 2024).
5. **Conflict Resolution Mechanisms**: Incorporates neutral arbitration or third-party facilitation in treaty frameworks, helping avoid stalemates and limit political interference (Espíndola & Ribeiro, 2020).
6. **Joint Emergency Exercises**: Entails conducting cross-border dam-break simulations and flood-response drills as confidence-building measures, enhancing cooperation among local officials and communities, and nurturing robust institutional ties for managing actual crises (Acharya et al., 2024).

These initiatives build trust, streamline crisis response, and reduce the probability of escalated conflicts.

8. Climate Change Implications for Transboundary Dams

8.1 Amplifying Existing Stresses

Rising temperatures, shifting precipitation patterns, accelerating glacial melt, and more frequent extreme events are placing considerable strain on transboundary dams, many of which were designed with mid-20th-century hydrological conditions in mind (Schilling et al., 2020). Infrastructure optimized for milder flood and drought cycles often proves inadequate in today's volatile climate context (Cooley & Gleick, 2011). Furthermore, population expansion and

heightened water demands amplify tensions in already delicate basins (Tian et al., 2020).

The Himalayan region, especially the Nepal-India river basins, offers a prime example, where older treaties do not address evolving climatic and hydrological realities (Acharya et al., 2023).

8.2 Adaptive Management Strategies

1. **Flexible Water Allocation Clauses**: Allow treaties to adjust outflow rules or share water surpluses and deficits in real time (Cooley & Gleick, 2011).
2. **Reservoir Reoperation**: Adapt hydropower-centric schedules to accommodate flood control, ecosystem needs, and irregular inflows (Bakker & Duncan, 2017).
3. **Climate-Resilient Infrastructure**: Retrofitting spillways, strengthening embankments, and installing advanced monitoring systems to handle intensifying flood peaks (Acharya et al., 2024).

8.3 Institutional Shortcomings and Need for Innovations

Most pre-21st-century treaties were drafted with limited awareness of climate volatility. This can intensify risks in shared basins as treaties fail to account for unpredictable water availability (Bakker & Duncan, 2017). Periodic revisions to treaty clauses, supported by real-time hydrological data and climate-risk assessments, are increasingly recognized as vital.

Transboundary river basins in the Himalayan region require innovative thinking to develop more flexible water allocation mechanisms that account for climate-related uncertainties such as fluctuating annual water availability and variable growing seasons. Rather than distributing fixed volumes or flow quotas, the allocation should be responsive to water availability.

Nepal, without any quid pro quo, has readily addressed this 'burning problem' through the Indo-Nepal 2022 Joint Vision on Power Sector Cooperation!

In a promising development, the World Bank and other international funding entities have begun tying financing to thorough climate-risk assessments, highlighting the need for adaptive, evidence-based treaties that can sustain cooperation across regions.

9. Risk Assessment Methods for Conflict and Dam Safety

9.1 Risk Assessment Methods

Approaches to evaluating transboundary conflict risks range from qualitative to semi-quantitative and quantitative methodologies:

1. **Qualitative**: Grounded in expert judgment, historical analogies, and political context to pinpoint potential "hotspots." Examples include examining basins at risk, which identifies conflict-prone regions based on scholarly insights (Wolf et al., 2003).
2. **Semi-Quantitative**: Merged socio-economic data, hydrological modeling, and historical interactions to create basin-specific "risk indices." It offers a systematic gauge of hydro-political risks (Bernauer & Böhmelt, 2014).
3. **Quantitative**: Employs machine learning, Bayesian networks, or fuzzy logic to simulate the intricate links among climate, demographics, and governance, offering scenario-based probabilities of conflict or dam failure (Rai et al., 2014; Ghoreishi et al., 2022).

9.2 Institutional Resilience and Reduced Hydro-Political Tension

Institutional resilience reflected in treaties with adaptive allocation and robust conflict-resolution provisions often correlates with reduced hydro-political tension (UNEP-DHI & UNEP, 2016; De Stefano et al., 2017). High-resilience institutions can reconfigure reservoir operations to meet emerging challenges, whereas low-resilience frameworks amplify mistrust.

9.3 Dam Safety Framework and Emergency Management

Dam safety is a public safety imperative, especially when failure can impact multiple jurisdictions. Global awareness of dam safety has grown, yet most transboundary treaties still overlook operational and structural risk management at transboundary projects (Acharya et al., 2022). Comprehensive guidelines should include:

- **Risk-Informed Decision-Making**: Balancing probability and consequences of various failure modes, including cascade failures and seismic events.
- **Cross-Border EPPs**: Mandating consistent protocols for evacuation, communication, and response coordination among different jurisdictions involving all relevant stakeholders.
- **Lifecycle Assessments**: Evaluating environmental and social impacts from dam construction to decommissioning, including

sediment management and potential reservoir-induced seismicity.

- **Cascade Failure Planning**: Accounting for scenarios where upstream dam breaches trigger failures downstream (Acharya et al., 2023).

10. Global Examples of Transboundary Cooperation

Below are some examples of transboundary cooperation:

10.1 Canada and the United States

- **Boundary Waters Treaty (1909)**: Created the IJC to address shared water governance. It is considered a long-standing mechanism for conflict resolution, equitable water sharing, and hydropower coordination (Wolf et al., 2003).
- **Columbia River Treaty (1961)**: Coordinates flood control and hydropower generation; modernization discussions now aim to integrate Indigenous rights, ecological flows, and climate change adaptation (Acharya et al., 2024).

10.2 Spain and Portugal (Albufeira Convention)

- **Shared Basins**: Tagus, Guadiana, Douro, Lima, Minho.
- **Cooperative Mechanisms**: Joint dam safety regulations, hydrometeorological data-sharing, and flood management committees (Marcus et al., 2020).
- **Outcome**: Greater trust and reduced flood impacts, demonstrating how regular treaty upgrades can foster enduring cooperation.

10.3 Eastern Nile and the Nile Basin Initiative

- **Key Players**: Egypt, Sudan, Ethiopia.
- **Focus**: Capacity building, integrated water resource management, and joint studies. It is expected to build a new era of cooperation in the Nile River basin.
- **Challenges**: Balancing national interests over large infrastructure (e.g., the Grand Ethiopian Renaissance Dam) while establishing basin-wide safety norms and collaboration frameworks.

11. Recommendations

11.1 Integrate Dam Safety Management in Transboundary Agreements

Existing treaties often prioritize water allocation while neglecting operational safety and emergency response measures. To bridge this gap and protect human lives and ecosystems, the following strategies should be implemented:

- **Mandatory Dam Safety Clauses**: Integrate comprehensive dam safety management provisions into water-sharing agreements and treaties. These clauses should cover emergency preparedness, risk management, modern design standards, reservoir drawdown protocols, flood-release rule curves, and robust risk management procedures (Acharya et al., 2024).

The Friendship Dam model serves as an excellent example, demonstrating how collaborative approaches can ensure resource equity and promote mutual development.

- **Comprehensive Public Engagement**: Recognize and incorporate the cultural and subsistence values tied to water resources by ensuring equitable distribution of benefits. This involves consulting and fairly compensating all relevant stakeholders, including local communities and Indigenous groups, throughout the planning and implementation processes (Acharya et al., 2024).

11.2 Adopt Risk-Based Regulatory Frameworks

Traditional prescriptive regulations may fail to account for changing hydrological and seismic conditions. To create more resilient frameworks:

- **Develop Societal Risk Tolerance:** Establish acceptable risk thresholds through transparent and participatory processes, ensuring that community values and safety standards are reflected.
- **Adopt Adaptive Protocols**: Implement regular reviews to update design parameters for floods, droughts, and earthquakes in response to climate change projections. Set clear thresholds that mandate additional protections, such as spillway expansions, when necessary (Marcus et al., 2020).

11.3 Enhance Data Sharing and Technical Collaboration

Improved data accessibility and collaborative technical efforts are essential for effective transboundary dam management:

- **Open Data Platforms**: Create jointly funded networks that provide all stakeholders with real-time data on water flows and reservoir levels, enhancing transparency and informed decision-making (Acharya et al., 2023).
- **Joint Modeling Efforts**: Develop basin-wide hydrological models that guide

reservoir operations, manage environmental flows, and assess hazards. These models help clarify the cumulative impacts of dam operations and potential cascading failures.

11.4 Strengthen Institutional Capacity and Hydro-Diplomatic Skills

Robust institutions and skilled professionals are critical for maintaining cooperation and effective dam management:

- **Financial Resources**: Ensure consistent funding and adequate staffing for River Basin Organizations (RBOs), including dedicated authorities for dam safety to maintain operational integrity and enforce regulations.
- **Training and Workshops**: Implement comprehensive training initiatives for engineers, diplomats, and community leaders, focusing on key areas such as negotiation, integrated flood management, and advanced risk assessment. Collaborative workshops centered around the **Friendship Dam** model can provide a practical framework for cooperation, equipping stakeholders with the skills needed to address complex transboundary water challenges effectively.

11.5 Recognize and Incorporate Local and Indigenous Knowledge

Integrating the insights and needs of local and Indigenous communities fosters inclusive and sustainable water management.

- **Stakeholder Inclusion**: Engage grassroots voices from the inception of projects through decommissioning. It ensures that the perspectives and needs of all affected parties are considered and addressed.
- **Knowledge Exchange**: Blend traditional ecological knowledge with modern risk assessment and reservoir management practices. This integration enhances the resilience and adaptability of water management strategies.
- **Benefit-Sharing Mechanisms**: Establish fair and transparent systems to distribute revenues generated from hydropower and irrigation projects to the affected communities. Equitable sharing of benefits not only enhances social and economic well-being but also fosters trust and goodwill among stakeholders. The **Friendship Dam** model serves as an excellent example, demonstrating how collaborative approaches can ensure resource equity and promote mutual development.

Recognize and incorporate the cultural and subsistence values tied to water resources by ensuring equitable distribution of benefits. This involves consulting and

12. Concluding Remarks

Water-related crises stand among the most critical challenges of the 21st century, driven by rapid population growth, environmental degradation, and the escalating impacts of climate change. At the center of these issues are transboundary dams, which hold the dual potential to either exacerbate geopolitical tensions or foster international collaboration, depending on their design, operation, management, and governance. These dams embody the complex intersection of technology, politics, and environmental stewardship. While they can ignite disputes that escalate across the seven-level conflict spectrum, they also can become pillars of regional stability and shared prosperity when managed with strategic foresight and cooperative governance.

Friendship Dams, in particular, highlight the transformative potential of shared infrastructure in transcending political divides and fostering regional stability. Projects such as the Afghan-India Friendship Dam and the Doosti Dam between Iran and Turkmenistan serve as tangible examples of how shared resource management can address pressing energy and water needs while building diplomatic goodwill and economic prosperity. However, these projects also underscore the importance of political stability, inclusive planning, and stakeholder engagement to ensure success.

Key Takeaways

- **Managing Transboundary Dam is Beyond Engineering**: Technical solutions must be paired with diplomatic engagement, equitable benefit-sharing, and robust emergency preparedness.
- **Interdependence is Inevitable**: Upstream and downstream fates are tied; disregarding these connections worsens distrust and instability.
- **Hydro-Diplomacy as a Cornerstone**: Combining diplomacy, science, and governance channels conflicts toward productive resolution.
- **Climate Variability Demands Adaptation**: Retrofit and modernize both physical infrastructure and legal frameworks to cope with extreme hydrological events.
- **Conflict Escalation**

Spectrum: The seven-level conflict taxonomy highlights early-warning signals and underscores the importance of timely dispute resolution.

- **Friendship Dams as Models for Cooperation**: These dams illustrate how inclusive, equitable frameworks can transform conflict-prone transboundary water systems into pillars of peace and development.
- **Future of Transboundary Dams**: Strengthening treaties with dam safety and adaptive management measures is essential for long-term resilience, equitable resource sharing, regional peace and shared prosperity.

Looking ahead, climate change will amplify water demands for energy and agriculture, underscoring the urgency of integrated, risk-based frameworks and proactive diplomacy. With consistent political will, innovative engineering, and inclusive stakeholder processes, transboundary dams can become catalysts for peace and development rather than sources of conflict. Friendship Dams represent a scalable model for addressing these challenges, balancing technical innovation with social and political inclusivity. By embracing this approach, nations can ensure that transboundary dams serve as catalysts for regional stability, environmental stewardship, social equity, and shared prosperity for upcoming generations.

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NEWSLETTER

COSMIC ELECTRICAL

Executive Summary

This newsletter provides an overview of the progress made across our key projects during the reporting month. Cosmic Electrical remains committed to advancing innovative power grid solutions while addressing challenges and fostering effective collaboration with stakeholders.

Recent Achievements

Cosmic Electrical Limited continues to make significant strides in advancing Nepal's energy infrastructure through its ongoing projects. Key achievements include the completion of 20 kilometers of hotline stringing and bay expansion works for the Kusma-Lower Modi-New Modi Transmission Line, substantial progress in the Amarpur-Dhungesaghu Transmission Line's civil foundation works, and engineering milestones for the OPGW Installation Project. Despite challenges such as land acquisition delays, adverse weather, and design adjustments, the company remains dedicated to overcoming obstacles through strategic planning, stakeholder collaboration, and innovative solutions.

Successful Hotline Stringing for Kusma-Lower Modi-New Modi 132 kV Transmission Line

Cosmic Electrical Limited proudly announces the successful completion of 20 kilometers of hotline stringing for the Kusma-Lower Modi-New Modi 132 kV Transmission Line Project. This landmark achievement reinforces the company's position as a leader in advancing Nepal's energy infrastructure while ensuring seamless transmission of renewable energy to the national grid.

Bay Expansion Milestone for Kusma-Lower Modi-New Modi 132 kV Transmission Line

Kathmandu, Nepal: Cosmic Electrical Limited has successfully completed two numbers of 132 kV bay expansion works for the Kusma-Lower Modi-New Modi 132 kV Transmission Line Project. This milestone strengthens Nepal's power transmission network, ensuring enhanced operational capacity and reliable energy flow.

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Prakash Chandra Paudel

Microtunneling: Applications in Urban ***Development and Project Guidelines***

The major applications for pipe jacking and microtunneling include new sewerage and drainage construction, sewer replacement and lining, gas and water mains, oil pipelines, electricity, telecommunications cable installation, and culverts.

1 Introduction and Applications

Microtunneling is the most practical technology for urban development in developing countries like Nepal. It is a rapidly growing sector of the construction and civil engineering industry. It is a trenchless underground construction method employed to accurately install pipelines under existing utilities, highways, railroads, levees, waterways, unstable ground conditions, and contaminated soils. The major applications for pipe jacking and microtunneling include new sewerage and drainage construction, sewer replacement and lining, gas and water mains, oil pipelines, electricity, telecommunications cable installation, and culverts. Special applications include the installation of rectangular or circular sections for pedestrian subways, road underpasses and bridge abutments.

The pipe jacking method can deliver environmental benefits in excess of 75 percent by reducing carbon emissions compared to disruptive open-cut construction, which requires considerably greater amounts of excavation and substantial backfill material. The pipe jacking method generally requires less overbreak than segmental tunnels and provides ground support and reduces potential ground movement. In many cases the use of pipe jacking techniques instead of open trenching contributes positively towards workplace safety, the interface with the general public and the environment.

2. Site Selection and Design Criteria

The site selection is based on the provision of safe clearance to the project structures from critical and sensitive building foundations as well as existing utility services.

The most practical and commonly used equipment for detecting underground utilities is the Ground Penetrating Radar (GPR). The GPR detects underground facilities, such as drainage & sewage pipelines, electric cables, optical cables, telecom lines and other metallic objects.

In addition, other essential data for the detail design are the stability and friction characteristics of the soil/rock to be tunneled through the self-weight & strength of the jacking pipes, the diameter of the pipe, the type of excavation method, and the available jacking reaction. The major constraint will be the nature of the ground and groundwater characteristics.

Other geotechnical properties for the design include shear strength, allowable bearing capacity, SPT (N) value, and coefficient of permeability of the soil.

Investigations by surface geological survey, borehole drilling, and electrical resistivity tests can confirm the nature of soil and its permeability condition. The static cone penetrometer test (CPT) can be carried out in soft ground using a 100kN Lightweight Cone Penetrometer to estimate soil type, coefficient of permeability, SPT, shear strength, Young's modulus, and shear modulus of the soil/rock layers.

Seismic shear wave velocity in the soil/rock layers may also be required.

3. Tunnel Boring Equipment Selection Process

In view of the geological and hydrological conditions of the special construction area, selection of a pipe jacking machine has become one of the key measures for construction risk control of the project.

Earth pressure balance machine (EPBM) is a full-face tunnel boring machine in which the excavated material is transported from the face by a balanced screw auger or screw conveyor. The face is supported by excavated material held under pressure behind the cutter head in front of the forward bulkhead. Pressure is controlled by the rate of outgoing excavated material through the balanced screw auger or valves on the screw conveyor.

EPBMs work best in cohesive soils. Where sand and gravels are encountered in a mixed face, these may be conditioned by injecting additives such as bentonite, water or polymers into the plenum and/or the screw to plasticize them.

The Slurry Balance Machine uses pressurized slurry to balance the groundwater and soil pressure at the face that helps in stabilizing the excavated surfaces and minimizing the ground settlement. It has a closed chamber to maintain the slurry pressure on the face. The slurry is pumped out and recycled from the surface. It is also equipped with a stone crusher for crushing cobbles. Various cutting heads are available to suit a broad range of ground conditions and may incorporate internal crushers to deal with cobbles and small boulders. This machine is suitable for water-bearing silts and sands with fine gravels.

The slurry balanced machine is comparatively simpler, less risky and a quicker process than the EPB machine.

4. Microtunneling Process

Microtunneling systems are remotely controlled and comprise several subsystems that function together. They are managed by an operator who monitors and controls pipe jacking operations from a control cabin inside a container on the surface beside the jacking shaft. MTBMs are accurately controlled by exerting continued support at the tunnel face by balancing thrust pressure and slurry with groundwater and earth pressures. The operator also monitors the position of the machine and the temperature of the driven motors from the control cabin.

The front part of the jacking equipment, together with its ancillaries, is set in the shaft along a cradle connected to the thrust wall. To drive the jacking equipment, jacking force is applied through the jacking frame cylinders installed on the thrust wall.

After driving the jacking equipment, a little into the ground and setting up the tunnel axis, the jacking pipe is installed at the backside of the equipment with a rubber gasket to continue the driving operation. In this way, jacking pipes are pushed into the tunnel one by one, simultaneously with the excavation.

5. Microtunneling Guidance System

Steering of the equipment is controlled by hydraulic cylinders that are connected to the cutter head. A laser guidance system is set in the computer for monitoring the alignment and position of the jacking equipment. With this guidance, the operator can steer the cutting head. The laser guidance system is set with the calculated value to guide the excavation. The location of the laser machine is set according to the tunnel alignment position. The operator can check the deviation status of the tunnel drive and adjust the direction of the cutter head, driving the boring equipment slowly and carefully from the control cabin while controlling the deviation within the tolerance limit. The tolerance limit for tunnel jacking is ±50 mm on the horizontal line and ±35 mm on the vertical line.

Figure 1: Pipe Jacking operation

Operating Pannel

Figure 2: Operation monitoring from the control cabin

Slurry de-sander system

Figure 3: The slurry separation tank

1. Jacking Load

Loads required to jack the pipeline forward are mainly a function of frictional forces built up around the pipeline. These forces depend on the type of ground, its arching characteristics, friction angle, the depth of overburden, the depth of the groundwater & any surcharge load, the length and diameter of the pipe being jacked and the time taken for the operation.

As much as hundreds of tons of force may be required to push the machine and liner forward. The jacking frame containing hydraulic rams produces these forces. The jacking shaft must be strong enough to support the forces it generates.

The friction of the ground around the pipe increases in proportion to the tunnel length. Two practices can minimize this friction. First, over-cutting is used to provide a gap between the tunnel and the outer edge of the liner. The gap is between 13 to 38 mm. A lubricant, often bentonite slurry, is injected into this gap. The pressure of the lubricant prevents the gap from collapsing.

2. Intermediate Jacking Stations

When the total jacking load exceeds the allowable jacking load of the pipe, the intermediate jacking station is to be installed. Inter jacking stations are not only used to increase the jacking lengths achievable but also to reduce the loads that are transmitted to the shaft structure.

3. Jacking Pipes

Jacking pipes are manufactured with a variety of materials that include concrete, clay, GRP and steel. Standard pipe diameters generally range from 0.5 to 4 m in diameter or greater if required. Jacking lengths can be in excess of 1 km depending on the pipe diameters, ground conditions and excavation methods.

4. Tunnel Stability Analysis

The tunnel stability calculation is based on the Mohr-Coulomb failure criteria and Peck's Ground Settlement Theory (1969). Maximum shear stress is considered as the vertical pressure that should be less than the shear strength on stability condition. The vertical pressure is determined by the ground cover and unit weight of the material.

The Principle of Peck's Ground Settlement Theory is that the volume of surface settlement is assumed to be equal to the volume of the lost ground. In normal circumstances, the volume of the lost ground shall be 1.5 to 3%. Greater ground loss can occur, especially if boulders are caught in a rotating cutter, a run or flow of sand or silt occurs, squeezing of clays or silts, unequal excavation of a soft material in a mixed-face situation.

Methods that reduce the lost ground include full and proper face control at all times, especially while shoving the shield, limiting the length-to-diameter ratio for the shield, rapid installation of ground support, and

pea gravelling or contact grouting of ground support. In critical situations, consolidation grouting of the ground before tunneling or from the tunnel face during excavation shall be required.

5. Risk Assessment and Monitoring Plan

Basic principles of the risk assessment and monitoring plan during the construction of tunnels and shafts are as follows:

i. High water inflow may occur in the tunnel.

ii. Contamination of groundwater may occur.

iii. Gradual damage to utility service lines may occur due to non-uniform settlement of ground.

iv. Occurrence of overbreak in the tunnel and total ground settlement should not exceed 2 cm.

v. Ground subsidence may cause damage of public roads, railway lines or the nearby building structures.

vi. Tilting of high, rigid buildings and cracking of panels & brick walls may occur if the total settlement exceeds 3.5 cm.

vii. Ground subsidence may cause noise and traffic congestion on the road.

6. Shaft Structures

Locations for the shafts are designed based on existing manholes, easy connection to the mainline, their impact on the surrounding buildings or facilities, and crossings of utility lines through the tunnel alignment. Construction methods include segmental lining, pre-cast or cast-in-situ concrete, sheet piling, ground anchorage, etc. The shape of the shafts may be circular, rectangular or polygonal based on the working platform, geological condition of the ground, and stability condition of the surrounding buildings. The size of the shaft shall be determined by calculating the length and diameter of the jacking machine, the length of jacking cylinder, the space for joining the jacking pipes, and the thickness of the thrust wall.

The Microtunnel Boring Machines (MTBMs) install pipelines from the jacking shaft to the receiving shaft. A concrete reaction wall is constructed at the rear of the jacking shaft to disperse the jacking loads onto the jacking pipe. The jacking frame tonnage and jacking pipe loads are properly calculated during the design.

Ground treatment or groundwater management can be performed by construction of wells, grouting, or ground freezing.

7. Grouting

For nearly all soft ground tunnels (the one exception being those supported by shotcrete), such contact can be stabilized only by expansion of the support system by grouting in contact between the excavated tunnel surface and the support system. Based on the purpose of execution, grouting can be categorized into the following types:

1. Permeation Grouting is the direct pressure injection of a chemical fluid grout into the ground to fill the spaces between and bind together soil particles without causing excessive movement or fracturing of the soil formation. It is performed prior to the commencement of tunneling operations to provide a more consistent and stable soil matrix.

2. Contact Grouting: The annulus between the pipe and the ground shall be grouted after pipe jacking is completed. Grouting shall be performed over the entire 360° circumference of the tunnel. Grout shall consist of Portland cement & water and sometimes may contain sand, bentonite or fly ash.

3. Consolidation Grouting or Jet Grouting, is conducted around the outer periphery of the shaft to prevent possible failure of side walls and sand boiling from the invert during excavation. Grouting pressure for consolidation grouting ranges from 3 to 7 bar, whereas Jet Grouting shall require a high pressure which can be up to 25 MPa. Necessary equipment for grouting includes drilling equipment, grouting equipment and a generator.

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Flexibility in Resource Planning:

Key for Nepal's Future

Ranju Pandey

However, the coordination of the various activities and the completion of all the activities is essential for the efficient application of flexible Adopted Resource Planning.

Deepa Shrestha

1. Abstract

Nepal is the developing country with huge hydropower and solar potential. Country is transitioning towards a sustainable and efficient power system, aiming to provide uninterrupted electricity to a growing economy while meeting the goals of the country's renewable energy commitment. Hence, to meet the government's goals and target Flexibility-Adopted Resource Planning (FARP) is very much importance. FARP is emphasized to integrate Variable Renewable Energy (VRE) into the power system, ensuring grid reliability and efficiency. Key strategies include resource diversification, grid modernization, energy storage, demand-side management, market design, and scenario-based planning. The Nepal Electricity Authority (NEA) prioritizes smart grids, transmission upgrades, and renewable integration while exploring regional energy trading opportunities. However, the coordination of the various activities and the completion of all the activities is essential for the efficient application of flexible Adopted Resource Planning. With implement of all the activities mentioned in FARP the flexibility of the grid will improve, and maximum MW of VRE can be integration in the Integrated Nepal's Power System (INPS) of Nepal without compromising the reliability, security, efficiency and sustainability of the grid.

2. Introduction

Nepal is a developing South-Asian country with a population of approx. 29.1 million (Sijapati, 2023). The Country is abundantly blessed with various natural renewable resources like hydropower, solar power, biogas, biomass. The Country is endowed with huge hydropower potential because of the enormous water resources and complementing steep topography, it has been found that the theoretical potential of hydropower of Nepal is 84 GW and economically feasible capacity is somewhere around 43 GW. Alongside, a study shows that Nepal receives sunlight for approximately 8 hours a day for 300 days a year (ADB, 2020), making it equally feasible for solar PV projects. As, Nepal is sandwiched between two big economies countries of world, India and China which opens possible door for regional electricity market.

Nepal is transitioning towards a sustainable and efficient power system, aiming to provide uninterrupted electricity to a growing economy while meeting the goals of the country's renewable energy commitments. Nepal has made commitments of net zero emission by 2045 AD in COP 2022 (GoN, 2021). Moreover, the Government of Nepal ambitiously plans to generate 28.5 GW of power by 2035, of which 13.5 GW is allocated for domestic consumption and 15 GW for export (Taylor, 2024), ensuring grid resilience has become a national priority. To be in-line with government policies and also to supply the reliable clean energy for both the domestic and regional market, it is essential for Nepal Electricity Authority (NEA) to conduct the FARP.

3. FARP

FARP refers to the approach used in power system planning to ensure the integration of diverse energy resources while maintaining grid reliability and efficiency.

This planning framework emphasizes flexibility to accommodate variability and uncertainty, especially with the increasing share of VRE like wind and solar. The goal is to balance supply and demand dynamically and cost-effectively.

> Flexibility in a power system refers to the ability of the system to rapidly and efficiently respond to changes in supply, demand, or grid conditions while maintaining stability, reliability, and power quality. It is a critical attribute for modern power systems, especially as renewable energy sources and decentralized energy resources become more prominent in the system. There should be flexibility in supply side, demand side, flexibility in the transmission, Energy Storage Flexibility, and Market Flexibility.(Babatunde, 2019)

Key aspects of FARP include:

a) Resource Diversification: It is essential Incorporating a mix of generation resources, such as renewables, energy storage, demand response, and conventional generation, to enhance the system's adaptability. Nepal has diversified the energy mixed as follows.

Table 1 with caption ?

Scheme of Energy	Allocated percentage
Run off the river, RoR	40-45%
Peaking RoR	25-30%
Storage	20-25%
Alternative Sources	5-10%

(NEA, 2024)

b) Flexible Grid Operations: Enabling resources to ramp up or down quickly in response to changes in demand or VRE output. Utilizing advanced grid technologies like Flexible AC Transmission Systems (FACTS) and Dynamic Line Ratings (DLR) ((RISE), 2019). So, to be in line with this, Nepal has developed the concept of smart grid with that automates the S/S and the use of the smart meters.

c) Energy Storage: Deploying battery energy storage systems (BESS), pumped hydro, or other storage solutions to manage surplus energy and address peak demand. For that, rigorous studies have been done for the development of the Pumped Storage Plant with a capacity of around 45,000 MW (NEA, 2024)

d) Demand-Side Management: Engaging consumers to shift or reduce energy usage during peak times or when supply is limited. Various peak and off-peak tariffs have been introduced to the industrial and the commercial consumers along with the implementation of net metering for rooftop PV systems. Furthermore, smart meters have been installed in the major cities.

e) Modernization: Engaging consumers to shift or reduce energy uses during peak times or Engaging consumers to shift or reduce energy usage during peak times or when supply is limited. Various peak and off-peak tariffs have been introduced to industrial and commercial consumers, along with the implementation of net metering for rooftop PV systems. Furthermore, smart meters have been installed in the major cities.

Advanced forecasting tools for VRE production have been realised. Enhanced transmission and distribution networks to handle power flows efficiently have been going on rigorously. Furthermore, improvement and upgradation of grid infrastructures have been given the major priority. Rigorous studies have been carried out and many new transmission line and substation projects have been identified to cope with the increasing future demands

f) Market Design and Policy Support: Implementing markets that reward flexible resources and aligning regulatory policies to encourage flexibility. Similarly, exporting power during wet season and importing power during dry season has indeed widened the grid flexibility.

g) Scenario-Based Planning: The Government of Nepal and NEA has been working continuously in considering multiple scenarios for future energy mix, demand growth, and changing policy.

Overall FARP is essential for modern grids as it helps to optimise costs, reduce emissions and improve the reliability of the energy system in the face of evolving challenges like VRE integration and climate change.

The following figure shows the plans of Government of Nepal on high voltage transmission lines to meet the future demands

Provide the Figure no. and cite the source correctly

Source(NEA)

Hence, the rapid adoption of VRE sources like solar has introduced intermittency into the power grid. Hence, Flexibility enables the grid to respond effectively to fluctuations in VRE generation, maintaining a balance between supply and demand. The government

has framed a policy to have 10% of energy from variable renewable energy sources (GoN, 2018). Therefore, the solar when solar generation drops during cloudy periods or at night, flexible resources such as batteries, pumped storage or demand-side adjustments can fill the gap. Therefore, with the addition of the solar sources in the system, flexible resources should also be addressed in such a way that the grid becomes resilient, sustainable, effective and efficient.

In nutshell to achieve a resilient grid, NEA emphasizes Infrastructure Modernization, Energy Resource Integration, Decentralized Energy Generation, Regional Trading, Demand and Supply Balancing, adopting smart grid technology, reduction of transmission and distribution line losses. NEA has been implementing as well as framed future plans on activities including grid modernization projects, VRE integration and diversification of resources. NEA has implemented the feed-in-tariff for the grid-connected roof top solar panels.

Furthermore, various initiations had been planned for the peak demand management. Likewise, NEA has formulated its IT Policy 2023 (NEA, 2024), aiming to modernize its functions and ensure a secure, stable and standard IT infrastructure. NEA has committed to harnessing the potential of IT with the necessary infrastructure and Software Applications for digital transformation and automation with the emergence of Internet of Things (IoT) . Cyber security and Disaster Preparedness has also been acknowledged.

4. Conclusion and Recommendations

In nutshell to achieve a resilient grid, NEA emphasizes Infrastructure Modernization, Energy Resource Integration, Decentralized Energy Generation, Regional Trading, Demand and Supply Balancing, adopting smart grid technology, reduction of transmission and distribution line losses. NEA has been implementing as well as framed future plans on activities including grid modernization projects, VRE integration and diversification of resources. NEA has implemented the feed in tariff for the grid connected roof top solar. Furthermore, various initiations had been planned for the peak demand management. Likewise, NEA has formulated its IT Policy 2023 (NEA, 2024) , aiming to modernize its functions and ensure a secure, stable and standard IT infrastructure. NEA has committed to harnessing the potential of IT with the necessary infrastructure and Software Applications for digital transformation and automation with the emergence of Internet of Things (IoT). Cyber security and Disaster Preparedness has also been acknowledged.

However, for the efficient and sustainable operation of the modern grid all the activities should be given high priority and should be implemented. The coordination, collaboration of the various activities and the completion of all the activities is essential for the efficient application of flexibility Adopted Resource Planning. With implement of all the activities mentioned in FARP the flexibility of the grid will improve, and maximum MW of VRE can be integration in the INPS of Nepal without compromising the reliability, security, efficiency and sustainability of the grid.

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Theoretical Line Loss Benchmark for 33kV ACSR DOG Conductors

Binod Sharma

The true equilibrium temperature of the conductor for that current is always the temperature at which heat generation in the conductor and heat dissipation through the conductor match.

Hari Prasad Pandey

1. Introduction

Electricity always loses some of its components when it passes through a conductor. The extent of loss depends on the current flowing through, conductor parameters, configurations, and climatic factors. The electricity regulator has to set a ceiling for the acceptable loss to ensure transparency and efficiency in the distribution of electricity. The total loss in any distribution line can be broadly classified as technical and non-technical losses. The technical loss can be reduced to theoretical value but can't be omitted but however non-technical losses can be reduced to ignorable value. For the analysis of 33 KV distribution lines, the losses resulting from capacitance and inductance have been omitted and resistance alone is the reason for the loss under consideration. The square of the line current and resistance determines the resistive loss. In this article, an attempt at accurate loss calculation is done by carefully determining the value of resistance. Along with the conductor's dimensions and composition, the conductor's operating temperature also affects its resistance. In this article, conductor diameter and conductor materials are fixed as we are considering an ACSR DOG conductor. We mainly focus on the conductor resistance and its variation with the conductor operating temperature. However, the conductor temperature depends on the heat generation in the conductor and heat dissipation through the conductor.

A conductor is heated whenever current flows through it, and convection and radiation cause the conductor to lose heat at the same time. During sunshine, solar radiation also heats the conductor. The true equilibrium temperature of the conductor for that current is always the temperature at which heat generation in the conductor and heat dissipation through the conductor match. To determine the loss, the conductor resistance at that equilibrium temperature has been computed. This study considers four ambient temperatures (10 °C, 20 °C, 30 °C, and 40 °C) to address the seasonal and regional variation of temperature throughout the country. The currents up to 400 amperes in the step of 25 amperes are considered for the analysis so that the loss percentage for certain amperes could be directly deducted. The equilibrium temperature of the conductor is calculated by solving the heat balance equation with the help of the solver feature of Excel. For the results with tolerable errors, two iterations are carried out.

Once the current's equilibrium temperature has been established, the resistance and power loss associated with that temperature are calculated. For each current level taken into consideration, the percentage power losses are determined. Then, the total power loss in a line can quickly deduced with the average current in the conductor during the period considered and the effective resistance. The weighted average current of several 33 KV feeders should be used to compute the loss for a distribution company. Then,

the loss percentage for that current is selected from the list.

2. Problem Statement

The electricity regulator should define a benchmark for power loss in the distribution line to assess and preserve the transparency, effectiveness, and efficiency of electricity distribution. However, the estimate of conductor technical power loss is complicated due to its dependence on the conductor specifications, climatic conditions, and the circular relationship between temperature, resistance, and current. Furthermore, we cannot separate the technical and non-technical losses from a measured total power loss of a line. Determining the theoretical technical power loss is therefore required in order to eliminate non-technical losses and keep the overall losses close to the technical losses. A line's technical power loss is determined by its current and resistance at operating temperature, which is affected by heat generation and dissipation. The amount of heat generated in the conductor is determined by current, resistance, and solar heat, whereas the amount of heat lost is primarily determined by the conductor type, conductor temperature, surrounding medium, and ambient temperature.

3. Literature Review

A. Heat Generation in Conductor

The electric heating effect, often known as Joules law, and solar heat gain during sunny days are the primary causes of heat generation in electric conductors.

i. Power Losses in the Conductor

Resistive power loss is a conductor's main source of power loss. Heat is the result of its dissipation. It can be expressed as:

$$P_{loss}=FR_t \qquad \text{Eq. 1}$$

Where, P_{Loss} is the KW power loss/km of the line, I is the current flowing through the conductor in Ampere and R_t

is the resistance of the conductor at t°C temperature in Ω/KM.

The resistance of conductor increases as the operating temperature of the conductor increases. It is governed by conductor initial resistance and temperature coefficient of resistance.

DC Resistance of the conductor at t°C can be calculated as

$$R_t=R_{20}(1+\propto(t-20) \quad Eq.\ 2$$

Where, R_{20} is the resistance of the conductor at 20°C, ∝ is the temperature coefficient of resistance in /°C.

ii. Heat Gain from Solar Radiation:

The solar heat gain is another factor contributing to the increase in the conductor temperature. The heat that a conductor receives from solar radiation on a sunny day can be expressed as

$$P_{solar}=\propto*I*A*Sunshine\ Duration\ Factor \quad Eq.\ 3$$

Where, ∝ is Solar absorptivity of the conductor (0.6 for ACSR), I is the intensity of solar radiation (931.13W/M^2 for Nepal), and A is the surface area of the conductor (M^2)

$$Sunshine\ duration\ factor = \frac{Sunshine\ Hours}{Total\ hours\ in\ a\ da}$$

B. Power Dissipation in the Conductor

Convection and radiation are the two ways that a conductor releases the heat it generates into its surroundings.

iii. Convection

The process of heat transfer by the air surrounding the conductor is called convection. Its value depends on the thermal conductivity of air, the dimension of the conductor, and the temperature difference between the conductor surface and the surrounding atmosphere. Power dissipation in the conductor through convection in Watt can be determined as,

$$P_{convection}=hA(t_c-t_a) \qquad Eq.\ 4$$

Where, h is the convective heat transfer coefficient in $WM^{-2}K^{-1}$, generally taken 5 to 25 $WM^{-2}K^{-1}$ for natural air. A is the surface area of the conductor in M^2, T_C is the conductor surface temperature in K, and T_a is the ambient temperature in K.

iv. Radiation

Every hot body emits electromagnetic waves that transfer heat, known as radiation. It can be quantized with the help of the Stefan-Boltzmann law of radiation. Radiation heat transfer of the conductor depends on the emissivity of the conductor, dimension of the conductor, and temperature difference between the surface of the conductor and the surrounding surface.

Power dissipation in the conductor through radiation in Watt can be expressed as,

$$P_{radiation}=\sigma\epsilon A(t_c^4-t_a^4) \quad Eq.\ 5$$

Where, σ is the Stefan-Boltzmann constant, $5.67\times10^{-8}J/S.m^2.K^4$, E Emissivity of the conductor surface, and A is the surface area of the conductor.

C. Calculating the Equilibrium Conductor Operating Temperature

Conductor temperature increases as current flows through it, and temperature reaches a stable condition when the heat generated equals heat dissipation.

The equilibrium temperature is decided by balancing the heat equation, i.e., at the stage of heat generation equal to heat dissipation.

At thermal equilibrium,

$I^2R_{tC}=hA(t_c-t_a)+\sigma\epsilon A(t_c^4-t_a^4)$ *Eq. 6*

Where, Tc is the equilibrium conductor surface temperature.

This equation is solved to get the equilibrium temperature.

4. Theoretical Loss Calculation

In this section, loss for a 33 KV distribution line built with an ACSR DOG conductor has been computed following the defined procedure.

A. Specifications of an ACSR DOG Conductor:

The construction of the ACSR DOG conductor is shown in the figure below. It consists of 7 steel strands in the inner two layers and 6 aluminum strands in the outer layer.

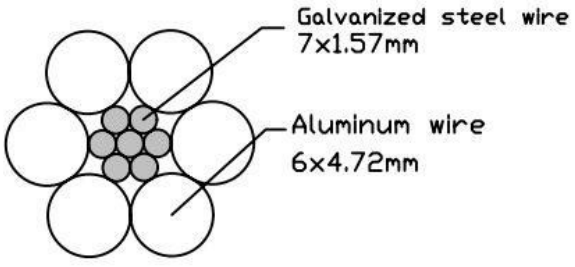

Figure 1 ACSR DOG Conductor Construction

The general specifications for an ACSR DOG conductor are:

- Resistance at 20 °C temperature: 0.2733Ω
- Temperature coefficient of resistance: 0.00403 /°C at 20 °C
- Resistivity of Aluminum: 2.826× $10^{-8}\Omega M$
- Diameter of aluminum strands: 4.72 MM
- Diameter of steel strands: 1.57 MM
- Sectional area of aluminum: 105 Sq. MM
- Total Cross sectional Area: 118.5 MM
- Overall diameter: 14.15 MM
- Conductor Weight per KM: 394 KG/KM
- Mass of aluminum in KG/KM: 284.55
- Thermal conductivity air: 0.0264 W/M/K
- Conductor continues maximum operating : 75 °C
- Conductor maximum short circuit temperature : 200 °C
- Specific heat: 0.904 KJ/KG/K
- Density/specific gravity of aluminum: 2.7 gm/ cm^3
- Melting Point: 658 °C.
- Conductor surface absorbency (0.27- 0.95): 0.6

The skin effect and proximity effect are less noticeable for 50 Hz, 33 KV lines made up of ACSR conductors that are appropriately spaced apart; therefore they can be disregarded in the computations. As a result, DC resistance of DOG Conductor is equivalent to the line's AC resistance.

B. Operating Temperature and Resistance Calculation for DOG Conductor:

The solver feature of Excel is used to solve the following heat equation.

Resistive loss +Solar heat gain = Convection heat loss + Radiation heat loss

$$\boldsymbol{I^2R_{tC}+\propto *I*A*Sunshine\ Duration\ Factor = hA(t_c-t_a)+\sigma\epsilon A(t_c^4-t_a^4)}$$

Surface area (A) of the 1 KM of ACSR DOG conductor is

$A=\pi D*1000M^2$

Taking D = $\frac{14.15}{1000}$ M, A = 44.45 M^2

The convective heat coefficient for natural air can be taken from 5 to $25WM^{-2}K^{-1}$. However, for ACSR conductor, lowest value 5 $WM^{-2}K^{-1}$ has been taken.

For the solution of the above equation, the first resistive power loss for the given current at ambient temperature is calculated. Then, the value of conductor temperature is decided such that resistive power loss is dissipated through convection and radiation. Again, the conductor resistance at the recently obtained equilibrium temperature is calculated. After getting new resistance at a new operating temperature, resistive power loss is again calculated, and another operating temperature is obtained for dissipating the generated heat. This process is repeated till a stable operating temperature is achieved. The results within the acceptable error have been found after two iterations.

The operating temperature also depends on the value of ambient temperature. Therefore, to cover the seasonal and regional variation of ambient temperature in Nepal, conductor operating temperature for four ambient temperatures (10°C, 20°C, 30°C, and 40°C) has been considered in the calculations. Furthermore, operating temperatures for seventeen current levels from 0 amperes to 400 amperes at an interval of 25 amperes are taken into consideration for calculations.

Table 1 below shows conductor operating temperature, effective conductor resistance, and actual resistive power loss for DOG conductors carrying various currents at an ambient temperature of 30 °C.

Table 1 Change in Conductor Operating Temperature

and Resistance with Current at 30 °C Ambient Temperature

	Iteration 1			Iteration 2		
A)	Heat Generation (Watts) [I^2*R30 + α*Is*A*7/24]	Equilibrium Temperature with Heat Dissipation through Convection and Radiation (°C)	New Resistance Value at Equilibrium Tempereture (Ω/KM)	New Heat Generation (Watts) [I^2*Rt + α*Is*A*7/24]	Equilibrium Temperature with Heat Dissipation through Convection and Radiation (°C)	Ne Va Eq Te (Ω
0	7243.03	32.42	0.2870	7243.03	32.42	
25	7420.71	32.48	0.2870	7422.43	32.48	
50	7953.78	32.65	0.2872	7961.12	32.66	
75	8842.21	32.95	0.2876	8860.54	32.95	
00	10086.03	33.35	0.2880	10123.11	33.37	
25	11685.21	33.88	0.2886	11752.14	33.90	
50	13639.78	34.51	0.2893	13751.90	34.55	
75	15949.71	35.26	0.2901	16127.49	35.31	
00	18615.03	36.11	0.2910	18884.87	36.20	
25	21635.71	37.07	0.2921	22030.81	37.20	
50	25011.78	38.14	0.2933	25572.79	38.31	
75	28743.21	39.30	0.2946	29519.02	39.54	
00	32830.03	40.56	0.2959	33878.35	40.88	
25	37272.21	41.92	0.2974	38660.20	42.34	
50	42069.78	43.36	0.2990	43874.54	43.90	
75	47222.71	44.90	0.3007	49531.85	45.58	
00	52731.03	46.51	0.3025	55642.98	47.36	

Similarly, the conductor operating temperature for various currents has been calculated for 10 °C, 20 °C, and 40 °C ambient temperatures and is shown in Table 2 and Figure 1.

Table 2 Conductor Operating Temperature with Current at Various Ambient Temperatures

S.N.	Currrent (A)	Conductor Temperature at 10°C Ambient Temperature	Conductor Temperature at 20°C Ambient Temperature	Conductor Temperature at 40°C Ambient Temperature
1	0	12.91	22.65	42.21
2	25	12.98	22.71	42.27
3	50	13.17	22.90	42.44
4	75	13.50	23.21	42.72
5	100	13.96	23.65	43.11
6	125	14.55	24.21	43.62
7	150	15.27	24.89	44.24
8	175	16.12	25.70	44.96
9	200	17.10	26.63	45.80
10	225	18.21	27.68	46.75
11	250	19.45	28.86	47.81
12	275	20.81	30.15	48.98
13	300	22.30	31.56	50.26
14	325	23.91	33.09	51.64
15	350	25.64	34.74	53.13
16	375	27.49	36.50	54.72
17	400	29.46	38.37	56.42

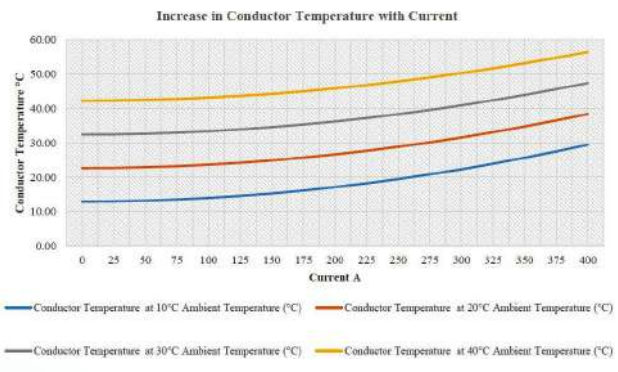

Figure 1 Change in Conductor Temperature with Current

Table 3 and Figure 2 below shows the variation of conductor resistance for various currents at 10 °C, 20 °C, and 40 °C ambient temperatures.

S.N.	Currrent (A)	Resistance at 10°C Ambient Temperature (Ω/KM)	Resistance at 20°C Ambient Temperature (Ω/KM)	Resistance at 40°C Ambient Temperature (Ω/KM)
1	0	0.2655	0.2762	0.2978
2	25	0.2656	0.2763	0.2978
3	50	0.2658	0.2765	0.2980
4	75	0.2661	0.2768	0.2983
5	100	0.2666	0.2773	0.2988
6	125	0.2673	0.2779	0.2993
7	150	0.2681	0.2787	0.3000
8	175	0.2690	0.2796	0.3008
9	200	0.2701	0.2806	0.3017
10	225	0.2713	0.2818	0.3028
11	250	0.2727	0.2831	0.3039
12	275	0.2742	0.2845	0.3052
13	300	0.2758	0.2860	0.3066
14	325	0.2776	0.2877	0.3081
15	350	0.2795	0.2895	0.3098
16	375	0.2816	0.2915	0.3115
17	400	0.2837	0.2935	0.3134

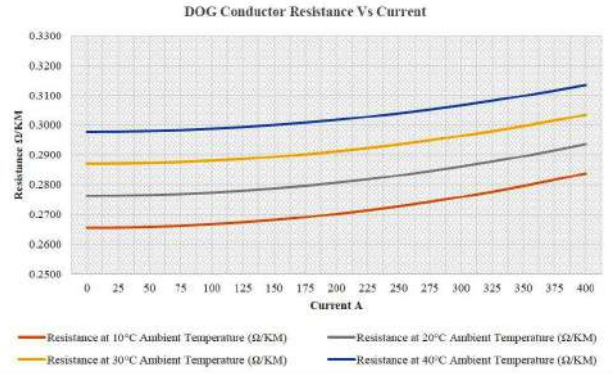

Figure 2 Change in Conductor Resistance with Current

C. Calculations for Percentage Power Loss:

After getting the conductor operating temperature and corresponding current, the power loss is calculated. The figure below shows the power loss for various current levels.

Figure 3 Power Loss per KW

Table 4 shows percentage power loss benchmark per KM of ACSR DOG line per hour for various current levels. It is used to compute the total line loss.

Table 4 Theoretical Power Loss Benchmark

S.N.	Current (A)	Conductor Temperature (Celsius)	Conductor Resistaance (Ω/KM)	Loss Units per KM per Hour (KWH)	Delivered in an Hour (KWH)	Loss Percentage per Unit Length
1	0	32.42	0.2870	0.00	0.00	0.0000%
2	25	32.48	0.2870	0.18	1357.49	0.0132%
3	50	32.66	0.2872	0.72	2714.99	0.0264%
4	75	32.95	0.2876	1.62	4072.48	0.0397%
5	100	33.37	0.2880	2.88	5429.98	0.0530%
6	125	33.90	0.2886	4.51	6787.47	0.0664%
7	150	34.55	0.2893	6.51	8144.97	0.0799%
8	175	35.31	0.2902	8.89	9502.46	0.0935%
9	200	36.20	0.2911	11.65	10859.96	0.1072%
10	225	37.20	0.2922	14.79	12217.45	0.1211%
11	250	38.31	0.2935	18.34	13574.95	0.1351%
12	275	39.54	0.2948	22.30	14932.44	0.1493%
13	300	40.88	0.2963	26.67	16289.94	0.1637%
14	325	42.34	0.2979	31.47	17647.43	0.1783%
15	350	43.90	0.2996	36.70	19004.93	0.1931%
16	375	45.58	0.3015	42.39	20362.42	0.2082%

5. Use of Proposed Loss Benchmark and Conclusions

The proposed loss standard is utilized to evaluate the losses of Butwal Distribution Center's two actual 33 KV feeders. The tables 5 and 6 display the feeders' actual and estimated losses during the month of Ashoj.

Table 5 Loss Calculation with Proposed Procedure

ılculation with Proposed Procedure:

3Kv Feeder Name	Total Length of Line, (1 Wire) (KM)	Average Loading of Line (A)	Units Delivered at Average Loading Per Hour (KWH)	Loss Percentage at Average Loading	Loss Unit Per Hour (KWH)	Actual Loss Percentage	Total L Units in month
utwal-Chauraha 33KV Line	6.6	153.85	8354.02	0.0820%	45.21	0.54%	3
lotipur-Saljhandi 33KV Line	54	75.88	4120.27	0.0397%	88.33	2.14%	6

Table 6

Actual Loss in those Feeders:

S.N.	33Kv Feeder Name	Sent Energy Reading (KWH) 2081.07.01: 12:00	Sent Energy Reading (KWH) 2081.06.01: 12:00	Net Sent Energy (KWH)	Received Energy Reading 2081.07.01: 12:00	Received Energy Reading 2081.06.01: 12:00	Net Received Energy	Total Loss Units in Ashoj (KWH)	Loss Percentage
1	Butwal-Chauraha 33KV Line	10213152	4167072	6046080.00	10279512	4264548	6014964	31116.00	0.51%
2	Motipur-Saljhandi 33KV Line	4748724	1676160	3072624.00	4579986	1610571	2966415	106209.00	3.46%

Actual Loss in the Lines

It is evident that the actual loss percentage and the calculated loss percentage differ significantly. The theoretical losses couldn't match the actual losses because the real 33 KV line experiences numerous other losses due to aging, leakage, and other factors. This effort attempts to construct a theoretical baseline in order to minimize losses to that extent reducing additional losses.

Based on the above results, as the Butwal-Chauraha feeder is operated at a current level lower than the taken average current for a longer period of time, the calculated loss is marginally higher than the real. Thus, the suggested computation exceeds the actual loss. However, the Motipur-Saljhandi feeder's calculated loss is lower than the real loss. It can be the result of variations in the average current and leakage loss as the feeder passes through a forest. Whatever the cause, the Motipur- Saljhandi feeder's loss appears to be higher than our benchmark; therefore, attention should be given to reduce the real loss.

As the benchmark has been used to explain the losses in the actual lines, care should be given in the calculation of average current for the feeder with a substantial load change otherwise it may lead to discrepancies in forecasting the loss using the suggested approach. Therefore, an accurate value of average current should be selected based on the type of feeder and its load pattern.

Mr. Sharma is an electrical engineer at the Butwal Distribution Center, and Mr. Pandey is the Provincial Chief of the Lumbini Province for Nepal Electricity Authority.

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Bridging the Energy Gap: *Nepal's Journey to Sustainable* Power and Growth

Rabindra Kafle

These exports provide the country not only with a cushion on foreign exchange earnings but also position itself as an emerging player in regional energy trade.

Nepal stands at a pivotal moment in its journey of energy development, with the country stepping towards harnessing its abundant hydropower resources to transform its economy. The country is blessed with an estimated 83,000 MW of hydropower potential, of which 42,000 MW is considered economically viable. Over the past decade, Nepal has made significant progress in the segment, achieving an installed capacity of over 2,500 MW. Large-scale power plants such as the 456 MW Upper Tamakoshi Hydropower Project have come online, while several others like Arun-III (900 MW) and Budhi Gandaki (1,200 MW) hydropower projects are at various stages of development. Despite these advances, only about 75 percent of the population has access to reliable electricity, with rural areas facing persistent challenges of connectivity and smooth supply.

Nepal's journey on its energy development also includes the recent momentum seen in electricity exports, particularly to India during monsoon months, when surplus power generation peaks. These exports provide the country not only with a cushion on foreign exchange earnings but also position itself as an emerging player in regional energy trade. Furthermore, the government is exploring avenues for regional energy trade under the Bangladesh-Bhutan-India-Nepal (BBIN) framework, signaling the possibility of a robust South Asian energy market where Nepal could play a key role.

Recently, the prospects for Nepal's energy sector have extended beyond hydropower. The government has expressed its commitment to diversifying its energy mix by promoting solar and wind energy projects. Additionally, the adoption of electric vehicles (EVs) is gaining traction, presenting an opportunity to utilize surplus electricity while reducing dependency on fossil fuels and addressing challenges of growing urban pollution. Implementation of the Renewable Energy Subsidy Policy and Power Trade Agreements with India have further encouraged foreign investments, while facilitating a gradual shift toward a greener and more secure energy future.

However, significant challenges remain on the path to realizing Nepal's energy potential. The lack of adequate transmission infrastructure is a critical bottleneck, leading to the wastage of generated power and limiting the country's export capacity. Although Nepal has formulated supportive policies, their inconsistent implementation, coupled with bureaucratic delays, often hampers in the achievement of targeted progress. Financing also remains a formidable obstacle, as large-scale energy projects require substantial investment, and developers face high interest rates domestically and limited access to international funding. Additionally, social and environmental concerns, including displacement and ecological impact, continue to delay project completion timelines.

As mentioned, the crux of Nepal's slow progress in energy development lies in a combination of systemic, infrastructural, and strategic shortcomings. Despite its immense hydropower potential, the country faces challenges such as inadequate transmission infrastructure, bureaucratic inefficiencies, and

inconsistent policy implementation. These issues create delays in project approvals, hinder investments, and lead to waste of the generated electricity.

In addition, financial constraints, including limited access to international funding and high domestic interest rates, make it hard to develop large-scale projects. Social and environmental concerns, such as displacement of local community people and ecological impacts, further complicate project implementation. The lack of a long-term vision to promote domestic energy consumption, industrialization, and regional energy trade too limits Nepal's ability to fully capitalize its energy resources.

In essence, Nepal's energy development is stalled by a lack of cohesive planning, infrastructure development, and effective governance, all of which are essential for unlocking its potential as a regional energy leader.

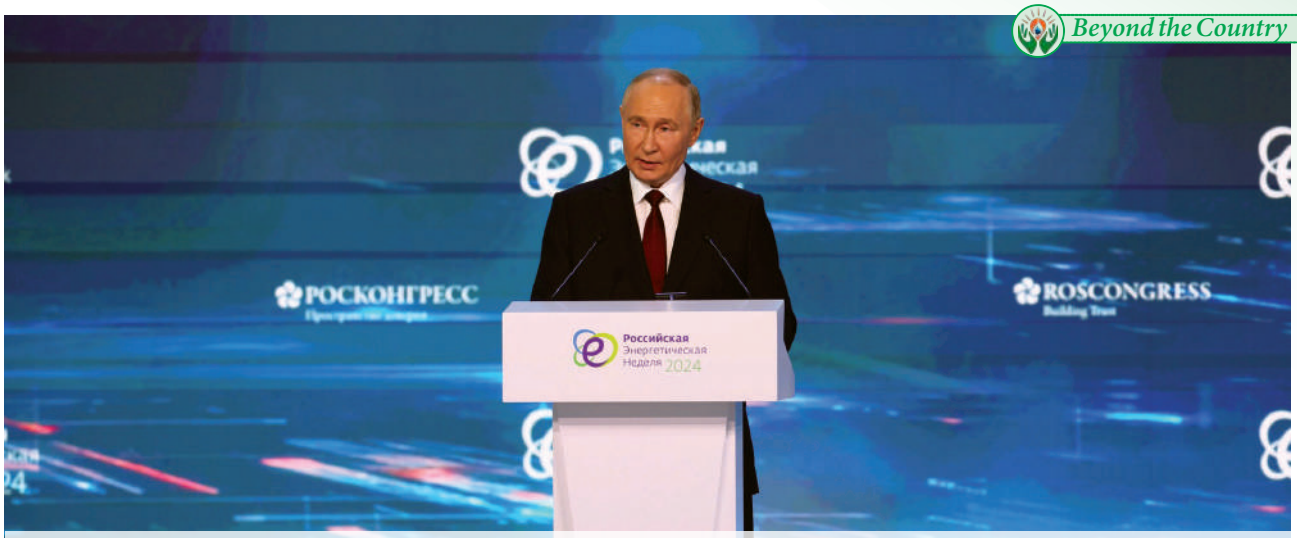
Addressing these challenges requires a multi-faceted approach. Nepal must prioritize robust infrastructure development to ensure efficient evacuation and distribution of power. Streamlined policy implementation, with a focus on reducing red tape and enhancing transparency, will boost investor confidence. Public-private partnerships and regional cooperation with neighboring countries can provide the financial and technical resources needed to accelerate project completion. Equally important is adopting sustainable practices that balance energy development with environmental preservation and community well-being.

The solution to Nepal's energy development challenges requires a comprehensive approach, addressing both immediate bottlenecks and long-term structural issues. Here are key strategies to drive progress:

1. **Strengthen Transmission Infrastructure**: Prioritizing the development of robust transmission and distribution networks is critical to evacuate generated electricity efficiently. Building cross-border transmission lines with India and other neighbors will also enhance export capacity.
2. **Streamline Policy Implementation**: Simplifying bureaucratic processes, reducing red tape, and ensuring consistent enforcement of energy policies can attract investment and accelerate project timelines. A centralized authority to oversee and expedite energy projects could be beneficial.
3. **Enhance Financing Mechanisms**: Access to affordable financing is vital. The government should work to secure international funding, offer tax incentives to investors, and promote public-private partnerships. Creating a specialized energy development fund could also help mitigate financial constraints.
4. **Promote Domestic Energy Consumption**: To ensure optimal utilization of energy resources, Nepal should focus on expanding industrialization, electrifying rural areas, and promoting the adoption of electric vehicles (EVs). Providing subsidies for EVs and taking initiatives to electrify transport and agriculture systems can drive forward consumption level.
5. **Foster Regional Cooperation**: Strengthening energy trade agreements within the South Asian region, such as through the BBIN framework, can open larger markets for Nepal's surplus electricity. Long-term bilateral agreements with India and other neighbors will ensure stable revenue streams in the segment.
6. **Adopt Sustainable Practices**: Addressing environmental and social concerns through community engagement, fair compensation for displaced populations, and eco-friendly project designs will reduce resistance to energy projects.
7. **Invest in Diversification**: Beyond hydropower, Nepal should invest in solar, wind, and other renewable energy sources to reduce dependency on a single resource and enhance energy security.
8. **Capacity Building and Innovation**: Developing local expertise in energy planning, management, and technology through training and collaboration with international experts will improve efficiency. Encouraging innovation in renewable energy technologies can also reduce costs and improve output.
9. **Ensure Political Commitment**: Political stability and a long-term commitment to energy development are essential. Policymakers should work across party lines to establish energy as a national priority with clear and achievable goals.

By implementing these solutions with coordinated efforts between the government, private sector, and international stakeholders, Nepal can unlock its energy potential, drive economic growth, and become a significant energy exporter in the region.

Nepal's energy sector holds immense promise, with the potential to not only meet domestic demands but also drive economic growth and regional integration. By overcoming its challenges with strategic planning and collaborative efforts, Nepal can establish itself as a leader in renewable energy, ensuring a brighter and more sustainable future for the nation and its neighbors.



Russia Pledges to Expand Green Energy Initiatives

Vladimir Putin

In recent decades, Russia has established itself as a prominent leader in global energy development. Its influence extends beyond Europe and the Americas, playing a pivotal role across Asia and South Asia. In this context, with permission from the Russian Embassy to Nepal, Kathmandu we put it as article format, an edited excerpt from the address delivered by Russian President Vladimir Putin during the 7th Russian Energy Week, Which was held in Moscow on September 26-28, 2024.

More than 4,000 participants from over 50 countries participated in Russian Energy Week International Forum this year. They discussed the most important issues on the energy agenda, and the challenges that both producers and consumers of energy resources are facing around the world.

Modern energy is one of the key sectors enabling global development. Its smooth operation based on transparent and predictable rules, when deposits are developed and resources are extracted, processed and supplied to the market without interruption, creates a solid foundation for economic growth, social progress, and improvement of the people's living standards.

Historically, the main elements of the supply infrastructure of the global energy market used to be consolidated in the West. Taken together, innovative mining solutions, logistics, insurance of resource supply, and the system of payments for these operations, constitute a global energy platform on a par with technologies.

Closing access to its platform has only encouraged the development of alternative solutions, alternative logistics, insurance and international settlement systems, as well as technological innovations.

These solutions are mostly immune to external influence. And since they are being gradually shaped on a fundamentally new technological basis, they are becoming more effective by the day and, which is even more important, more widespread, first of all in the countries that are gathering momentum and demonstrating a high economic development pace.

The modern world has entered an era of fundamental and irreversible changes. A multipolar development model is emerging, starting a new wave of global growth for the rest of the 21st century. And this growth will be concentrated not in Europe or North America. There will be gradual shift in growth drivers. In 1992, the G7 accounted for 45 percent of global GDP, while BRICS had just 22 percent. As of the end of 2023, the G7's share declined to 30

percent, while BRICS increased its share to 36 percent. And this trend is gaining traction.

According to international experts, several BRICS countries, including the People's Republic of China, the Russian Federation, the United Arab Emirates and Saudi Arabia will enjoy positive, albeit quite modest, economic trends. Once again, this is what experts have been saying, including international experts. At the same time, the countries of what we call the Global South will lead the pack in terms of economic growth rates. For now, their per capita GDP is quite low, and so is the share of people living in cities, but they have a high birth rate. This group primarily includes countries in South and Southeast Asia, as well as Africa, including Equatorial Guinea.

There is a need to build an effective development platform for countries that are promising growth centers now or will become ones – a platform free from malign outside influence, with unimpeded access to resources, technology, personnel, finance, trade and investment. In this regard, the energy sector in particular, is crucial for economic growth and social progress.

Russia remains one of the leading participants in the global energy market. Over the past two and a half years, Russian companies have successfully redirected their exports of oil, petroleum products, and coal. Previously, the Asia-Pacific region accounted for about 39 percent of our energy exports, but by the end of last year, its share exceeded 60 percent.

Russia is expanding the geography and scale of its energy cooperation. New routes are being created to connect to fast-growing receptive markets, including the countries of the EAEU, the CIS, and southern Eurasia. Gas exports through the Power of Siberia pipeline are increasing, and LNG exports continue to grow.

Russia claims to have adopted the models of nuclear and hydraulic power industries that have a minimal carbon footprint, one of the 'greenest' in energy balance in the world.

LNG from the Russian Arctic has become one of the anchors, the main type of cargo shipped via the Northern Sea Route. Russia has expressed its commitment to continue to develop its LNG services and technologies, create centers for its transshipment, storage and trade. The country has planned to mobilize sufficient tankers for its LNG projects, augment the capacity of our Arctic and Eastern seaports, improve communications and enhance the Northern Sea Route infrastructure.

Russia in its plan is expanding international transport corridors. Freight traffic on these routes is scheduled to increase by at least 50 percent by 2030 compared to 2021. While developing the Eastern Operating Domain, the throughput capacity of the Baikal-Amur Mainline and the Trans-Siberian Railway, which is nearly 180 million tons this year, will grow to 270 million tons in ten years. This is expected to enable Russia to transport large volumes of fuel and energy products and refined products from the regions in Siberia to markets of the Global South.

To resolve various problems related to the system of payments, Russia is switching its trade settlements to national currencies, which is of great interest to its partners. In the gradual development, between 2021 and 2023, the share of the ruble in export payments has grown nearly threefold to 39 percent, and the figure reached 39.4 percent in the first six months of 2024.

In addition, the BRICS countries have been developing their own payment configuration that is expected to provide conditions for servicing all foreign trade efficiently and independently.

Russian energy exports could help allied countries restrain the growth of import prices, maintain their energy security and economic stability, as well as compete more successfully in the global market.

Russia expresses its commitment not to limit cooperation to trade in resources. The country further states that is ready to help strengthen the technological sovereignty of its partners in the energy sphere by creating comprehensive scientific and production chains. The similar cooperation is being done in the peaceful use of nuclear technology. Rosatom is building nuclear power plants abroad and simultaneously training local personnel –

engineers, workers and managers for the new facilities. It will not be limited to the country itself but will create new power generation and economic sectors for its partners.

While Russia saw immense growth in domestic energy consumption last year, setting a new record that exceeds the Soviet-era indicators, its energy system is claimed to have met the growing demand from businesses, the economy, and the social sphere, but also is in the process of qualitative transformation.

Over the past 15 years, the total capacity of the Russian power industry has increased by 18 percent, while the power plants themselves have undergone an in-depth overhaul, becoming more advanced, effective, and environment-friendly. For example, natural gas, an ecologically clean and effective hydrocarbon, accounts for 48 percent of Russia's energy balance and for over 85 percent.

Russia claims to have adopted the models of nuclear and hydraulic power industries that have a minimal carbon footprint, one of the 'greenest' in energy balance in the world. The country says, it will continue to upgrade and strengthen our energy system, which has entered upon a stage of retooling and conversion to new technological solutions.

The country has focused its substantial scientific and practical potential in a number of promising areas, such as renewable energy sources, small nuclear power plants, thermonuclear fusion, as well as hydrogen generation and production of motor vehicles, ships, and rail transport burning this kind of fuel. Research and technologies are at different stages of implementation in this regard.

It is important to be aware of this outlook and make plans for the future. The forward-looking approach is reflected in system-wide projects with long investment cycles, projects to master new technology, develop deposits and build the necessary infrastructure, power stations and grids.

The key priority is to satisfy demand on the domestic market and to ensure stable and affordable power supplies to the country's own regions, cities and companies. The country puts its emphasis that the fuel and energy sector must play its role in ensuring that all the 2030 national development goals are fulfilled.

According to the available estimates, power consumption will grow at an [annual] rate of two percent until the end of this decade in the world. During this period, Russia intends to launch 27 gigawatts of new power generating capacity, including thermal, hydro and nuclear power plants.

Over the past two and a half years, Russian companies have successfully redirected their exports of oil, petroleum products, and coal. Previously, the Asia-Pacific region accounted for about 39 percent of our energy exports, but by the end of last year, its share exceeded 60 percent.

In addition, the country looks forward to promote connectivity between the power grids in the Urals, Siberia and the country's east, while paying special attention to supplying power to Russia's Far East as power consumption there has been growing at a rate exceeding the national average, and it is expected to increase even more as manufacturing expands and as new housing, infrastructure and social facilities are built. The country is firm that the energy sector must be able to meet this demand by using modern coal power generation, with low environmental stress.

To ensure the reliability of power supply to the regions, Russia has applied a fundamentally new approach-- introduction of territorial grid organisations. The project starting in 2025, will operate in each region of the country and will be responsible for power supply. They will also take over abandoned facilities (unfortunately, there are some) and address the consequences of accidents on networks, among other responsibilities.

The Russian gas industry, which is undergoing serious changes, is not only reorienting exports from the west to the east but also significantly increasing supply to the domestic market, including under the social gas supply program launched in 2021, which is progressing at a good pace. The country has put forth its extensive plans to supply gas to all Russian regions and increase gas processing within the country.

Next, the growth of hydrocarbon processing volumes at Russian plants and complexes is another priority task for the domestic fuel and energy complex.

It is crucial to provide a raw material base and the necessary resource extraction. For this purpose, the Russian government is providing special tax incentives to the firms.

The energy projects in offshore fields, such as Prirazlomnoye in the Arctic and projects on Sakhalin, are being developed. Hard-to-recover reserves are being developed: the Palyanovskoye oil field in the Khanty-Mansiysk Autonomous Area and the Yuzhno-Neprikovskoye field in the Samara Region. New oil and gas provinces are being introduced in Eastern Siberia and the Arctic. The coal mining center in the Far East is expanding its capacity. The Pacific Railway, is starting its operation next year. It is a private railway going from the Elga field in Yakutia to the port of Elga in the Khabarovsk Territory.

It is essential that the exploration of Russia's unique reserves makes it possible to develop domestic processing enterprises, creating maximum added value in Russia. The country has launched a state program to upgrade oil refineries. Its goal is to provide the economy, cities, all populated areas and people with high-quality fuel, lubricants, bitumen, and other products.

Special focus must be placed on the development of oil, gas, and coal chemistry. According to estimates, the demand for these products will only grow both in Russia and around the world. Moreover, these sectors are highly profitable. The price from raw materials to final goods in the chains can grow up to 12 times.

The country has put forth its extensive plans to supply gas to all Russian regions and increase gas processing within the country.

Russia implements projects in this sphere, which are large even by global standards. The country's largest petrochemical plant, ZapSibNeftekhim, is operating, and the Amur Gas Chemical Complex, which will become the most powerful Russian enterprise for the production of basic polymers, is being built. There are other large projects as well. It is important that there be more such projects, that new production facilities are opened in various regions and modern, well-paid jobs are created.

Furthermore, it is clear that, under current conditions, the reliable operation of production fields, pipelines, refining facilities, and power plants, as well as the fuel and energy complex in general, is dependent on the availability of our own specialists, technologies, and competencies in the equipment used for producing and delivering resources, power engineering, and so on.

A national project to be launched next year will serve as a major system-wide instrument of support for domestic initiatives. It is called New Nuclear and Energy Technologies. This national project will set ambitious goals, namely, to consolidate Russia's global leadership in the nuclear sector.

Russia's fuel and energy complex is a modern, dynamic industry. The country claims to have successfully met current, including global, challenges and strengthens the raw materials, technological, and industrial sovereignty of our country; it supports and develops trade and cooperative ties with responsible foreign partners. Russia is fulfilling its obligations to supply energy resources to the world market and plays a stabilising role within it, participating in such authoritative formats as OPEC Plus and the Gas Exporting Countries Forum.

The country is firm that it will accomplish the strategic and long-term tasks facing its energy industry. It is committed to contribute to balancing the world energy markets for the sake of sustainable global development.

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Contingency Planning for *Addressing Energy Crisis*

Saleque Sufi

by planning and executing effective measures of austerity and efficiency and eliminating system loss, theft, and pilferages, the government can create comfort.

The prevailing energy crisis likely will deepen further in 2025 and 2026. The power and gas consumers will continue to suffer from supply shortages. Many small to medium-capacity industries may have to close business. Many people may lose their jobs. Local and foreign investment may slow down. The economy may suffer. There is no need to reinvent the wheel. The present interim government cannot turn around in the shortest possible time. It can stabilize the situation by making pragmatic plans and creating a congenial disciplined environment for seamless growth and development of the sector. Ill-motivated flawed planning and poor governance leading to an absence of transparency and accountability have created a weak and sick energy and power sector. The previous government took pride in bringing the country under a power supply grid. They boasted of achieving over 30,000MW grid and non-grid power generation capacity. However, for various reasons, from lack of primary fuel supply to transmission and distribution constraints and cash crisis for purchasing primary fuel, the power supply chain struggles to generate and supply consistently required power (less than 50% of installed capacity). Substantial superior quality coal resources remain unexploited and significant petroleum resources onshore and offshore could not be explored. Bangladesh does not have the resources to purchase primary fuel from the volatile global market. State-owned power and energy enterprises cannot meet the financial obligations to fuel and power suppliers for cash crises. The interim government has inherited all the above. The government in limited time has taken some major steps in disciplining the sector. But in a short time, it cannot increase power generation to the expected level nor can increase fuel supply to meet the actual present and emerging demand. But by planning and executing effective measures of austerity and efficiency and eliminating system loss, theft, and pilferages, the government can create comfort. For all these, the government requires bringing major changes in the governance process, placing the right people in the right places, and ensuring accountability and transparency in all transactions. The immediate task is making a short-term contingency plan for managing the impending crisis of 2025 and 2026. During the dry season (irrigation season), Ramadan and summer will increase power demand to 16,500-17,000MW from the average of 9,500-10,000MW now. There is no way the gas and LNG supply can be increased. The government will struggle to arrange money to purchase primary fuel and make payments for power purchases from private sector producers and exporters of India. This interim government is likely to stay in office

until June 2026 as it announced to hold a general election by then. The government must make and execute contingency plans to manage the crisis until then.

Present Situation of Power and Energy

The present installed generation capacity of grid power is 27,840MW. State-owned companies can generate 11,821MW (42%), private companies can contribute 10,885MW (39%), joint venture companies 2,478MW (9%), and import 2,656MW (10%). As per the BPDB website, 2,800MW captive generation, 549MW off-grid renewables, and 5MW off-grid HFO make a total generation capacity of 31,194 MW. However, according to BERC, captive generation capacity exceeds 4,000MW.

The real challenge is ensuring a sustainable supply of fuel for power generation. Gas supply is a major problem. Gas-based power plants need about 2,000 MMCFD gas to utilize 90% of the generation capacity. Due to production limitations, Petrobangla can supply only 1000-1100 MMCFD at summer peak. It is possible to generate 8,500-9,000MW of electricity with this amount of gas, leaving 2,500-3,000MW generation capacity idle. BPDB follows a merit-based generation policy. Recently, three highly fuel-efficient power plants have been constructed in the Meghnaghat area. These plants, apart from gas shortage, have gas supply infrastructure constraints. Until the under-construction Bakhrabad–Shiddhirganj 42-inch diameter transmission pipeline gets ready for operation, TGTDCL will not be able to economize gas supply for power generation. On the other hand, there is no possibility of increasing gas production from domestic gas fields over the short term. It is also not possible to increase LNG imports. In such a situation, the government has hardly any option but to ensure the generation of at least 4,500-5,000MW coal-based power consistently. For this, the necessary foreign currency must be provided to coal power companies for importing coal. Coal plants at Payra have no operational issues, but the Rampal power plant suffers from frequent technical glitches. Matarbari Power Plant had issues with coal import and Bashkhali Power Plant had contractual issues that the interim government must deal with. Another area of concern is payment to Adani Group and other export companies for the power they supply. During 2025 and 2026, Bangladesh will be required to import at least 2,000MW consistently. Then comes liquid fuel-based power generation. The government should gradually phase out dirty liquid fuel-based power generation. However, the situation demands keeping at least 3,500-4,000MW liquid fuel-based generation for peak shaving. For this, the government must ensure that the IPPs get payment for the power supplied and get government assistance for opening LCs for fuel import.

Contingency Measures

Intensive irrigation season from the middle of February 2025 will increase power demand by 2,500-3,000MW. Ramadan followed by summer will peak power demand to 16,500-17,000MW. In the present and emerging situation, it is highly unlikely that it will be possible to generate consistently over 15,000-15,500MW. The government is trying desperately to bring the first unit of the Rooppur nuclear power plant into operation. We are not sure whether infrastructures have been developed yet for the seamless evacuation of power to the national grid.

The other contingency measure can be effective demand-side management. During the summer peak, austerity measures must be introduced at all segments of the power supply chain. Cooling and lighting loads are the major sources of demand. Use of air conditioners must be rationalized in all government offices and organizations capping the colling to 25 degrees Celsius. The government must restrict all social events during the day, and none should be allowed for marriage and other social ceremonies past evening. Shopping hours on weekdays can be restricted to 8 pm. Shop owners may be given some alternate incentives to cover their business losses if any.

Industries use gas for captive power generation. BPDB may explore whether the excess power from the gas-based captive power plants can be evacuated to the grid.

Petrobangla is implementing a host of exploration and development projects. These projects must be treated as top-priority national projects, and all must ensure that the projects are implemented within schedule. BAPEX must be utilized to its capacity. International companies may not risk investment in the present political uncertainty as evidenced by no response to the Petrobangla PSC bidding round and poor response to bids for LNG import from spot market.

The government must also review relieving taxes and duties from the import of solar panels, inverters, and batteries. Given proper incentives, by the end of 2025 at least 1,000MW solar power can be made available to the grid from rooftop installations.

Even after taking all the initiatives, load-shedding during the summer peak cannot be avoided. Giving priority to power and energy supply to industries, planned load-shedding may be done with prior announcement. Petrobangla carrying out combing operations against unauthorized use of gas must endeavor to save 100-150 MMCFD gas and divert this for power generation.

All must realize that ensuring power and energy supply security is a national priority. Not only the government but also every sensible

citizen has the responsibility to ensure the optimum utilization of electricity and gas. All must do their best for efficient use and avoid wastage. There is no magic formula for solving the power and energy crisis that is inevitable now.

We may conclude by mentioning that energy efficiency and energy conservation are the keys. In the short time, it is not possible to increase fuel supply at a desired level from local sources or imports. All have to realize that cutting the coat according to the cloth is the only way to go now.

We have taken this story from Enegy and Power Magazine (6th January 2025) publish from Bangladesh, which is very popular magazine across the country.

The article is taken from Energy and Power Magazine, a popular publication in Bangladesh, dated January 6, 2025.

Flovel is a world-class equipment manufacturer and supplier specializing in hydropower and renewable energy. We spoke with Ranjil Basnet, established hydropower investor, entrepreneur and a supply partner of Flovel in Nepal, about the company's business expansion in Nepal as part of Urja Khabar's regular segment, Corporate Talk.

'Flovel's Success in Advancing Nepal's Hydropower Development'

1. How do you perceive the expansion of Flovel's market in Nepal's energy development sector?

As you are aware, Flovel has been synonymous with the hydropower sector for over five decades. Flovel is an India-based manufacturer of hydraulic turbines and valves and a full-line supplier of Electromechanical Equipment & Services for Small & Medium Hydropower plants. Flovel is relatively new to the Nepal market but has already established a strong footprint here. With 27 hydro projects in its portfolio, Flovel is the fastest-growing EM manufacturer in Nepal. Flovel has added a new state-of-the-art workshop to its currently existing workshop at Faridabad, India, targeting medium and large hydropower projects. Flovel has three full-time engineers posted in Nepal with a prime focus on after-sales service and spares-related requirements.

Flovel is receiving a positive response. Flovel is here for the long run and preparing to meet the demand of Nepal's requirement of a quality EM partner.

2. As a businessperson and a hydropower promoter, what types of equipment do you consider essential in Nepal's hydropower sector, especially in light of climate change and increasing natural calamities?

In Nepal's hydropower sector, both the growing demands of energy generation and the challenges posed by given issues require a careful selection of equipment. The right technology and infrastructure can enhance resilience and optimize energy production while also minimizing the environmental impact. The equipment/ infrastructure to be considered are:

a. Hydropower Turbines

- Francis Turbines: For medium- scale to large-scale projects, these turbines are commonly used in Nepal and can be adapted to varying water flow conditions, which may be influenced by shifting weather patterns due to climate change.
- Pelton and Kaplan Turbines: For projects involving high-head (Pelton) or low-head (Kaplan) systems, these turbines are vital for optimizing efficiency in diverse geographical conditions. Hydropower plants may need turbines that can operate effectively even during seasonal or long-term variations in river flow.

b. Flood Protection and Control Infrastructure

- Reservoir and Dam Safety Equipment: With Nepal's vulnerability to monsoon-induced floods and landslides, safety infrastructure like floodgates, spillways, and pressure relief systems is critical for preventing dam failure. These systems help control sudden increase in water volume.
- Sediment Management Systems: Sediment buildup can damage turbines and reduce efficiency, so effective sediment flushing mechanisms and hydraulic dredging systems are essential to maintain operational efficiency and ensure long-term sustainability.

c. Advanced Monitoring and Control Systems

- SCADA Systems (Supervisory Control and Data Acquisition): A modern SCADA system helps operators remotely monitor the status of the plant, detect anomalies, and respond to operational issues quickly. It is especially useful for early detection of problems caused by natural calamities like earthquakes or floods.
-

d. Seismic-Resilient Infrastructure

- Earthquake-Resistant Structure: Since Nepal lies in a seismically active zone, the hydropower infrastructure needs to be designed and constructed to withstand earthquakes. It includes using seismic dampers and flexible construction materials that allow some movement during tremors.

e. Flood Forecasting and Early Warning System

- Weather Prediction and Flood Forecasting Technology: The use of advanced meteorological equipment for real-time weather data is crucial for anticipating floods or drought conditions that can significantly affect hydropower generation. These include rain gauges, flow meters, and weather radar systems.
- GIS (Geographic Information Systems) for Disaster Management: GIS tools are useful for mapping flood-prone areas and predicting the potential impacts of natural disasters on hydropower plants, which is important for mitigation and emergency response planning.

f. Micro and Mini-Hydropower Equipment (for Remote Areas)

- Small-Scale Turbines: Micro-hydropower systems are becoming an important solution for off-grid rural areas, especially as climate change may cause shifts in seasonal water availability. Low-cost, durable, and easily deployable micro and mini-turbines can help power remote communities.
- Hybrid Systems: Combining micro-hydropower with other renewable sources like solar or wind can provide more stable and reliable energy to the community while reducing reliance on fossil fuels.

Nepal's hydropower sector requires a combination of advanced hydropower turbines, flood management infrastructure, seismic-resilient designs, smart grid systems, and environmental safeguards to address both the growing demand for energy and the increasing threats posed by climate change and natural calamities. Integrating climate-resilient technologies, data-driven monitoring systems, and sustainable practices will help Nepal's hydropower sector become more adaptable, reliable, and environmentally responsible in the face of a changing climate.

3. From the perspective of a hydropower entrepreneur, what are the primary risks associated with hydropower development in Nepal?

There are several key risks associated with the development of hydropower projects, ranging from environmental to political and financial factors.

a. Regulatory and Policy Risks

- Changes in Policy and Regulations: Frequent changes in hydropower-related policies including local government guidelines, licensing, and land acquisition processes, can create uncertainty and disrupt project timelines and financial forecasts.
- Regulatory Delays: Bureaucratic inefficiencies, frequent changes in the governing bodies, and complex compliance requirements often lengthen the permitting process.

b. Political Instability

- Government Changes and Policy Shifts: Political instability could lead to delays in decision-making, non-implementation of projects, or shifts in the focus of infrastructure development.
- Local Politics and Conflicts: Local resistance to hydropower development is common, especially when communities are displaced or affected by projects. Political conflicts at the local level can lead to protests, strikes, or legal challenges that delay or derail projects.

c. Environmental and Social Risks

- Environmental Impact: Nepal's natural landscapes are vulnerable to environmental degradation from hydropower projects. Issues such as river ecosystem damage, changes to water flow, and fish migration can attract criticism from environmental

organizations, leading to public backlash, legal challenges, or regulatory scrutiny.

- Social Displacement: While going into land acquisition process, if the compensation process is not handled effectively, it can lead to protests, legal battles, and long-term social unrest. Inadequate resettlement packages and poor rehabilitation measures can tarnish the developers' reputation.
- Cultural and Heritage Concerns: Many hydropower projects are located in areas with significant cultural or historical importance to local communities. Failure to address the cultural sensitivities of affected communities can result in resistance, social unrest, and protests.

d. Financial Risks

- High Capital Investment: Hydropower projects, particularly large-scale ones, require significant upfront capital investments. Political instability, environmental concerns, and regulatory uncertainties can result in notable risks to make it difficult to obtaining financing.
- Financing and Currency Risks: Many projects depend on foreign loans or investments, which exposes developers to risks of currency exchange rate, interest rate fluctuations, and changes in the global investment climate.
- Project Cost Overruns and Delays: As with any large infrastructure project, cost overruns and delays are a common risk. Delays in obtaining permits, construction challenges due to Nepal's mountainous terrain, and unforeseen environmental conditions can increase costs and extend project timelines.
- Revenue Risks: Uncertainty regarding the future of power purchase agreements (PPAs) and tariffs, especially in the context of changing energy policies, may affect revenue generation potential of a project. Additionally, power pricing might not reflect the true cost of production, leading to financial shortfalls.

e. Geological and Environmental Hazards

- Natural Disasters: Nepal is located in a seismically active zone and is prone to earthquakes, landslides, and floods. These natural hazards pose a significant risk to the safety of hydropower infrastructure and could lead to the destruction of facilities, delayed construction, or additional repair costs.
- Water Availability and Climate Change: Shifts in rainfall patterns, reduced snowmelt, or more extreme flooding caused by changing weather patterns and climate change could reduce the predictability and sustainability of water resources, affecting the operational performance of hydropower plants.

f. Infrastructural and Technical Risks

- Access to Remote Locations: Many hydropower projects in Nepal are located in remote and rugged mountainous regions, which presents logistical challenges in transporting equipment and labor. Poor infrastructure, including inadequate road access, can delay construction and increase operational costs.
- Transmission Infrastructure Constraints: Nepal's transmission and distribution network is limited, which can create bottlenecks for the evacuation of power from hydropower plants to urban centers or export markets. Investments in upgradation of the grid infrastructure are necessary but can be costly and time-consuming.
- Technical Expertise and Local Capacity: Developers often rely on foreign contractors and consultants, which can increase costs and create dependencies. The local capacity for operating and maintaining large hydropower plants is still developing, and there is a risk of underperformance due to technical issues or lack of training.

g. Market and Export Risks

- Export Markets and Power Grid Connectivity: While there is potential to export power to neighboring countries like India and China, the actual realization of these opportunities depends on cross-border energy agreements, grid interconnection projects, and the political climate. Delays in the development of regional transmission infrastructure or changes in trade policies could hinder export opportunities.
- Domestic Demand: While Nepal's domestic electricity demand is growing, it still depends heavily on imported electricity, particularly during dry seasons when hydropower generation is low. A mismatch between power supply and demand can affect the financial performance of hydropower projects, especially if they cannot export surplus power.

h. Supply Chain and Material Risks

- Material Shortages and Supply Chain Disruptions: Given Nepal's landlocked geography, many construction materials and equipment must be imported, often from India, China, or other countries. Disruptions in the supply chain (due to global shortages, trade barriers, or political issues) can delay construction or increase costs.
- Skilled Labor Availability: The demand for skilled labor (such as engineers, technicians, and project managers) often exceeds the supply, which can slow down the project development process.

Despite having significant opportunities in hydropower due to the country's abundant water

resources, it is fraught with numerous risks. Entrepreneurs need to carefully manage regulatory, environmental, financial, technical, and political risks while working closely with stakeholders to ensure the sustainability and profitability of their projects. Success in this sector requires a solid risk management strategy, local engagement, and a strong understanding of Nepal's unique challenges and opportunities in hydropower development.

4. What key factors should hydropower producers prioritize to ensure their projects' resilience and sustainability?

Producers must prioritize several key factors that address environmental, social, economic, and operational considerations. These factors are crucial for maintaining the long-term viability of hydropower plants while minimizing negative impacts.

Operational Efficiency:

Maintaining and upgrading turbines, generators, and other infrastructure is crucial for long-term operational efficiency. Regular maintenance schedules and modernization programs help extend their lifespan and optimize energy production.

Climate Change Adaptation

- Water Availability: Hydropower is highly dependent on water flow, which can be affected by changing precipitation patterns and temperatures due to climate change. Producers should invest in forecasting systems, diversify water sources (e.g., integrating with other renewable sources), and adapt their operational strategies for varying hydrological conditions.
- Extreme Weather Events: The frequency of extreme events such as droughts, floods, and heatwaves is rising. Hydropower projects should be designed to withstand these events, including infrastructure that can handle flooding and fluctuating water levels.

Summerising, ensuring the long-term resilience and sustainability of hydropower projects requires a holistic approach, balancing ecological, social, economic, and technical factors. By addressing these dimensions effectively, hydropower producers can contribute to sustainable energy generation while safeguarding vital environmental and social values.

Flovel Energy

Introduction

Established in 1971, FLOVEL Energy is a company committed to advancing hydropower solutions. Over the past 54+ years, the company has continually evolved, solidifying its reputation as a leader in the hydropower industry, globally.

Flovel has latest state of the art manufacturing facilities in India to produce high quality turbines and valves meeting global standards. Flovel is fully equipped with the capabilities of manufacturing all type of Hydro Turbines. Moreover, Flovel has vast experience in hydro turbine industry and also has the vital experience of working on various hydro power plants in India, Nepal, Vietnam, Japan and other countries globally.

Five-Star Commitment

- Expertise Across Generations: Over five decades of hydropower excellence.
- Customer-First Principle: Delivering optimal solutions with a customer-centric approach.
- Zero-Compromise Engineering: Best-in-class engineering ensures superior performance.
- State-of-the-Art Manufacturing: Cutting-edge facilities producing high-quality turbines and valves.
- Fast Forward Support: Comprehensive post-implementation support to ensure ongoing success.

Guiding Philosophy

"Success is a Spiral, not a Door": FLOVEL focuses on continuous improvement in performance and customer service, reinforcing its leadership in the hydropower industry.

Product Overview

Pelton Turbines: For high-head applications.

- Fully forged or cast runners.
- Factory-assembled and shop-tested units.
- Efficiency guarantees based on model tests.

Francis Turbines: For medium-head applications.

- Weld-fabricated or forged runners.
- Comprehensive model library

Kaplan / Axial Flow Turbines: For low-head applications.

- Oil-free runner hubs.
- Maintenance-free, water-lubricated guide bearings.
- Easy blade dismantling without runner removal.

Axial Flow Turbines: For very low-head applications.

Valves: Includes butterfly, spherical/ball, and pressure relief valves.

Mechanical BoP : Covers oil pressure systems, cooling water, drainage &dewatering, and more.

Electrical BoP: Comprehensive systems including

generators, transformers, switchgear, and automation. **Governor, Automation & SCADA:** Indigenous developed advanced digital solutions like iNDUS for monitoring and control.

Manufacturing Excellence

FLOVEL's 30,000m² facility is equipped with state-of-the-art machinery capable of handling unit up to 100 MW. Adhering to global safety and quality standards, the facility is operated by a team of skilled professionals ensuring top-notch products.

Research & Development

Innovation drives FLOVEL's success. The company invests heavily in R&D to deliver cutting-edge, customer-focused solutions, ensuring sustained leadership in the hydropower industry.

Digital Intelligence Ecosystem

iNDUS: FLOVEL's tailored digital solution for hydropower plants.

Features: Digital turbine governor, real-time monitoring, alarms, data security. Advantages: Versatile, flexible, user-friendly, cost-effective, and secure.

Fast Forward Support

FLOVEL's after sales service ensures:

- Maximum system profitability.
- Efficient operation.
- Failure prevention.
- Continuous updates to remain state-of-the rt.
- Prolonged system lifetime.

Conclusion

FLOVEL Energy stands as a beacon of trust and innovation in the hydropower sector, delivering high-quality solutions and unparalleled customer support worldwide.

Fascinating Fact

China's 60,000 MW Hydropower Project: A New Era in Renewable Energy

China is set to construct a massive 60,000 MW reservoir-based hydropower project on the Brahmaputra River (known as Yarlung Tsangpo in China) in the autonomous region of Tibet. Named as the "Medog Project," this undertaking will surpass China's Three Gorges Dam (22,500 MW) -- currently the world's largest -- by nearly three times in size and production capacity. Utilizing ahead of 2,000 meters at the **"Great Himalayan Bend"** of the Brahmaputra River, the massive dam will harness the river's flow to generate this unprecedented amount of electricity.

The "Power Construction Corporation of China," responsible for the project, has stated that upon completion, it will be recognized as the world's largest civil engineering project, setting a record unlikely to be broken for a long time. It will stand as an exceptional example of human ingenuity. The project, part of China's 14th Five-Year Plan, is targeted for completion by 2033, with a vision to supply renewable energy to less energy-intensive provinces.

However, India has expressed its concern with opposition, fearing that China might divert the Brahmaputra's water northward through this massive dam. Environmental experts warn of potential negative impacts, including reduced water flow downstream and an increased risk of artificial flooding. Concerns have also been raised about water shortages in downstream regions.

China announced the project in 2021 on the Yarlung Tsangpo River, its longest river. Located in Medog County, Tibet, near India's Arunachal Pradesh, the dam is expected to accelerate Tibet's economic growth and support China's strategic goal of achieving carbon neutrality by 2060. While the dam is designed to retain significant volumes of sediment, which could benefit agriculture downstream, studies suggest it might also reduce agricultural productivity in these areas. If China releases water from the dam, it could exacerbate flooding in India's Assam state, which is already prone to recurring inundation. China, however, claims the project is a run-of-the-river (RoR) scheme that will not impact downstream water flow.

Experts caution that building such a massive dam in the Himalayan region poses unimaginable risks for downstream areas. With the region already experiencing the effects of climate change, large-scale dam construction could lead to deforestation, soil erosion, and increased incidents of floods and landslides. The Brahmaputra River, originating from Mount Kailash at an altitude of 5,300 meters, flows through Tibet, enters India via Arunachal Pradesh, passes through Assam and Bangladesh, and ultimately empties into the Bay of Bengal. The river basin spans 293,000 square kilometers in Tibet, 240,000 square kilometers in India and Bhutan, and 47,000 square kilometers in Bangladesh.

According to Global Data, by the end of 2023, hydropower accounted for 15.40% (1,407 GW) of the world's total electricity generation capacity. This capacity is estimated to increase by 10.90% to 1,562 GW by 2030. Notably, 29.95% of the world's total hydropower capacity is located in China, as reported by Global Data.

The Perils of Progress

Vivekanand Jha

We're aboard a rudderless boat,
The pace lost between nature and species,
Like two soldiers marching out of step.
What were once old-age diseases and disabilities
Are now found in sperm, embryos, and infants.

Global warming is poised
To spit its deadly venom,
Like the raised hood of a cobra.
It crawls clandestinely,
Like a crocodile in quest of its prey.

Climate betrays like a chameleon changes its color,
Calamities arrive like uninvited guests,
Summer burns like a furnace fire,
Winter falls like snow on Everest.

Some by drought, some by deluge;
Draining drops of diligence
Into the gutter of self-carved calamity.

This Poem is An International Bilingual Poetry Anthology, It is co-published by Korean Expatriate Literature & Cross-Cultural Communications

Potential of Power Generation from different sources

Source	Capacity (MW)
Hydropower (WECS Study)	72,000 (Technical and Economics)
Hydropower (Dr. Hariman Shrestha)	83,000
Micro Hydropower	100
Solar PV (GIZ)	432,000
Wind Power	3000

Power Generation Scenario

Source	Capacity
Hydropower	3240.71
Hydropower (Isolated)	4.536
Thermal	53.41
Grid Connected Solar	97
Co-Generation	6
Off Grid (Micro hydro, Solar)	103
Total Generation	3505

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

South Asia Energy Scenario (MW)

S.N	Country	Installed Power	Potiential power (Hydro)	Installed (Hydro)
1	Afghanistan	1285	23000	600
2	Bangladesh	27515	-	230
3	India	426140	150,000	52,117
4	Bhutan	2600	36900	2600
5	Nepal	3505	1,00,000	3240.71
6	Sri Lanka	5024	2000	1727
7	Maldives	290	-	-
8	Pakistan	4035	60,000	10,635
9	China	2920 (GW)	600 (GW)	421 (GW)

Per Capita Energy Consumption (KWh)

Country	Quantity
Afghanistan	152
Bangladesh	484
India	1327
Bhutan	5550
Nepal	400
Sri Lanka	631
Maldives	1125
Pakistan	560
China	5728

Existing High Voltage Transmission Lines (FY 2080/81)

S.N	Description	Length Circuit km
1	66 kV Transmission Line	514
2	132 kV Transmission Line	4136
3	220 kV Transmission Line	1213
4	400 kV Transmission Line	644
	Total	6508

Sources of Power Generation (MW)

Institution	Hydropower		Solar	Thermal	Co-generation	Micro Hydro	Total
NEA	Grid 578.05	Off Grid 4.536	25	53.41			661
NEA Subsidiry	646.4						646.4
IPP	2016.26		71.94		6		2094.20
AEPC			62.75			40.25	103
Total	3240.71	4.536	159.69	53.41	6	40.25	3505

Energy Development Roadmap, 2081, Officially Announced by Government
Indicators of achievement in the energy sector by 2035

Particulars	2024 A.D or 2081 B.S.	2035 A.D. or 2092 B.S
Total Installed Capacity	3402 MW	28,500 MW
Per-Capita Energy Consumption	400 unit	1500 unit
Electricity Export	941 MW	15000 MW
Broadcasting systems	6,507 Circuit KM	17,446 Circuit KM
Substation	13,050 M.V.A	40,000 M.V.A
Electrical access	98%	100%
Annual Energy Demand	27,700 GWh	40,710 GWh

Projection of Investment According to Roadmap

S.N	Source of Investment	Amount (billion, USD)	Percentage
1.	NRN and Remittances	12	26
2.	Internal Management	10	22
3.	Foreign Grants and Loans	8.5	18
4.	Nepal Electricity Authority	8	17
5.	Government of Nepal	6	13
6.	Climate Finance	2	4
	Total	46.5	100

Hydropower Projects Projected to be Constructed with the Objective of Achieving the Targets

S.N	Project's Details	Capacity (MW)	Percentage
1.	PPA is in Process	12,968	46
2.	PPA Completed	11,168	39
3.	Indian Government Company	3,700	13
4.	Nepal Electricity Authority	662	2
	Total	28,498	100

Slogan: To become a partner in nation-building by developing and operating hydropower projects to boost the country's renewable energy production.

greenlife
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GEPPERT

Turbine	3 Jet Pelton
Head	237.8 m
Total Capacity	8.5 MW
Project Name	Upper Hewa Khola
Country	Nepal
Year of completion	2022

Turbine	Francis
Head	187.2 m
Total Capacity	19.8 MW
Project Name	Upper Solu Khola
Country	Nepal
Year of completion	2023

Turbine	4 Jet Pelton
Head	632.7m
Total Capacity	54 MW
Project Name	Super Dordi
Country	Nepal
Year of completion	2023

Turbine	Francis Turbine
Head	188.9 m
Total Capacity	40 MW
Project Name	Upper Chameliya
Country	Nepal
Year of completion	2023

Turbine	2 Jet Pelton
Head	128 m
Total Capacity	998 KW
Project Name	Chukeni Khola HPP
Country	Nepal
Year of completion	2024

Turbine	Francis Turbine
Head	182.2 m
Total Capacity	9.7 MW
Project Name	Ingwa Khola
Country	Nepal
Year of completion	2024

Turbine	Francis Turbine
Head	120 m
Total Capacity	9.9 MW
Project Name	Kuwarsi
Country	India
Year of completion	2024

Turbine	3 Jet Pelton
Head	320.59 m
Total Capacity	6 MW
Project Name	Super Hewa Khola
Country	Nepal
Expected Year of completion	2025

PROJECTS UNDER EXECUTION
Upper Lohore - 4.2 MW
Upper Piluwa Khola - 2 HEP - 4.72 MW
Upper Irkhuwa Khola HEP - 14.5 MW
Upper Deumai Khola - 8.3 MW
Khani Khola Balance of Plant Equipment - 30 MW
Irkhuwa Khola - B HEP 15.52 MW
Phedi Khola SHEP – 4.3 MW
Rellichu - 1 HEP - 28.8 MW
Banu HEP - 5 MW
Pareng HEP - 14.55 MW

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EMPOWERING EVERYONE EVERYWHERE

WATER TO WIRE SOLUTIONS FOR HYDRO PROJECTS