विद्युत VIDYUT

◆ वर्ष ३६ ◆ अंक १ ◆ भाद्र २०८२

नेपाल विद्युत प्राधिकरण ८औं वार्षिकोत्सव २०८२-२०८३

नेपाल विद्युत प्राधिकरण

दरबारमार्ग, काठमाडौं

MoU Signing Ceremony between Nepal Electricity Authority & Power Grid Corporation of India Limited.

Recently Completed Udipur Substation in Lamjung District

विद्युत

◆ वर्ष ३६ ◆ अंक १ ◆ भाद्र २०८२

प्रकाशन/व्यवस्थापन

पुनम जोशी

मिनु थापा

बिमला महर्जन

अलिसा बरुवाल

कुसुम कुमारी शर्मा

मिना कुमारी देवकोटा

प्रकाशक:

नेपाल विद्युत् प्राधिकरण
सामान्य सेवा विभाग
जनसम्पर्क तथा गुनासो
व्यवस्थापन शाखा
दरबारमार्ग, काठमाडौं
फोन. ४१५३०२१, ४१५३०२२
आन्तरिक : २००२, २००३
इमेल : pro@nea.org.np

मुद्रण/डिजाइन:

जय भैरव इन्टरप्राइजेज
काठमाडौं
फोन : ०१-५५२३८८२
इमेल : raashushrestha@gmail.com

संरक्षक

हितेन्द्र देव शाक्य
कार्यकारी निर्देशक

सल्लाहकार

दिर्घायु कुमार श्रेष्ठ
उपकार्यकारी निर्देशक
वितरण तथा ग्राहक सेवा निर्देशनालय

तुलाराम गिरी
उपकार्यकारी निर्देशक
प्रशासन निर्देशनालय

मदन तिम्सिना
उपकार्यकारी निर्देशक
उत्पादन निर्देशनालय

सम्पादन समिति

राजन ढकाल
नि. उपकार्यकारी निर्देशक
प्रसारण निर्देशनालय

बेल प्रसाद शर्मा
निर्देशक
अपर अरुण हाईड्रो इलेक्ट्रिकल कम्पनी लिमिटेड

बलराम सिलवाल
निर्देशक
जनसाधन विभाग

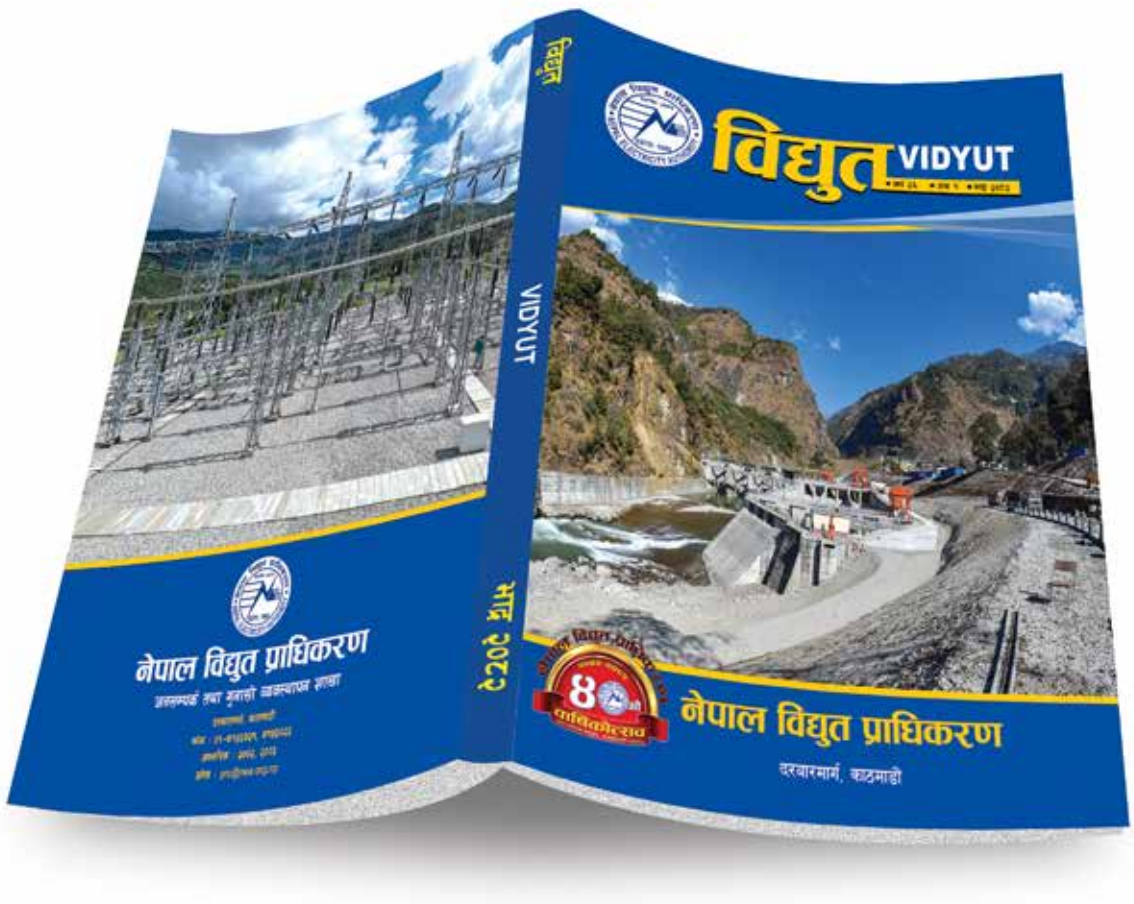
शिव कुमार अधिकारी
निर्देशक
पदपूर्ति विभाग

अच्युत बाबु घिमिरे
निर्देशक
योजना तथा प्राविधिक सेवा विभाग

शिव प्रसाद आचार्य
निर्देशक
सामान्य सेवा विभाग
कार्यकारी सम्पादक

राजा भाई सिल्पकार
निर्देशक
कार्यकारी निर्देशकको सचिवालय

सर्वजित कुमार चौधरी
प्रमुख
जनसम्पर्क तथा गुनासो व्यवस्थापन
शाखा



आवरण तस्विर: निर्माणाधीन मध्य भोटेकोशी जलविद्युत कम्पनीको ड्याम साइट

आवरण अन्तिम तस्विर: Completion of New Modi 132kV Bay Expansion Work

'उज्यालो नेपालको संवाहक'

नेपाल विद्युत प्राधिकरण

(नेपाल सरकारको स्वामित्व)

प्रधान कार्यालय, दरबारमार्ग, काठमाडौं

शुभकामना

नेपाल विद्युत प्राधिकरणको नियमित अर्धवार्षिक प्रकाशन "विद्युत" वर्ष ३६, अंक १ प्रकाशन हुन लागेकोमा खुशी लागेको छ।

कूल ७५३ पालिका मध्ये ७३५ पालिका, ६७४३ वडा मध्ये ६४१८ वडामा भरपर्दो विद्युत सेवा पुऱ्याउन सफल रहेको प्राधिकरणले कर्णाली र सुदूरपश्चिम प्रदेशका बाँकी क्षेत्रमा समेत विद्युतीकरणको कार्यलाई प्राथमिकताका साथ अगाडि वढाएको छ। प्राधिकरणले आफ्नो नीतिगत, संरचनागत, प्रक्रियागत र व्यवहारगत कार्यप्रणालीमा रचनात्मक सुधार गर्दै मुलुकलाई ऊर्जा क्षेत्रमा आत्मनिर्भर र सुरक्षित बनाउन तथा सेवा प्रवाहलाई थप गुणस्तरीय, विश्वसनीय, सरल, सुलभ, जनमैत्री तथा प्रविधिमैत्री बनाउन क्रियाशील रही आएको छ।

मुलुकमा उत्पादित विद्युत स्वदेशमै खपत गर्ने व्यवस्था मिलाई सामाजिक, आर्थिक रुपान्तरण तथा हरित अर्थतन्त्र प्रवर्द्धन अभियानमा जुटेको प्राधिकरणले स्वदेशमा खपत हुन नसकेको अतिरिक्त ऊर्जा मित्रराष्ट्र भारत र बङ्गलादेशमा निर्यात सुनिश्चित गरी जलविद्युतलाई मुलुकको अर्थतन्त्रको महत्वपूर्ण मेरुदण्डको रुपमा विकास गर्न समेत प्राधिकरण सफल भएको छ।

नियमित, गुणस्तरीय र भरपर्दो विद्युत आपूर्तिलाई सुनिश्चित गर्दै अन्तरदेशीय विद्युत व्यापारबाट राष्ट्रको अर्थतन्त्रलाई टेवा पुऱ्याउन दूधकोशी जलाशययुक्त, माथिल्लो अरुण, तामाकोशी-५,चैनपुर-सेती जस्ता जलविद्युत आयोजनाहरूको निर्माण कार्य अगाडि बढाइएको छ भने ऊर्जा सम्मिश्रण कार्यक्रम अन्तर्गत सौर्य ऊर्जालाई प्राथमिकतामा राखिएको छ। कुलेखानी-सिस्नेरी, हुलिङटार एवम् स्यार्फुदह जस्ता पम्पस्टोरेज आयोजना निर्माणका लागि लाइसेन्स प्राप्तिको प्रक्रिया अगाडि बढाइएको छ। ऊर्जा आयात निर्यातका लागि अन्तरदेशिय प्रसारण लाइनहरूको विकास, विस्तार एवं स्तरोन्नतिमा विशेष जोड दिनु आवश्यक देखिएको छ। यसका साथै निजी क्षेत्रलाई उल्लेख्य प्रोत्साहन हुने गरी ऊर्जा विकासमा लगानी गर्ने वातावरण सृजना गर्नु पनि उत्तिकै आवश्यक देखिन्छ।

प्राधिकरणले आफ्नो लगानीसँगै नेपाल सरकार र विभिन्न दातृ निकायहरूको आर्थिक सहयोगमा १४० मेगावाटको तनहुँ, ४० मेगावाटको राहुघाट, ३७ मेगावाटको माथिल्लो त्रिशुली ३ बी, ४६ मेगावाटको अपर मोदी लगायतका विभिन्न आयोजनाहरू तथा नयाँ प्रसारण लाइन र सवस्टेशन निर्माणको कार्यहरू द्रुत गतिमा अगाडि बढाई सम्पन्न हुने चरणमा छ।

प्राधिकरणको सेवालाई अझ प्रभावकारी बनाउन, प्रणालीलाई स्वचालित बनाई भरपर्दो र गुणस्तरीय विद्युत आपूर्ति सुनिश्चित गर्न, कर्मचारीलाई तालिम र संस्थालाई डिजिटाइजेसन गर्ने कार्यलाई उच्च प्राथमिकतामा राखी आधुनिक डिजिटल प्रविधि र कृत्रिम बौद्धिक प्रविधि समेत प्रयोग गर्दै हरेक क्रियाकलापलाई डिजिटल प्रविधिमा रूपान्तरण गर्न शुरु गरिएको छ। प्रसारण लाइन तथा वितरण प्रणालीको सुदृढीकरणको लागि ठूलो परिमाणमा लगानी गर्नुपर्ने अवस्था रहेको र प्राधिकरणको श्रोत साधनबाट मात्र उक्त लगानी सम्भव नरहेको कारण वित्तीय व्यवस्थापनमा चुनौती रहेको छ।

विद्युत प्राधिकरणको ४०औँ वार्षिकोत्सवको अवसरमा प्राधिकरणलाई एक विशिष्ट र सफल व्यावसायिक संस्थाको रूपमा स्थापित गराउन सदैव सहयोग र मार्गनिर्देश गर्ने नेपाल सरकार,ऊर्जा,जलस्रोत तथा सिंचाई मन्त्रालय,दातृ निकाय,कार्यरत कर्मचारी,क्रियाशील ट्रेड युनियन, पूर्व कर्मचारी,आम उपभोक्तालगायत सम्बद्ध सबैप्रति हार्दिक आभार प्रकट गर्दै आगामी दिनमा समेत निरन्तर सहयोगको अपेक्षा गर्दछु।

अन्त्यमा, विद्युत पत्रिकाको यस अंकलाई पूर्णता दिनका लागि स्तरीय लेख रचना उपलब्ध गराउनु हुने सर्जकहरू, सम्पादक मण्डल एवं प्रकाशन व्यवस्थापनमा संलग्न सबैलाई हार्दिक धन्यवाद ज्ञापन गर्दै प्राधिकरणको सिर्जनात्मक क्रियाकलापहरूको निरन्तरताको लागि शुभकामना व्यक्त गर्दछु।

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हितेन्द्र देव शाक्य

कार्यकारी निर्देशक

१ भदौ,२०८२

सम्पर्क फोन : ०१४१५३००७, ०१४१५३०१२, ०१४१५३१९३, ०१४१५३०८२ फ्याक्स : ०१४१५३००९

Email: neamd@nea.org.np, Web: www.nea.org.np

सम्पादकीय

नेपाल विद्युत प्राधिकरणको नियमित अर्धवार्षिक प्रकाशन **"विद्युत"** को वर्ष ३६ अंक १ प्रकाशन गर्न पाउँदा सम्पादन समिति हर्षित भएको छ । विद्युत राष्ट्रिय अर्थतन्त्र एवं आम जनताको जनजीविकासँग जसरी जोडिँदै गएको छ त्यसरी नै यस क्षेत्रसँग चासो राख्ने व्यक्ति, संस्था र समुदायको दायरा फराकिलो बन्दै गएको छ । त्यसैले विद्युत र विद्युत प्राधिकरणसँग चासो राख्ने सम्पूर्ण सरोकारवाला पक्षहरूको लागि मूलत: विद्युत सम्बन्धी जानकारी उपलब्ध गराउनका लागि समसामयिक विषयमा लेखिएका लेखहरूको सँग्रहको रूपमा यो अंक प्रकाशन गरिएको छ ।

हरित ऊर्जाको विकास र विस्तारबाट वातावरण संरक्षण गर्दै जनजीविकामा सहजता ल्याउने, देश भित्र औद्योगिक विकास गर्ने र क्रमश: पेट्रोलियम पदार्थको आयात प्रतिस्थापन गरी आत्मनिर्भर अर्थतन्त्रको बाटोमा मुलुकलाई अगाडि बढाउन विद्युत प्राधिकरण क्रियाशील रहेको छ । निकट भविष्यमा नै सारभूत रूपमा देशभर राष्ट्रिय ग्रिड मार्फत विद्युत सेवा पुऱ्याउने गरी प्राधिकरण क्रियाशील रहेको छ ।

विद्युत सेवाको पहुँच विस्तार मात्र होइन अविच्छिन्न र गुणस्तरीय विद्युत सेवा सुलभ मूल्यमा उपलब्ध गराउन पनि विद्युत प्राधिकरणले पूर्वाधार विकासलाई ध्यानमा राख्दै ठूलो लगानी गर्दै आएको छ । विद्युत क्षेत्रको समग्र सुधार एवं विकासको लागि प्राधिकरणको लगानी मात्र पर्याप्त नहुने भएकाले नेपाल सरकार तथा निजी क्षेत्रबाट समेत थप पूँजीगत लगानी गर्नु आवश्यक देखिएको छ । गुणस्तरीय विद्युतको राष्ट्रिय अन्तर्राष्ट्रिय माग पूर्ति गर्दै समृद्धिको महाअभियानमा ऊर्जा क्षेत्रलाई संवाहक बनाउनु आजको आवश्यकता हो ।

ग्राहक सेवालाई थप प्रभावकारी बनाउन कल सेन्टरहरूको विस्तार तथा विद्युत सेवालाई प्रविधि मैत्री बनाउन अनलाइन दरखास्त लिने, स्मार्ट मिटरिङ्ग लागू गर्ने, अनलाइन पेमेन्ट सेवा विस्तार गर्दै जाने कार्यलाई पनि प्राथमिकता दिँदै आएको प्राधिकरणले अबका दिनमा कर्मचारीहरूलाई तालिम तथा विकासको अवसर दिने, कर्मचारीहरूलाई योग्यता तथा अनुभव समेतका आधारमा सही जिम्मेवारी प्रदान गर्ने, निर्णय प्रक्रियामा Artificial Intelligence को प्रयोग बढाउँदै लैजानु आवश्यक देखिन्छ ।

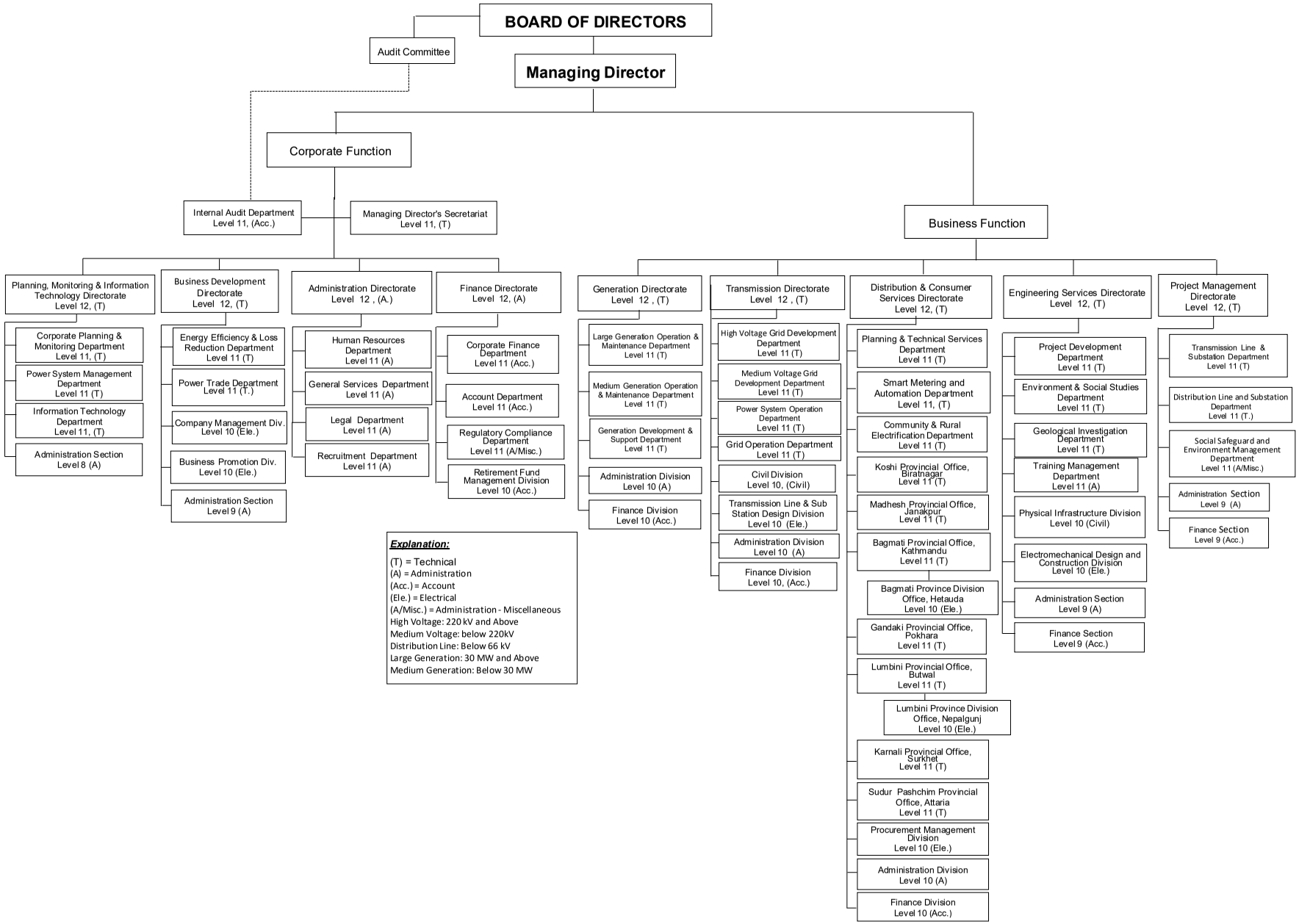
अन्त्यमा, विद्युत अर्धवार्षिक पत्रिकाको यस अंकलाई पठनयोग्य एवं उपयोगी बनाउनका लागि लेख रचनाहरू उपलब्ध गराउनुहुने संस्था भित्र तथा बाहिरका सम्पूर्ण सर्जकहरू एवं यस अंकको प्रकाशनमा प्रत्यक्ष परोक्ष सल्लाह सुझाव दिनुहुने महानुभावहरू प्रति हार्दिक आभार प्रकट गर्दछौं । विद्युतको आगामी अंकहरूलाई पनि सदा झैं समसामयिक, ज्ञानवर्द्धक एवं उत्कृष्ट लेख रचनाहरू उपलब्ध गराइ सहयोग पुऱ्याइ दिनुहुन सबैलाई आग्रह गर्दै हार्दिक धन्यवाद ज्ञापन गर्दछौं ।

सम्पादन समिति

रचनाक्रम

NEPAL ELECTRICITY AUTHORITY

Organization Structure



प्रसारण लाइन निर्माणका चुनौती र समाधानका उपायहरू

राज कुमार पोखरेल
उप निर्देशक, ने.वि.प्रा.
कानून विभाग

पृष्ठभूमि :-

हाम्रो संवैधानिक विकास क्रम र प्रचलित कानूनी व्यवस्था हेर्दा नेपालको संविधान २०१९ मा सम्पत्तिको हकलाई मौलिक हकमा राखी सम्पत्तिको हक सम्बन्धि धारा १५ को कानून बमोजिम बाहेक कुनै पनि व्यक्तिको सम्पत्ति अपहरण हुनै छैन भनी उल्लेख गरेको छ भने नेपाल अधिराज्यको संविधान २०४७ को मौलिक हक अन्तर्गत धारा १७ मा सार्वजनिक हितको लागि बाहेक राज्यले कुनै व्यक्तिको सम्पत्ति अधिग्रहण वा प्राप्त गर्ने वा त्यस्तो सम्पत्ति उपर अरु कुनै अधिकारको सृजना गर्ने छैन । सार्वजनिक हितको लागि राज्यले कुनै व्यक्तिको सम्पत्ति अधिग्रहण गर्दा दिनुपर्ने क्षतिपूर्ति कानूनद्वारा निर्धारित भए बमोजिम हुने छ भन्ने व्यवस्था रहेको छ । नेपालको संविधान २०७२ को धारा २५ मा प्रत्येक नागरिकलाई कानूनको अधीनमा रही सम्पत्ति आर्जन गर्ने, भोग गर्ने, बेचविखन गर्ने, व्यावसायिक लाभ प्राप्त गर्ने र सम्पत्तिको अन्य करोबार गर्ने हक हुनेछ भने ऐ उपधारा (३) मा प्रयूक्त "क्षतिपूर्ति" भन्ने शब्दावलीको उचित र पर्याप्त (just and fair compensation) क्षतिपूर्तिलाई इंगित गरेको मान्नु पर्ने हुन्छ । क्षतिपूर्ति बिना व्यक्तिको सम्पत्ति अधिग्रहण हुन नसक्ने अवस्थालाई मौलिक हकको रूपमा संविधानमा नै सुनिश्चित गरेको हुँदा मुआब्जा निर्धारण गर्दा उचित र पर्याप्त क्षतिपूर्ति निर्धारण नभएमा व्यक्तिको सम्पत्ति अधिग्रहणको नाममा हरण र जफत हुन गई उल्लिखित संवैधानिक प्रावधान केवल सजावटी (ornament) व्यवस्थामा परिणत हुन जाने भएकाले राज्यका सम्बन्धित निकायले संवेदनशील हुनु पर्दछ ।

माथि उल्लेखित संवैधानिक व्यवस्थाले सार्वजनिक हितको प्रयोजनका लागि भने राज्यले व्यक्तिको सम्पत्ति अधिग्रहण गर्न सक्ने राज्यको अन्तरनिहित प्रथमाधिकार (Eminent domain) लाई भने अन्यथा भन्न सक्ने अवस्था छैन ।

सम्पत्तिको अधिकारसम्बन्धी विधिशास्त्रीय मान्यतामा सार्वजनिक हितका लागि राष्ट्रिय सम्पत्ति उपर राज्यको पहिलो हक *(Eminent domain)* राज्यका अन्तरनिहित रहने र सम्पत्ति प्राप्त गर्ने सन्दर्भमा राज्यलाई उक्त सिद्धान्त अन्तर्गत व्यक्तिको सम्पत्ति वृहत्तर राष्ट्रिय हितका लागि राज्यले नियन्त्रण, नियमन र अंकुश लगाउन सक्ने ।

जग्गा प्राप्त गर्दा विचारणीय विषय :-

मुलुकको सर्वाङ्गीण विकासको निम्ति जलविद्युत, जलाशययुक्त आयोजना, नहर, रेल, सडक, खानेपानी, औद्योगिक क्षेत्र लगायतको सार्वजनिक हितको क्षेत्रमा निर्माण र विस्तार आवश्यक हुन्छ । तर विकास निर्माणको कार्य गर्दा नागरिकको सम्पत्ति सम्बन्धी हकलाई कानून बमोजिम वृहत्तर राष्ट्रिय हितका लागि राज्यले नियन्त्रण नियमन र अंकुश लगाउदा कानूनका कार्यविधिगत कुराहरूलाई मिहिन ढंगले हेर्नु पर्ने हुन्छ ।

राज्यले व्यक्तिको सम्पत्ति अधिग्रहण गर्दा क्षतिपूर्तिको आधार र कार्यप्रणाली ऐन बमोजिम हुनेछ भन्ने व्यवस्था रहेको देखिँदा व्यक्तिको सम्पत्ति अधिग्रहण गरी मुआब्जा निर्धारण गर्दा होस् वा क्षतिपूर्ति निर्धारण गर्दा कानून बमोजिमको प्रक्रिया (Due process of law) अवलम्बन गर्नुपर्ने हुन्छ ।

सार्वजनिक हितको लागि जग्गा प्राप्त गर्दाको स्थितिमा क्षतिपूर्तिको आधार के हुने, जग्गा प्राप्त गर्ने निर्णय गर्दाको अवस्थाको मूल्य हुने, क्षतिपूर्ति निर्धारण गर्दा घर वा जग्गाको के कति हिस्सा वा प्रतिशत प्राप्त हुन गएको छ, जग्गा प्राप्त गरेको कारणबाट व्यक्तिको बसोबास र सम्पत्तिको आर्थिक मूल्य (economic value) बढ्ने वा घट्ने स्थिति के रहेको छ । पूर्वाधारको निर्माणबाट त्यस्तो व्यक्तिलाई फाइदा वा नोक्सान के हुने स्थिति छ, सरकारबाट हस्तान्तरण भएका र समुदायको अधुरो हक (inchoat Right) भएका श्रोतहरू प्राप्त भएको अवस्थामा जग्गा प्राप्ति ऐन २०३४ को कानूनी प्रावधान आर्कषित हुने नहुने सम्बन्धमा जग्गा अधिग्रहण वा क्षतिपूर्ति निर्धारण गर्ने निकायले मनन गरी कार्य गर्नुपर्ने हुन्छ ।

प्राधिकरणले प्रसारण लाइनको लागि नागरिकको सम्पत्ति आवश्यक परी अधिग्रहण गर्नुपर्ने भएमा कानूनले निर्धारण गरेको प्रक्रिया *(Due process of law)* पुऱ्याएर मात्रै अधिग्रहण गर्न सकिने ।

विद्युत प्रसारण लाइनको अवस्था :-

विद्युतको उत्पादन केन्द्रबाट उत्पादित विद्युत शक्तिलाई सवस्टेशनसम्म पुऱ्याउने संरचनालाई प्रसारण लाइन भनिन्छ । अर्को शब्दमा भन्दा विद्युत ऊर्जालाई उत्पादन स्थलबाट उपभोक्ता सम्म पुऱ्याउने तार, खम्बा, टावर, र अन्य उपकरणको प्रणाली नै प्रसारण लाइन हो । यो प्रणालीले विद्युत ऊर्जालाई लामो दूरी सम्म पुऱ्याउने कार्य गर्छ ।

नेपाल विद्युत प्राधिकरणको विद्युत प्रणालीमा ३३ के.भी.,६६ के.भी.,१३२ के.भी.,२२० के. भि.र ४०० के.भी. भोल्टेज स्तरमा विद्युत प्रसारण भइरहेका छन् । नेपाल विद्युत प्राधिकरणले वा कुनै निकायले सवस्टेशन मात्र निर्माण गर्दा कुनै एक स्थानमा मात्र जग्गा अधिग्रहण गर्दछ भने प्रसारण लाइन निर्माण गर्दा टावर प्याडको लागि विभिन्न स्थानमा अवश्यक जग्गाको क्षेत्रफल जति जग्गा अधिग्रहण गर्ने गर्छ । प्रसारण लाइन मुनिको जग्गा अर्थात् Right of way भित्रको जग्गा, बालीनाली, घरगोठ भौतिक वस्तुको क्षतिपूर्ति दिइन्छ । प्रसारण लाइन मुनि पर्ने जग्गा प्राधिकरणले प्राप्त गर्दैन । उक्त जग्गाको स्वामित्व यथावत जग्गाधनीमा रहन्छ । प्रसारण लाइनको मुनि पर्ने जग्गामा कानूनले नै आवासीय घर निर्माण गर्न र रुख लगाउन प्रतिबन्ध लगाएको छ ।

विद्युत प्रसारण लाइन निर्माण गर्दाका चुनौती :-

जुन काम गर्न कठिन वा समस्या हुन्छ, त्यसलाई समाधान गर्न प्रयास गर्नुलाई चुनौती भनिन्छ । कुनै पनि कार्यको लक्ष्यसम्म आइपुग्ने परिस्थितिहरू, कठिनाइहरू नै चुनौती हुन् । यहाँ प्रसारण लाइन निर्माण गर्दाको चुनौतीलाई हेरिएको छ ।

कार्यविधिगत प्रक्रियाका चुनौती :-

उत्पादित विद्युत शक्तिलाई एक निश्चित गन्तव्यमा पुऱ्याउने विद्युतीय संरचना निर्माण गर्न आवश्यकता महसुस भएपछि श्रोत जुटाउनु पहिलो समस्याको रूपमा देखिन्छ । बोलपत्रको तयारी, मूल्याङ्कन प्रक्रियाहरू, ठेकेदारका व्यवस्थापकीय कमजोरी र कार्य सम्पादनले समेत निर्माण कार्य समयमा सम्पन्न गर्न सकिदैन भने Initial Enviromental Examination (IEE), Environmental Impact Assessment (EIA), Enviromental Management Plan (EMP) स्वीकृत गर्न लाग्ने समय, Drawing Design, तयारी तथा स्वीकृति DPR निर्माण Detal Survey, check survey र रुख कटान गर्दा आउने समस्या, मुआब्जा र क्षतिपूर्तिको समस्या, प्रसारण लाइन निर्माण गर्ने स्थान, भौगोलिक अवस्था, प्राकृतिक प्रकोप र महामारी आदि प्रसारण लाइन निर्माणका प्रक्रियागत चुनौतीको रूपमा देखा पर्छन् ।

सरकारी निकायसँगको चुनौती

जग्गा प्राप्त गर्दा शुरुको प्रक्रिया गर्ने व्यक्ति प्रारम्भिक अधिकृत हो । अहिले प्रारम्भिक अधिकृत मन्त्रिपरिषद्बाट निर्णय गर्नुपर्ने व्यवस्थाले प्रक्रिया लम्बिन गई कार्यान्वयनमा चुनौती थपेको देखिन्छ । प्रसारण लाइन निर्माण गर्दा स्थायी बसोबास, शहरी क्षेत्र छली जंगल, वन खोलानालाबाट टावर निर्माण गर्नुपर्ने हुन्छ, जुन कुरा व्यवहारिक र उचित पनि हो तर वनजंगलबाट प्रसारण लाइन निर्माण गर्दा वन ऐन, कानून र वन कार्यालयको प्रक्रियागत कार्यले समयमा कार्य नहुँदा विकास निर्माणमा थप चुनौतीको सामना गर्नुपरेको छ । स्थानीय बासिन्दाको दबाब, राजनीतिक नेतृत्वले कर्मचारी प्रति गर्ने व्यवहारले प्रमुख जिल्ला अधिकारीबाट समयमै मुआब्जा तथा क्षतिपूर्ति निर्धारण हुन नसक्दा तोकिएको समयमा कार्य हुन सकेको देखिदैन ।

स्थानीय जनतासँगको चुनौती :-

नेपाली जनतालाई घरमा बिजुली(उज्यालो) चाहिने तर आफ्नो घर जग्गाको छेउछाउ बिजुलीका खम्बा वा टावर हुनुहुँदैन भन्ने स्थानीयको भावनाले गर्दा अहिले Rout re-aligment गर्न स्थानीय जनताले दबाब दिने गरेका छन् । जसले गर्दा DPR (Detail Project Report), detail survey, check survey, EIA, IEE भइसकेको अवस्थामा नयाँ Alignment प्राविधिक, आर्थिक र वातावरणीय दृष्टिकोणले समेत न्यून सम्भावना देखिए पनि कार्यस्थलमा स्थानीयको नाजायज मागले प्रसारण लाइनमा एक थप चुनौती देखापरेको छ ।

मुद्दा मामिलाको चुनौती :-

संविधानले दिएको सम्पत्ति सम्बन्धी मौलिक हक अन्तर्गत कुनैपनि प्रसारण लाइनमा टावर निर्माण गर्दा होस वा क्षतिपूर्ति निर्धारण गरी कार्यान्वयन गर्दा मुद्दा नपरेको छैन । २२० के.भी कोशी कोरिडोर, २२० के.भी कालिगण्डकी कोरिडोर, १३२ के.भी मध्यमर्स्याङ्गदी कोरिडोर, ४०० के.भी ढल्केवर -इनरुवा- हेटौडा प्रसारण लाइन लगायत अन्य प्रसारण लाइनको आयोजनाहरूमा मुआब्जा, क्षतिपूर्ति र Rout re-aligment का विवाद अदालतसम्म पुगेर न्यायिक प्रक्रियामा लामो समय लाग्ने भएकोले आयोजना समयमा सम्पन्न भएका छैनन् । जनताको मौलिक हकको आधारमा अदालत प्रवेश गर्ने बाटो न्यायको रोहमा हेर्दा उचित भए पनि विकास निर्माणको कार्य नै रोकावट हुने गरी मुद्दा पर्नु प्रसारण लाइन निर्माणको अर्को चुनौतीको रूपमा आएको छ ।

ऊर्जा उत्पादक कम्पनीाई तिर्नुपर्ने हर्जानाको चुनौती :-

नेपाल विद्युत प्रधिकरणले ऊर्जा उत्पादक कम्पनीसँग विद्युत खरिद बिक्री सम्झौता (PPA) र ग्रिड कनेक्सन सम्झौता गरेको हुन्छ । सम्झौता अनुसार ग्रिड कनेक्सन गर्ने स्थानमा समयमा सब स्टेशन र प्रसारण लाइन निर्माण भएन तर सोही समयमा निजी उत्पादकको विद्युत उत्पादन भएमा ग्रिडमा विद्युत connection नभए पनि ने.वि.प्रा.ले सम्झौता बमोजिम हर्जाना तिर्नुपर्ने हुन्छ । उक्त रकम प्राधिकरणलाई महँगो साबित हुन्छ । जुन प्रसारण लाइन समयमा निर्माण नहुँदा हर्जना तिर्नुपर्ने चुनौतीको रूपमा देखिन्छ ।

मुआब्जाको चुनौती :-

असन्तुष्टि मानवीय स्वभाव नै हो । परियोजना भन्ने बित्तिकै पैसाको विटो बोकेको हुन्छ जुन हाम्रो लागि आएको हो भन्ने जनतामा भ्रम फैलाउने एउटा समूह नै संस्थागत रूपमा लागेको हुन्छ । जसले गर्दा जग्गाको न्यायोचित मूल्य भन्दा बढीको आकांक्षा नागरिकको हुन्छ । मुआब्जा निर्धारणको निर्णयमा चित्त नबुझ्फेर प्रसारण लाइनको कार्य सम्पन्न नगर्दासम्म स्थानीयको अवरोध हुन्छ । त्यस्तै ऐलानी जग्गाको हकमा लामो समयदेखि भोग चलन गरी रहेको, लालपूर्जा (जग्गाधनी प्रमाण पूर्जा) तथा फिल्डबुकमा समेत नाम नभएको व्यक्तिहरूको हकमा मन्त्रिपरिषद्बाट निर्णय भै मुआब्जा निर्धारण समितिसम्म आउँदा कार्यविधिगत प्रक्रियाले समय लाग्ने भै समयमा नै आयोजना सम्पन्न गर्न चुनौती देखिन्छ ।

जनतालाई घरमा बिजुली (उज्यालो) चाहिने तर आपनो घर जग्गाको छेउछाउ बिजुलीका खम्बा वा टावर हुनुहुँदैन भन्ने स्थानीयको भावनाले गर्दा अहिले Rout re-aligment गर्न स्थानीय जनताले दबाब दिने गरेका छन् ।

समाधानका उपयहरू :-

प्रसारण लाइनको निर्माण गर्दा आउने चुनौतीहरूलाई प्रशासनिक, कानूनी र प्राविधिक उपायहरूद्वारा निराकरण गर्ने कार्यलाई नै प्रसारण लाइनको समाधान भन्न सकिन्छ । प्रसारण लाइनका समाधानहरू यिनै हुन् भनी यकिन गर्न गाह्रो हुन्छ । आयोजना निर्माण गर्ने स्थान, भौगोलिक अवस्था, जनताको चेतनाको स्तर, ठेकेदारको कार्यशैलि, आयोजनामा कार्यरत कर्मचारीको भूमिका लगायत विविध क्षेत्रले फरक पार्न सक्छ । प्रसारण लाइनका केही साझा चुनौतीहरूलाई निम्न कार्यहरू गरेमा समाधान गर्न सकिन्छ ।

विकासको अधिकार व्यक्तिको सामूहिक अधिकार भएकाले कुनै एक दुई व्यक्तिको मात्र अधिकार नभई ठूलो समुदायको अधिकारको रूपमा रहेको हुन्छ । नागरिकको व्यक्तिक अधिकारको संरक्षणको विषय जति महत्वपूर्ण हुन्छ । विकासका कार्यहरू निर्बाध रूपमा सम्पन्न भइ विकासले पूर्णता पाएमा आम नागरिकको विकासको अधिकारको प्रत्याभूतिको विषय उतिकै महत्वपूर्ण रहने छ ।

जग्गा प्राप्ति ऐनमा समय सापेक्ष सुधार गरेर :-

कुनै पनि कानून आफैमा पूर्ण हुँदैन, समय सापेक्ष सुधारको आवश्यकता पर्दछ । लगानी सहजीकरण सम्बन्धी केही नेपाल ऐनलाई संशोधन गर्ने अध्यादेश, २०८१ को दफा ४ मा जग्गा प्राप्ति ऐन २०३४ मा संशोधन गरी जग्गा प्राप्ति ऐन २०३४ को दफा १६ को उपदफा २ पछि देहायको उपदफा ३ थपिएको छ जसमा "मुआब्जा निर्धारण गर्दा रजिष्ट्रेशनको प्रयोजनको लागि निर्धारण गरिएको न्यूनतम मूल्याङ्कनको तीन गुणा भन्दा बढी मुआब्जा रकम निर्धारण गरिने छैन ।" भन्ने राखिएको व्यवस्थाले जग्गाको मुआब्जा निधारण गर्ने कार्यमा एकरूपता ल्याई विवाद कम गर्नेछ भन्न सकिन्छ । सो व्यवस्था विधेयकको रूपमा ल्याउने र सोही किसिमको कानूनको व्यवस्था क्षतिपूर्ति निर्धारणमा पनि राखिएमा विबादले स्थान पाउन सक्ने थिएन । जुन कानूनमा सुधार गरी समाधान गर्न सकिने छ ।

जग्गा प्राप्तिको लागि स्पष्ट कार्यविधि बनाइ लागू गरेर :-

प्रसारण लाइन निर्माण गर्दा जग्गा अधिग्रहण गर्न, जग्गाको मुआब्जा र क्षतिपूर्तिको निर्णय गर्नु पर्ने प्रावधान छ । जग्गा अधिग्रहण गर्दा जग्गा प्राप्ति ऐन छ भने क्षतिपूर्ति निर्धारण र कार्यान्वयन सम्बन्धमा विद्युत ऐन २०४९ मा केही कानूनी व्यवस्था भए पनि पर्याप्त छैन । प्रसारण लाइन मुनि परेका जग्गाको क्षतिपूर्ति कति प्रतिशत निर्धारण गर्ने, के को आधारमा दिने स्पष्ट व्यवस्था नभएकाले आयोजना अनुसार फरक फरक किसिमको विधि र प्रक्रिया अपनाएर क्षतिपूर्तिको निर्णय भएका छन् । जग्गाधनी प्रमाणपूर्जा भएका जग्गाधनीको हकमा प्रसारण लाइनको जग्गाको मुआब्जा निर्धारणको मूल्यलाई आधार मानेर १० देखि २० प्रतिशत सम्म तार मुनिको Riht of way को जग्गाको क्षतिपूर्ति दिने गरेको देखियो । जग्गाधनी प्रमाणपूर्जा नभएका जग्गाधनी जो लामो समयदेखि भोगचलन गरिरहेका फिल्डबुकमा समेत नाम नभएका ऐलानी जग्गाको हकमा दिने क्षतिपूर्ति को सम्बन्धमा कानूनमा स्पष्ट व्यवस्था नभएकोले समेत कार्यविधि निर्माण गरेर क्षतिपूर्ति दिने कार्य गर्दा समस्या समाधान हुने देखिन्छ ।

विस्थापित हुने घर परिवारको व्यवस्थापन गरेर :-

संविधानले दिएको आवासको हक अन्तर्गत कसैलाई पनि आवासको सुविधाबाट बञ्चित गर्नुहुँदैन । तसर्थ जग्गा प्राप्त गर्दा परापूर्व कालदेखि स्थायी बसोबास गरी आएका स्थानीय जनताको थातथलो नै उठ्ने भएमा निजको निवास निर्माण नहुन्जेलसम्म बस्ने व्यवस्था र यातायात खर्च समेत प्रदान गर्ने गरी कार्यविधि बनाई एकरूपता कायम गर्न सकिन्छ । जसले विस्थापित हुने परिवारको समस्या समाधन भई जग्गा प्राप्तिमा सहजता कायम हुने गर्छ ।

प्रसारण लाइनको शेयर जनतालाई दिने व्यवस्था गरेर :-

विद्युतको क्षेत्रमा कम्पनी बनाइ आयोजना निर्माण गर्दा सफलता मिलेको कैयौं उदाहरण छन् । नेपालमा जलविधुतको क्षेत्रमा चिलिमे जलविधुत कम्पनी पहिलो नामको रूपमा आउँछ । प्रसारण लाइन निर्माणको मोडालिटी पनि सोही अनुसारको भएमा कम्पनीको शेयरहरू केही प्रतिशत जनतालाई दिने गरी कार्य गर्दा जनताको अपनत्व हुने गरी आयोजना निर्माणमा सहजता हुने गर्दछ । जसले गर्दा प्रभावित पर्ने स्थानीय जनतालाई क्षतिपूर्तिको साथसाथै शेयरको केही अंशले प्रसारण लाइन निर्माणमा अपनत्व जगाई स्थानीय जनताको विरोध कम गर्न सकिने देखिन्छ ।

अस्थायी रोजगारीको व्यवस्था गरेर :- मूल आयोजना सँगसँगै सामाजिक उत्तरदायित्व अन्तर्गत बाटो, खानेपानी, स्वास्थ, शिक्षा, मठ मन्दिर लगायतका कार्यका लागि केही बजेटको व्यवस्था गरेको हुन्छ । सामाजिक उत्तरदायित्व अन्तर्गतका कार्य स्थानीयबाट उपभोक्ता समिति मार्फत् गराउने अनिवार्य व्यवस्था गर्नु पर्छ । स्थानीय जनताका लागि विकास भएको हो भन्ने अनुभूति गराउनको लागि परियोजना कालमा अदक्ष, दक्ष केही कामदारहरू स्थानीयबाट नै लिई विकास निर्माण गराउँदा स्थानीय जनतालाई रोजगारी पाएको अनुभूति भै प्रसारण लाइन निर्माण कार्यमा अवरोध कम हुन्छ ।

Right of Way को जग्गामा अन्य विकल्प प्रयोग गरेर :-

प्रसारण लाइन निर्माण गर्दा तार मुनिको जग्गामा क्षतिपूर्ति दिए पनि उक्त जग्गामा जग्गाधनीले भवन निर्माण र रुख रोप्न नपाउने गरी कानूनले नै बन्देज लगाएको हुन्छ । त्यस्ता जग्गाको उपयोग गर्न सामूहिक तरकारी खेतीको लागि कृषि कार्य लगायत वैकल्पिक ऊर्जा (सौर्य ऊर्जा) उत्पादन गर्नका लागि सोलार प्यानलको व्यवस्था सरकारी अनुदानबाट गराइएमा त्यस्ता उत्पादनमूलक कार्यले पनि प्रसारण लाइन आयोजना निर्माण गर्दा जनताको अवरोध कम हुने देखिन्छ ।

निष्कर्ष :-

विकासको अधिकार व्यक्तिको सामूहिक अधिकार भएकाले कुनै एक दुई व्यक्तिको मात्र अधिकार नभई ठूलो समुदायको अधिकारको रूपमा रहेको हुन्छ। प्रसारण लाइनको अभावमा वा पूरानो जीर्ण लाइनको भरमा संचालित विद्युतीय प्रणालीबाट धेरै कम भोल्टेज प्रवाह हुने, सानो हावा हुरीले पनि घण्टौसम्म लाइन प्रभावित हुने लगायत कारणले त्यहाँका जनताको जनजीवन अत्यन्त कष्टपूर्ण रहन्छ । उद्योग कलकारखाना चलाउन कठिन भइ अनेक समस्या भोग्नुपर्ने बाध्यता हुन्छ । नागरिकको वैयक्तिक अधिकारको संरक्षणको विषय जति महत्वपूर्ण हुन्छ । विकासका कार्यहरू निर्वाध रूपमा सम्पन्न भई विकासले पूर्णता पाएमा आम नागरिकको विकासको अधिकारको प्रत्याभूतिको विषय उतिकै महत्वपूर्ण हुने भएकाले सार्वजनिक हितका लागि मध्यनजर गरी विकासका कार्यलाई असर पर्ने गरी जनताले प्रत्यक्ष हस्तक्षेप गर्नु उपयुक्त हुँदैन ।

सन्दर्भ सूची :-

१ नेपालको संविधान

२ सर्वोच्च अदालतबाट प्रतिपादित सिद्धान्तहरू

३ जग्गा प्राप्ति ऐन २०३४

४ विद्युत ऐन २०४९

Under Construction Khudi Substation in Lamjung District

नेपालको अर्थतन्त्रमा अपरिवर्त्य विनिमय दरका फाइदा तथा बेफाइदाहरू

राम बहादुर के.सी.
उप सचिव
अर्थ मन्त्रालय, नेपाल सरकार

लेखसार:

केन्द्रीय बैंकले आधिकारिक विनिमय दरको रूपमा सेट र कायम राखेको दर अपरिवर्त्य (पेग्ड) दर हो। मुद्रा पेग गर्ने कारणहरू मौद्रिक तथा विनिमय स्थिरतासँग जोडिएका छन्। नेपाल राष्ट्र बैंक ऐन, २०५८ले नेपाल राष्ट्र बैंकलाई विदेशी विनिमय सम्बन्धी नीति, कानून तथा कार्यविधि बनाउने, विदेशी विनिमय कारोबारको व्यवस्थापन गर्ने, विदेशी विनिमय पद्धति निर्धारण गर्ने तथा विदेशी विनिमय सञ्चितिको व्यवस्थापन गर्ने अधिकार दिएको छ। सोही अनुरूप सो बैंकले नेपाली रूपैयाँको विनिमय दर पद्धति तोक्ने तथा विदेशी मुद्राहरूको खरिद-बिक्री दर कायम गरी कारोबार गर्ने जस्ता काम गर्दै आएको छ। यस व्यवस्थाले मौद्रिक अर्थतन्त्रमा योजनाको लागि स्थिर आधार (Stable Basis for Planning), विश्वसनीय र अनुशासित मौद्रिक नीति (Credible And Disciplined Monetary Policy) र अस्थिरता न्यूनीकरण (Reduced Volatility) जस्ता फाइदाहरू पुगेको छ भने बढ्दो विदेशी प्रभाव (Increased Foreign Influence), स्वचालित समायोजनमा कठिनाइ (Difficulty in Automatic Adjustment) सट्टेबाजी आक्रमणहरू (Speculative Attacks) जस्ता बेफाइदाहरू समेत व्यहोर्नुपरेको छ। हालका दिनमा नेपालको मौद्रिक अर्थतन्त्रमा आन्तरिक उत्पादन तथा उत्पादकत्वमा वृद्धि, निर्यात क्षमतामा अभिवृद्धि गरी विदेशी मुद्राको दिगो व्यवस्थापन सहित परिवर्त्य विनिमयदरमा रूपान्तरण गर्ने सोंच १६औं योजनाले लिएको छ। यो सोंचलाई कार्यान्वयन गर्न पूंजीखातामा आंशिक परिवर्त्यता प्रदान गर्न आवश्यक पर्ने नीति, ऐन, विनियम, निर्देशिका सहित कानूनी तथा संस्थागत संरचना तयार गर्न आवश्यक छ।

विषय प्रवेश:

परोक्ष/अप्रत्यक्ष विधि अनुसार विदेशी विनिमय दर भन्नाले एक विदेशी मुद्रा किन्नलाई तिर्नुपर्ने कूल नेपाली रूपैयाँलाई जनाउँछ। प्रत्यक्ष विधि भनेको एक नेपाली रूपैयाँले आउने अन्य विदेशी मुद्रालाई जनाउँछ। नेपालमा परोक्ष विधिअनुसार विनिमय दर प्रकाशित हुने गर्दछ। हिजोको तुलनामा आज थोरै नेपाली रूपैयाँमा एक विदेशी मुद्रा किन्न सकिन्छ भने यसलाई नेपाली मुद्रा अधिमूल्यन (Overvaluation) भएको मानिन्छ। त्यसै गरी, त्यही विदेशी मुद्रा किन्न बढी नेपाली रूपैयाँ तिर्न परेमा नेपाली रूपैंयाँ अवमूल्यन (Undervaluation) भएको मानिन्छ। एउटा मुद्रा व्यवस्था, जसमा एक देशको मुद्रा अर्को देशको मुद्रासँग सामान्यतया संगति कायम गरिएको अवस्था तथा विनिमयदर स्थिरता राख्ने कार्य पेग्ड विनिमय दर हो। परिवर्तित विदेशी मुद्रासँग स्वदेशी मुद्राको मूल्य स्थिर राख्नु नै विनिमय स्थिरता हो। पेग्ड दरहरूले कहिलेकाहीं उच्च दीर्घकालीन मुद्रास्फीतिको नेतृत्व गर्न सक्छ। पेग्ड गरिएको विनिमय दर कायम राख्न सामान्यतया ठूलो मात्रामा विदेशी मुद्रा भण्डारण (Foreign Currency Stock) चाहिन्छ। नेपालमा विदेशी विनिमय व्यवस्थापनको सम्पूर्ण अधिकार नेपाल राष्ट्र बैंकमा निहित छ। विनिमय दरमा स्थायित्व अथवा अर्थतन्त्र अनुकूल राख्न राज्यले आफ्ना मौद्रिक, वित्तीय, पूँजी खाता परिवर्त्य तथा संरचनात्मक परिवर्तन नीति अन्तर्गतका विभिन्न उपकरणको निरन्तर प्रयोग गरिराखेका हुन्छन्। नेपाल राष्ट्र बैंकको स्थापना हुनुपूर्व नेपाल सरकारले विदेशी मुद्रा भारतीय रिजर्भ बैंकमा राख्ने व्यवस्था रहेको थियो। नेपालले वि.सं. २०४९ देखि भारतीय रूपैंयाँसँग अपरिवर्त्य (पेग्ड) विनिमयदर कायम गरेको छ। अपरिवर्त्य विनिमयदर

कायम राख्ने नीतिगत व्यवस्थाका कारण नेपालको मौद्रिक अर्थतन्त्रमा केही फाइदा तथा वेफाइदाहरू रहेका छन् ।

अपरिवर्त्य (पेग्ड) विनिमय दरका प्रकारहरू:

मौद्रिक अर्थशास्त्र (Monetary Economics) मा देहायका प्रकारहरू छन् :

(क) फ्लोटिङ्ग विनिमय दर (Floating Exchange Rate): एक नीति जसले विदेशी विनिमय बजारलाई विनिमय दरहरू सेट गर्न अनुमति दिन्छ । फ्लोटङ्ग विनिमय दरको रूपमा सन्दर्भित रहन्छ । यसको मतलब विनिमय दर लगातार बजार शर्तहरूमा (माग र आपूर्तिमा) आधारित रहन्छ ।

(ख) नरम अपरिवर्त्य विनिमय दर (Soft Exchange Rate Pegs): नरम पेग्ड भनेको विनिमय दर नीतिको नाम हो जहाँ सरकारले सामान्यतया विनिमय दरलाई बजारले सेट गर्न अनुमति दिन्छ तर केही केसहरूमा विशेष गरी यदि विनिमय दर एक दिशामा द्रुत गतिमा अघि बढीरहेको देखिन्छ भने केन्द्रीय बैंकले बजारमा हस्तक्षेप गर्नेछ.। यसबाट मौद्रिक नीतिमा स्थिरता कायम हुन सहयोग हुन्छ ।

(ग) कडा अपरिवर्त्य विनिमय दर (Hard Exchange Rate Pegs): कडा पेग्ड विनिमय दर नीतिको साथ केन्द्रीय बैंकले विनिमय दरको लागि निश्चित र अपरिवर्तित मूल्य सेट गर्दछ.

(घ) मर्जिङ्ग विनिमयदर (Merging Currencies): विनिमय दर नीतिमा अन्तिम दृष्टिकोण भनेको एक राष्ट्रले एक वा बढी राष्ट्रहरूसँग साझा मुद्रा छनौट गर्नलाई मर्ज गरिएको मुद्रा पनि भनिन्छ.। दुई वा सोभन्दा बढी देशहरूसँग मुद्रालाई साझा बनाईएको हुन्छ । युनियन मुलुकहरूमा प्रायश: यस अवधारणाको प्रयोग हुन्छ ।

भारतीय मुद्रासँग अपरिवर्त्य विनिमयदर (Pegging) गर्नुका कारणहरू:

नेपालले लामो समयदेखि भारतीय मुद्रासँग 'पेग्ड' विनिमय दर प्रणाली अन्तर्गत कारोबार गर्दै आएको छ।यस अन्तर्गत भारतीय मुद्रासँगको विनिमयदर स्थिर रहने तथा अन्य मुलुकका मुद्रासँग भने भारतीय मुद्राको ती मुद्रासँगको दरका आधारमा परिवर्तन हुने प्रणाली कायम गरिएको छ । यस्तो पद्धति अवलम्बन गर्नुका पछाडि नेपालको भौगोलिक, आर्थिक, साँस्कृतिक कूटनीतिक, भारतसँगको अधिक व्यापार निर्भरता, निर्यात क्षमता, नेपालको विदेशी विनिमय प्राप्तिको दिगो आधारको कमी जस्ता आधारहरू रहेका छन्। अपेक्षाकृत Stable Currency सँग Pegging गर्दा व्यापार सहजीकरण हुने हुन्छ। यसबाट मुद्रा स्फीति, व्यापार अनिश्चितताको भयबाट ढुक्क बनाउँछ। पेग्ड विनिमयदरले व्यापारी तथा लगानीकर्ताको हित संरक्षण गर्न सघाउने हुन्छ । नेपाल र भारत बीच करिब १८०० किलोमिटरको खुला सिमाना रहेको छ। Pegging नगरेमा मुद्रा मध्यस्थता (Currency Arbitation) हुन सक्ने सम्भावना रहन्छ। जस्तो कि युएस डलर र युरो मुद्रा बीचमा खरिद तथा बिक्री गर्दा मूल्य निर्धारणमा विसंगति आउन सक्छ । यस्तो अवस्थामा भारतीय रूपैयाँको विनिमयदरलाई खुला बजारमा छाड्दा नेपाली र भारतीय दुवै लगानी निरुत्साहित हुन सक्ने देखिन्छ । Pegging गर्दा पेगिङ्ग गरिएको देशको आर्थिक वर्चस्व (Economic Hegemony) भित्र फस्नबाट रोक्न सकिन्छ। जस्तै भारतले आफ्नो मौद्रिक नीति परिवर्तन गर्दा बजारमा देखिने प्रभावहरू जस्तै मुद्रा स्फीति, माग-आपूर्ति सन्तुलन, साटफेर आदिबाट नेपालको अर्थतन्त्रलाई सुरक्षित गर्न सकिन्छ। मुद्रास्फीतिलाई असर पार्ने तत्व उस्तै रहेको अवस्थामा भारतले मुद्रास्फीति नियन्त्रण तथा विनिमय दर स्थायित्व प्राप्त गर्न परिचालन गर्ने मौद्रिक तथा विदेशी विनिमय नीति र नेपालले अवलम्बन गर्नुपर्ने उक्त नीति उस्तै रहन सक्ने अवस्थालाई ध्यानमा राखी भारतीय मुद्रासँग स्थिर विनिमय दर प्रणालीलाई कायम गरिएको हो। नेपालको भारतसँग कूल वैदेशिक व्यापारमा वस्तु व्यापारको अंश ६७ प्रतिशत, सेवा व्यापार तर्फ पर्यटन, शिक्षा, स्वास्थ्य लगायतका सेवा अन्य राष्ट्रको तुलनामा अत्यधिक छ । खुला सिमाना तथा प्रवेशाज्ञा नचाहिने हुँदा भारतीय श्रमिक नेपालमा र नेपाली श्रमिक पनि भारतमा धेरै रहेकाले श्रम बजार लचिलो छ। पछिल्लो वैदेशिक लगानी सर्वेक्षणअनुसार कूल लगानीको २० प्रतिशत र औद्योगिक क्षेत्रको अंश मात्र हेर्ने हो भने करिब ४० प्रतिशत भारतीय लगानी छ । दुवै देशका नागरिक, व्यावसायिक फर्म, प्रतिष्ठान, निकाय र लगानीकर्ताले निर्बाध रूपमा वस्तु तथा सेवाको प्रवाह गर्ने हुँदा नेपालले यो नीति अवलम्बन गरेको देखिन्छ । यसका फाइदा र बेफाइदाहरू निम्न बमोजिम रहेका छन् :

अपरिवर्त्य विनिमय दरका फाइदाहरू:

पेग्ड विनिमय दरले एक देशबाट अर्को देशमा पैसा/मुद्राको सहज प्रवाह सुनिश्चित गर्न मद्दत गर्छ । यसले साना र कम विकसित देशहरूलाई विदेशी लगानी आकर्षित गर्न मद्दत गर्छ । यसले साना देशहरूलाई उनीहरूको मुद्राको अवमूल्यनबाट बच्न र मुद्रास्फीति स्थिर राख्न मद्दत गर्दछ । हाल भारतसँग कायम रहेको विदेशी विनिमय दर पद्धतिका कारण विनिमय दरमा हुन सक्ने परिवर्तनबाट सृजना हुन सक्ने अनिश्चितता न्यून छ भने नेपालमा भारतीय लगानीको आप्रवाह उल्लेख्य छ।यसका साथै भारतीय अर्थतन्त्रको उच्च आर्थिक वृद्धि तथा न्यून मुद्रास्फीतिको लाभ नेपाललाई प्राप्त हुने गरेको छ। साथै, अन्य फाइदाहरू देहाय अनुसार रहेका छन् :

(क) नेपाली रूपैयाँको विश्वसनियता अभिवृद्धि हुन सघाउ पुग्ने ।

(ख) मुद्राको सट्टेबाजी निरुत्साहित भई पूर्वानुमानयोग्य र स्थिर विनिमयदर हुँदा विनिमयदर जोखिम न्यून हुँदा व्यापार र लगानी सहजीकरणमा सहयोग पुग्ने,

(ग) लागत अनुमान कम हुन्छ, व्यापार गर्न सहज हुन्छ र आयको वितरणमा समस्या रहँदैन ।

(घ) विदेशी लगानी आकर्षण गर्न सघाउ पुग्ने हुन्छ ।

(ङ) मौद्रिक अर्थतन्त्र निर्माणको आधार र गति प्रदान गर्न सहयोग भइरहेको छ जस्तै:- मुद्रा स्फीति सीमाभित्र राख्ने र विदेशी विनिमय सञ्चितिको निश्चित जोहो गर्न सहज हुने ।

(च) मौद्रिक स्थिरताको वातावरण कायम गर्न सहयोग हुने जस्तै:- बजारमा साटफेर, कालोबजारी नियन्त्रण, माग र आपूर्ति बीच सन्तुलन कायम गर्न सहयोग पुग्ने ।

(छ) मूल्य स्थिरता कायम गर्न सहयोग

(ज) नेपालमा गरीबी न्यूनीकरण गर्नमा सहयोग

(झ) भारतको न्यून मुद्रास्फीतिको लाभ नेपाल सरकारले प्राप्त गर्न

(ञ) विदेशी विनिमयदर नीतिलाई मौद्रिक नीतिसँग संगति (Link Up) गरी मौद्रिक अंकुशको भूमिका निर्वाह गर्न सघाउ पुग्ने जस्तै:- नेपालको रिजर्भ भारतीय बैंकमा निश्चित दरमा सञ्चित गरी राख्ने ।

(ट) आर्थिक स्थायित्व कायम गर्न मद्दत पुग्ने

(ठ) मौद्रिक तथा कर्जा योगांकहरूलाई वाञ्छित सीमामा राखी वित्तीय क्षेत्रको स्थायित्व कायम गर्ने जस्तै निजी क्षेत्र र सरकारी क्षेत्रमा प्रवाह हुने ऋण बीचमा सन्तुलन कायम गर्ने,

(ड) शोधानान्तर स्थितिलाई अनुकूल बनाइराख्न सहयोग पुग्ने ।

अपरिवर्त्य विनिमय दरका बेफाइदाहरू:

पेग्ड मुद्राले घाटाहरूको लागि खातामा स्वचालित सुधारहरूको लागि अनुमति दिँदैन । घरेलु र विदेशी राष्ट्रहरूको लागि पूँजी खाताहरूमा कुनै वास्तविक-समय परिवर्तनहरू नभएकाले यसले असन्तुलनलाई बढावा दिन्छ । यदि यो निश्चित विनिमय दरको मूल्यबाट विचलित भयो भने यसले मुद्राको मूल्यमा सट्टा आक्रमण गर्न सक्छ । विद्यमान विनिमय पद्धतिका कारण नेपालले केही लागत समेत बेहोर्नुपरेको छ।भारतीय अर्थतन्त्र भन्दा नेपालको अर्थतन्त्रमा मुद्रास्फीति बढी रहने गरेका कारण नेपाली मुद्रा यथार्थ रूपमा अधिमूल्यन हुन गई नेपालको निर्यात क्षमता खस्किँदै गएको छ भने भारतीय अर्थतन्त्रमा बाह्य क्षेत्रबाट सिर्जित समस्याहरूको असर नेपालले समेत बेहोर्नुपरेको छ। साथै अन्य बेफाइदाहरू देहाय अनुसार रहेका छन् :

(क) आयात दुई तिहाइ भारतबाट हुने जसले भारतीय मुद्रा अवमूल्यन (Devaluation) हुँदाको लागत (Cost) पनि नेपाली अर्थतन्त्रले ब्यहोर्नु पर्दछ ।

(ख) भारतीय मुद्रास्फीति पनि नेपालले ब्यहोर्नु पर्दछ । Pegging भएको अवस्थामा बढेको मूल्य नेपालले तिर्नुपर्छ। स्वदेशी मुद्राको Revaluation/Devaluation बाक्लो अन्तरालमा गरिदैंन ।

(ग) Indian Currency Devaluation हुँदा तेस्रो देश (Third Country) बाट आयात हुने सबै वस्तु स्वत: महँगो हुन जाने ।

(घ) भारुको अन्य मुद्रासँगको विनिमय दरका आधारमा नेपाली रूपैयाँको अन्य मुद्रासँगको विनिमय दर तोकिने र भारुसँगै परिवर्तन हुने अन्य मुद्रासँग भने परिवर्त्य विनिमय दर प्रणाली कायम हुन जान्छ। सानो अर्थतन्त्र त्यसमा पनि सीमित देशसँग ठूलो हिस्सामा कारोबार रहँदा, उक्त देशमा हुने उतारचढावले नेपाली मुद्राको विनिमय दरमा ठूलो प्रभाव पर्छ ।

(ङ) स्थिर विनिमयदर अपसरेखित (Misaligned) हुने हुँदा नेपालको मुद्रा स्फीति केही उच्च रहेकोले यथार्थ प्रभावी विनिमयदर (Real Effective Exchange Rate) अधिमूल्यन रहन सक्ने हुन्छ किनकि भारतको मुद्रास्फीतिका साथ साथै नेपालको आफ्नो मुद्रास्फीति पनि बहन गर्नु पर्दछ ।

(च) नेपालको निर्यात अन्तर्राष्ट्रिय बजारमा प्रतिष्पर्धी हुन नसकेको र आयात सस्तो हुन गई व्यापार घाटा उच्च, फराकिलो हुँदै गएको,

(छ) अर्थतन्त्रलाई गतिशील बनाउन र उत्पादकत्व बढाउन उत्प्रेरणा दिन नसकेको

(ज) भारतले ब्यहोर्नुपर्ने मौद्रिक धक्का (Monetary Shock) नेपालले पनि ब्यहोर्नुपर्ने जस्तैः- Interest rate परिवर्तन, Money Supply Policy जस्ता धक्काले नेपालको अर्थतन्त्रमा सम्पत्तिको मूल्य, पूँजी पलायन, मुद्रास्फीति जस्ता पक्षमा प्रभाव पर्दछ ।

(झ) व्याजदर तथा कर्जा नीति स्वतन्त्रतापूर्वक अवलम्बन गर्न नसकिएको,

(ञ) मौद्रिक र वित्त नीतिलाई स्वतन्त्रतापूर्वक आर्थिक विकासका लागि प्रयोग गर्न नसकिएको

(ट) भारतीय रूपैयाँ र अमेरिकी डलर बीचको विनिमयदरमा उतारचढाव आउँदा नेपाली रूपैयाँ र अमेरिकी डलरबीचको विनिमयदरमा आउने उतारचढावको कारण नेपाली अर्थतन्त्रमा प्रतिकूल परिस्थिति उत्पन्न हुनसक्ने,

अपरिवर्त्य (पेग्ड) विनिमय दरको नेपालमा रहेको मुख्य चुनौतीहरू:

(क) नेपालको मौद्रिक अर्थतन्त्रमा भारतीय मुद्राको माग कति छ भनी यकीन गर्नु,

(ख) दुवै देशका मुद्रा एक आपसमा सजिलै जनस्तरमा विनिमय (Exchange) हुने हुँदा अर्थतन्त्रमा अनौपचारिक कारोबारको नियन्त्रण गर्नु,

(ग) विप्रेषण आयको मुद्राको सट्टामा आन्तरिक उपभोग्य सामान र तुलनात्मक लाभका वस्तु तथा सेवाको उत्पादन र निर्यात वृद्धि गरी दिगो विदेशी मुद्राको स्रोत सुनिश्चतता हासिल गर्नु,

(घ) मुलुकको साख मूल्याङ्कन (Country Credit Rating) गरिएको विषयमा बाह्य मुलुकमा नेपालको आर्थिक तथा मौद्रिक व्यवस्थाको जानकारी प्रदान गर्नु चुनौतीपूर्ण रहन्छ । किनकि यसले देशको ऋण बहन दक्षता, ऋणको लागत र लगानीको प्रवाह बारे यथार्थ जानकारी गराउन सक्छ ।

(ङ) अमेरिकी डलर बिक्री गरी भारतीय रूपैयाँ खरिद गरी नेपाल-भारतको मौद्रिक भुक्तानी सेटलमेन्ट गर्नु,

वैश्विक(Global) रूपमा पेग्ड विनिमय दरको विवरण:

अन्तर्राष्ट्रिय मुद्राकोष (IMF) को सन् २०१६ को प्रतिवेदन अनुसार विश्वका १३ प्रतिशत देशहरूले हार्ड पेग, ३९.६ प्रतिशत देशहरूले सफ्टपेग, ३७ प्रतिशत देशहरूले परिवर्त्य विनिमय दर प्रणाली र १०.४ प्रतिशत देशहरूले अन्य विनिमय प्रणालीमा रहेको देखाएको छ । नेपालले अवलम्बन गरेको प्रणाली सफ्ट पेग अन्तर्गत पर्छ । २०१३ सम्म चीन, थाइल्यान्ड, मलेसिया जस्ता ठूला अर्थतन्त्रले अमेरिकी डलरसँग स्थिर विनिमय दर प्रणाली अवलम्बन गरेका थिए। अर्थशास्त्रीहरू Aashish R. Ghosh, Ann–Marrie Gulde, Jonathan, Ostry, Holger Wolf को IMF सँग सम्बन्धित साझा प्रतिवेदन Does The Exchange Rate Regime Matter for Inflation and Growth मा पेग्ड विनिमयदरले मुलुकमा मुद्रास्फीति र आर्थिक वृद्धिमा सकारात्मक प्रभाव पार्ने उल्लेख गरेका छन् । अर्थशास्त्रीहरू प्रतिवेदनको सारमा लेख्छन् Although the theoretical relationships are ambiguous, evidence suggests a strong link between the choice of the exchange rate regime and macroeconomic performance= Adopting a pegged exchange rate can lead to lower inflation, but also to slower productivity growth= The exchange rate regime can influence economic growth through investment or increased productivity= Pegged regimes have higher investment floating regimes have faster productivity growth= On net, per capita GDP growth was slightly faster under floating regimes. उल्लिखित अर्थशास्त्रीहरूको प्रतिवेदनको आधारमा नेपालले हालको आर्थिक, मौद्रिक र वित्तीय अवस्था अनुसार अवलम्बन गरेको अपरिवर्त्य विदेशी मुद्राले नेपालको अर्थतन्त्रमा सकारात्मक प्रभाव नै परेको देखिन्छ ।

नेपालको मौद्रिक अर्थतन्त्रमा विनिमय दर निर्धारणको तरिका:

आज मिति २०८२/०१/३० को विनिमय दर भारुसँग १.६०, डलरसँग १३२.९४ र भारुको डलरसँग ८३.३१ रहेको छ । भारुसँगको दर १.७० राखियो र अन्य दर यथावत् रह्यो भने बजारले पहिला एक डलरलाई ८३.३१ भारु बनाउँछ, ८३.३१ भारुलाई नेपाली १३३.२९ बनाउँछ । सट्टेबाजहरूबाट हुनसक्ने यस्ता व्यापारले गर्दा विदेशी विनिमय दरको निर्धारण सामान्य वस्तुको जस्तो छुट्टाछुट्टै नभई समग्र राष्ट्रको मुद्राको अन्तर्राष्ट्रिय विनिमय दर एकैपटक निर्धारण हुन्छ । तसर्थ अहिलेको स्थिर विनिमय दरबाट परिवर्त्य विनिमय दर अवलम्बन गरियो भने भारुसँग नेपाली मुद्रा अवमूल्यन हुन्छ भन्ने आम मान्यता सही नहुन सक्छ । अवमूल्यन भएको अवस्थामा भारुसँग मात्र नभई अन्य मुद्रासँग पनि अवमूल्यन हुने र अधिमूल्यन हुँदा पनि सोही अनुसार हुन्छ ।

मुलुकको आर्थिक क्रियाकलापको आकार तथा संरचनामा हुने परिवर्तन सँगै नीतिगत व्यवस्थाहरूमा समेत समयानुकूल परिवर्तन गर्दै लगिएको हुन्छ । यसै अनुरूप नेपालको विनिमयदर प्रणाली तथा वर्तमान भारतीय मुद्रासँगको 'पेग' दरमा समेत परिवर्तन गर्नुपर्ने आवाज बेलाबेला उठ्ने गरेको छ। हालको विनिमयदर पद्धतिकै कारण नेपालको यथार्थ विनिमयदर अधिमूल्यन भई निर्यात क्षमता खस्किँदै गएको आवाज अन्तर्राष्ट्रिय मुद्रा कोष लगायतका संस्थाहरूले उठाउँदै आएका छन् । तथापि विदेशी विनिमयदर निकै संवेदनशील पक्ष भएकाले समग्र स्थिरतामा खलल नपुगोस् भन्नका लागि पर्याप्त अध्ययन बिना यो परिवर्तन गर्ने विषय भने होइन।

अपरिवर्त्य विनिमय दरबाट परिवर्त्य विनिमय दरमा परिवर्तन गर्न नहुनुका सम्बन्धमा रहेका आधारहरू:

(क) नेपालको अर्थतन्त्रमा मौद्रिक विषयमा सकारात्मक पक्षहरू भन्दा नकारात्मक पक्षहरू धेरै रहनु जस्तै अर्थतन्त्रमा आर्थिक वृद्धि, मुद्रास्फीति नियन्त्रण, उच्च व्यापार घाटा लगायतमा पेग्ड विनिमय दरले हालसम्म सहयोग गर्न सकेन कि भन्ने धारणा,

(ख) भारत नेपालको सबैभन्दा ठूलो व्यापार साझेदार मुलुक रहनु, करिब अठारसय कि.मि.को खुला सिमाना, भारतसँग नेपालको विशेष कूटनीतिक र आर्थिक सम्बन्ध रहनु,

(ग) व्यापार तथा लगानीलाई नराम्रोसँग प्रभाव पार्न सक्ने,

(घ) आयात झनै महँगो पर्न सक्छ, उच्च मुद्रास्फीति सृजना गर्ने तथा प्रतिस्पर्धात्मक क्षमता कमजोर बनाउने सम्भावना,

(ङ) कच्चा पदार्थ आयात गर्दा उत्पादन लागत बढ्न जाने र यसले समग्र मूल्य स्तरमै बढोत्तरी ल्याई मूल्य वृद्धिमा चाप पर्ने,

(च) मार्शल लर्नर शर्त सिद्धान्त- The Marshall-Lerner condition Principle) को आधारमा लाभ प्राप्त गर्न सक्ने अवस्था नरहेको किनकि भारतसँग नेपालको व्यापार सन्तुलन हुन सक्ने अवस्था तुलनात्मक लाभका वस्तु तथा सेवा निर्यात नभएसम्म हुने देखिएन ।

(छ) पूँजी खाता समेत बिस्तारै खुला गर्नुपर्ने हुन्छ तर भारतीय रूपैयाँ तथा अन्य विदेशी मुद्रा प्राप्तिको दिगो आधार नहुन्जेल पूँजी खातालाई पूर्ण परिवर्त्य बनाउन नसकिने,

(ज) अल्पकालमा भारतीय मुद्रा सञ्चिति गर्ने प्रवृत्ति बढ्न सक्ने, यसबाट भारतीय मुद्राको मागमा थप विस्तार भई नेपाली मुद्रा अझै अवमूल्यन हुँदै जाने तथा नेपालबाट अवैध रूपमा पूँजी बहिर्गमन हुने सम्भावना छ।

(झ) नोवेल पुरस्कार बिजेता क्यानेडियन अर्थशास्त्री Robert Alexander Mundell ले आफ्नो पुस्तक Analysis of Monetary and Fiscal Policy under different Exchange Rate Regime and Optimum Currency Areas तथा International Monetary Fund (IMF) समेतले विद्यमान स्थिर विनिमयदर (Pegged Exchange Rate) नै नेपाल राष्ट्रको मौद्रिक हितमा रहेको तर्क पेश गरेका छन् ।

(ञ) नेपालमा मुद्रा बजार, पूँजी बजार तथा विदेशी विनिमय बजार अझै पनि पूर्ण रूपमा विकसित भइ नसकेकाले बजारले निर्धारण गर्ने विनिमय दर यथार्थ स्तरमा नहुने सम्भावना हुन्छ, जसबाट व्यापार तथा लगानीमा नकारात्मक असर पर्न सक्छ।

अपरिवर्त्य (पेग्ड) विनिमय दरबाट परिवर्त्य विनिमयदरमा परिवर्तनको लागि सुझावहरू:

वर्तमान समयमा नेपालको अर्थतन्त्रको परिदृष्य हेर्दा भारतसँगको व्यापार घाटा अत्यधिक रहेको, आन्तरिक उत्पादन र उत्पादकत्वको अवस्था न्यून रहेको, निर्यात व्यापारको क्षमता कमजोर रहेको अवस्थामा विदेशी मुद्रा प्राप्तिको दिगो व्यवस्थापन अत्यन्त चुनौतीपूर्ण रहेको अवस्थामा विप्रेषण आयबाट बाह्य क्षेत्र सन्तुलन कायम गरिएको छ । यस अवस्थामा स्पष्ट रूपमा अपरिवर्त्य विनिमयदरबाट परिवर्त्य विनिमय दरमा तत्काल रुपान्तरण गर्ने कार्य निकै नै चुनौतीपूर्ण भए तापनि राज्य/सरकारले पन्छौं योजनाबाट यसको सोच रूपान्तरण तर्फ रहेकाले देहायका सुझावहरू परिवर्तनको लागि उपयुक्त हुने देखिन्छ:

(क) वित्त र मौद्रिक अधिकारी अपरिवर्त्य विनिमयदरबाट परिवर्त्य विनिमय दरमा रुपान्तरणका लागि मानसिक रुपमा तयार हुने,आउन सक्ने जोखिमको पूर्वानुमान गर्ने, विकल्पहरूको विकास गर्ने,

(ख) विनिमय दर प्रणाली परिवर्तन गर्दा बजारलाई आफ्नो मुद्राको मूल्य स्थिर रहने विश्वास दिलाउन सक्ने प्रशस्त आधार तयार गर्नु जरुरी हुन्छ जस्तै आन्तरिक उत्पादन वृद्धि, निर्यात व्यापारमा बढोत्तरी, Foreign Direct Investment, Trade, Tourism and Information Technology र अन्य सँभावित क्षेत्रबाट विदेशी मुद्राको दिगो सुनिश्चितता भएको वातावरण तयार गर्ने,

(ग) स्थिर विनिमयदर प्रणालीलाई यथावत कायम राख्दै नेपालको वित्तीय क्षेत्रलाई विश्व वित्तीय र मौद्रिक क्षेत्रसँग सँगति कायम गर्न आवश्यक क्लिनिकल अर्थशास्त्र (Clinical Economics) को रूपमा विज्ञ मौद्रिक अर्थशास्त्री (Monetarist) हरूबाट प्राविधिक पक्षमा जाँच गर्दै यसका लागि आवश्यक ऐन, विनियम, निर्देशिका, परिपत्र तथा कानूनहरूको संशोधन तथा तर्जुमा प्रक्रिया अगाडि बढाउने,

(घ) पूँजी खातालाई क्रमशः आंशिक खुकुलो बनाउँदै विद्यमान विनिमयदर प्रणालीको संक्रमणकालीन व्यवस्थापन (Transitional Period Management) को लागि क्रमशः परीक्षणको रूपमा देहायका तरिकालाई Pilot Project को अवधारणा अवलम्बन गर्ने :

(अ) मुद्रा डालो वा क्षितीजीय व्यान्ड वा व्यवस्थित परिवर्त्य (Exchange Rate or Horizontal Band or Currency Basket or Managed Float Rate) : यो विनिमय दर प्रणाली त्यस्तो हो जसमा विनिमय दर न त पूर्ण रूपमा स्वतन्त्र हुन्छ (वा फ्लोटिंग) न त स्थिर हुन्छ । मुद्राको मूल्य केन्द्रीय बैंकको हस्तक्षेपद्वारा अर्को मुद्राको विरूद्ध एक दायरामा राखिएको छ ।

(आ) क्रवलिङ्ग पेग (Crawling Peg Rate): यो विनिमय दर एक प्रणाली हो जहाँ एक मुद्राको मान विस्तारै समय सँगै समायोजन (Adjustment) हुन्छ । सामान्यतया पूर्व निर्धारित व्यान्ड भित्र, प्रतिस्पर्धा र आर्थिक स्थिरता कायम गर्न यसले सहयोग गर्दछ ।

(इ) विनिमय दर करिडोर (Exchange Rate Corridor) : यो एक प्रणाली हो जहाँ केन्द्रीय बैंकले यसको मुद्राको विनिमय दरलाई एक विशिष्ट दायरा वा व्यान्डभित्र राखेर अर्को मुद्रामा ठीक नभई एक विशिष्ट दायरा वा व्यान्डमा राख्दछ । यो दृष्टिकोणले विनिमय दरमा केही लचिलोपनका लागि अनुमति दिन्छ जब अझै स्थिरता र पूर्वानुमानताको डिग्री प्रदान गर्दछ । केन्द्रीय बैंकले विदेशी एक्सचेन्ज बजारमा हस्तक्षेप गर्दछ र विनिमय दरलाई परिभाषित सिमाना बाहिर सार्नको लागि सहयोग गर्दछ ।

(ङ) उल्लिखित विनिमयदर सफल भएमा मौद्रिक स्थायित्वको सुनिश्चित गरेर पूँजी खाता खुल्ला गरी परिवर्त्य विनिमयदर (Flexible Exchange Rate) मा रुपान्तरण हुने ।

निष्कर्ष:

कुनै पनि मुलुकको बाह्य क्षेत्रलाई सन्तुलनमा राख्दै समग्र आर्थिक स्थायित्व कायम गर्नका लागि विनिमय दरको महत्वपूर्ण भूमिका हुने गर्छ । विनिमयदरलाई उचित स्तरमा राख्न सकिएन भने निर्यातमा प्रतिस्पर्धात्मक क्षमता ह्रास हुन गई बाह्य क्षेत्र नै अस्थिर रहने सम्भावना हुन्छ । तसर्थ सबै मुलुकले आफूलाई उपयुक्त हुने विनिमय दर पद्धति अवलम्बन गरेका हुन्छन्। विनिमय दर प्रणाली परिवर्तन गर्दा बजारलाई आफ्नो मुद्राको मूल्य स्थिर रहने विश्वास

दिलाउन सक्ने प्रशस्त आधार तयार गर्नु जरुरी हुन्छ । नेपालमा पूँजी खाता (Capital Account) परिवर्त्य नरहेकाले व्याजदरबाट हुने पूँजी कारोबार न्यून रहन्छ। हाल भारतसँग अत्यधिक व्यापार घाटा रहेकाले भारतीय मुद्राको तुलनामा नेपाली रूपैयाँ अवमूल्यन हुनुपर्ने र अन्य मुद्रामा खर्चको तुलनामा आम्दानी बढीरहेको हुँदा अन्य मुद्राको तुलनामा अधिमूल्यन हुनुपर्ने देखिन्छ । समग्रमा, नेपालको वर्तमान अवस्था हेर्दा विदेशी मुद्रा अधिमूल्यन अथवा अवमूल्यन भए पनि राज्यलाई वैदेशिक दायित्व भुक्तान गर्न समस्या छैन, यद्यपि नाफा गर्ने र घाटा बेहोर्ने पक्ष भने फरक छन् । हालको भारतसँगको अपरिवर्त्य 'पेग्ड' विनिमय दर प्रणालीको अल्पकालीन विकल्प नभए पनि पेगको दरमा भने केही परिवर्तन गर्दा उपयुक्त हुने देखिन्छ। अन्तर र्ाष्ट्रिय मुद्राकोष, विश्व बैंक तथा एशियाली विकास बैंक लगायतका वैश्विक संस्थाहरूले नेपालको यथार्थ विनिमय दर अधिमूल्यन भएकाले निर्यात व्यापारमा नकारात्मक प्रभाव परेको निष्कर्ष निकालेका छन्। यस्तो अवस्थामा भार तसँगको विनिमय दरलाई हालको एक भारतीय रूपैंयाँ बराबर एकसय साठी रूपैयाँबाट केही वृद्धि गर्दा नेपाललाई थोरै लाभ हुने देखिन्छ। तर यस्तो निर्णय उत्पादन/उत्पादकत्व तथा निर्यात क्षमतामा कुनै वृद्धि नगरी गरिएमा यो झन् प्रत्युत्पादक हुने जोखिम पनि त्यत्तिकै रहने भएकाले पूर्व वृहत तयारी बिना भारतसँगको पेग्ड दरमा परिवर्तन गरेमा त्यसले अपेक्षित लाभ दिने भन्दा मुद्रा स्फीतिमा दबाब सिर्जना गरी समग्र आर्थिक स्थिरतामा खलल पुऱ्याउन सक्ने जोखिम छ। पर्याप्त मौद्रिक अर्थतन्त्रको अध्ययन, अनुसन्धान तथा विश्लेषण बिना विनिमयदर पद्धति परिवर्तन गर्ने गल्ती गरिएमा नेपालले बाह्यक्षेत्र अस्थिरताको दबाब सामना गर्नुपर्ने अवस्था आउन सक्छ। यसका लागि वित्त र मौद्रिक अधिकारी एवं नीतिहरू बीचमा चुस्त समन्वयको आवश्यकता देखिन्छ । मौद्रिक नीति शिल्पीहरूले फाइदा तथा बेफाइदाहरू तथा समग्र चुनौतीहरूको विश्लेषण गरी आगामी दिनमा उपयुक्त कदम चाल्नु ग्राह्य हुनेछ ।

सन्दर्भ सामग्री:

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आर्थिक वर्ष २०८२।०८३ को बजेट वक्तव्य र आर्थिक सर्वेक्षण, अर्थ मन्त्रालय, सिंहदरबार ।

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उज्यालो नेपाल : साझा प्रयास र समृद्ध भविष्यको यात्रा

नारायण ज्ञवाली
अध्यक्ष
सामुदायिक विद्युत उपभोक्ता राष्ट्रिय महासंघ

नेपाल पहाड, तराई र हिमालको सुन्दर संयोजन मात्र होइन, सम्भावनाको भूमि पनि हो । यो सम्भावनालाई यथार्थमा रूपान्तरण गर्न आधारभूत पूर्वाधार, विशेषतः ऊर्जा क्षेत्रको विकास अत्यन्त महत्वपूर्ण छ । "उज्यालो नेपाल" भन्नाले केवल बत्ती बाल्ने कुरा मात्र होइन, जनताको जीवनशैली, शिक्षा, स्वास्थ्य, रोजगारी, तथा उद्यमशीलता प्रवर्द्दन गर्ने शक्तिशाली माध्यम हो । यस अभियानको मूलधारमा रहेका छन् - नेपाल विद्युत प्राधिकरण, सामुदायिक विद्युतीकरण, वैकल्पिक ऊर्जा प्रवर्धन केन्द्र, स्वतन्त्र विद्युत उत्पादक कम्पनीहरू, बुटवल पावर कम्पनी, दातृ निकायहरू र तिनको साझा संकल्पवाट मात्र उज्यालो नेपाल बनाउन र भन्न हामी सक्ने अवस्थामा आएका छौं ।

नेपाल विद्युत प्राधिकरण (Nepal Electricity Authority-NEA): समर्पण र सेवा

नेपाल विद्युत प्राधिकरण (ने.वि प्रा) देशकै सबैभन्दा ठूलो सार्वजनिक संस्था हो, जसले उत्पादन, प्रसारण र वितरणका माध्यमबाट देशलाई उज्यालो बनाउन नेतृत्वदायी भूमिका निर्वाह गर्दै आएको छ । पछिल्लो दशकमा आयोजना निर्माणमा तीव्रता, लोडसेडिङ अन्त्य, ऊर्जा व्यापार बिस्तार, स्मार्ट मिटर प्रणालीको शुरुवात र ग्रामीण क्षेत्रमा सेवा बिस्तार जस्ता महत्वपूर्ण कार्यहरू सम्पन्न गर्दै, यो संस्था अब केवल सरकारी मात्र नभई जन-विश्वासको केन्द्र बन्न सफल भएको छ ।

सामुदायिक विद्युतीकरणः जनताको नेतृत्व, जनताको स्वामित्व

ने.वि.प्रा. को सहकार्यमा स्थानीय समुदाय आफैले निर्माण र व्यवस्थापन गर्ने जनसहभागितामा आधारित सामुदायिक विद्युतीकरण कार्यक्रम नेपालको ग्रामीण विकासको मेरुदण्ड बन्न पुगेको छ । जनताको श्रमदान, स्वामित्व, भावना र सेवा मनोवृत्तिले देशका विकट भूगोलसम्म विद्युत पुऱ्याएको छ । यसले न केवल उज्यालो ल्यायो, स्थानीय रोजगारी सिर्जना, उद्यम विकास र शिक्षा प्रवर्द्धनमा समेत योगदान पुऱ्याएको छ । विद्युतीय चुल्हो प्रवर्द्धन, ई-रिक्सा जस्ता नविनतम प्रविधि पनि प्रवर्द्धन गरि रहेको छ ।

वैकल्पिक ऊर्जा प्रवर्धन केन्द्र (AEPC) : सुदूरका लागि सहारा

जहाँ राष्ट्रिय प्रसारण लाइन पुग्न सकेको छैन, त्यहाँ सौर्य, जल, बायोग्यास वैकल्पिक ऊर्जाका माध्यमद्वारा उज्यालो फैलाउने कार्य वैकल्पिक ऊर्जा प्रवर्धन केन्द्रले गर्दै आएको छ। ग्रामीण तथा दुर्गम क्षेत्रका हजारौं घरहरूमा विद्युतीकरण, स्वच्छ चुलो प्रवर्द्दन र नवीकरणीय ऊर्जा प्रविधिको बिस्तार यस संस्थाको सफलता हो । महिलाको सशक्तीकरण र जलवायु न्यायमा पनि यसको भूमिका उल्लेखनीय छ ।

बुटवल पावर कम्पनी र स्वतन्त्र विद्युत उत्पादक संस्था (IPPAN) निजी क्षेत्रको योगदान

नेपालमा जलविद्युत् सम्भावनाको भरपूर उपयोगका लागि निजी क्षेत्रको लगानी अपरिहार्य छ । बुटवल पावर कम्पनी जस्ता अग्रणी निजी कम्पनीहरूले ठूला आयोजना निर्माणमा अग्रसरता लिएका छन् । स्वदेशी लगानी, प्रविधि र व्यवस्थापनद्वारा आज नेपालले ऊर्जा निर्यात गर्न सक्ने स्थितिमा पुग्नुमा स्वतन्त्र विद्युत उत्पादक संघ (IPPAN) अन्तर्गतका संस्थाहरूको योगदान बिर्सन मिल्दैन । बुटवल पावर कम्पनीले पनि विद्युत उत्पादनका अतिरिक्त ग्रामीण विद्युतीकरण सेवा विस्तार गर्दै हजारौं ग्राहकहरूलाई सेवा

दिई उज्यालो नेपाल बनाउन सहयोगी भूमिका खेलेको छ ।

दातृ संस्था र अन्तर्राष्ट्रिय साझेदारको साथ

नेपालको ऊर्जा विकासमा दातृ निकायहरूको भूमिकालाई पनि स्मरण गर्नैपर्छ । विश्व बैंक, एशियाली विकास बैंक, नर्वे, कोरियालगायत अन्तर्राष्ट्रिय सहयोगी संस्थाहरूको प्राविधिक तथा आर्थिक सहयोगले आयोजना निर्माण, नवीकरणीय ऊर्जा बिस्तार र संस्थागत सुधारहरू सम्भव भएका छन् ।

अबको आवश्यकता: उज्यालो मात्र होइन, मन-मनमा उज्यालो

हामीले उज्यालो नेपाल बनाइसकेका छौं तर अबको आवश्यकता केवल बत्ती बाल्नु मात्र होइन, जन-जनको मनमा विश्वास, अवसर, समानता र समृद्धिको उज्यालो फैलाउनु हो । यसको लागि चाहिन्छ गुणस्तरीय विद्युत सेवा, पारदर्शी सुशासन, उपभोक्ता-मैत्री प्रविधि र सबै नागरिकसम्म सरल पहुँच ।

नेपाल विद्युत प्राधिकरण जस्ता संस्थाहरूको प्रभावकारिता, निजी क्षेत्रको सक्रियता, समुदायको सहभागिता र दातृ सहयोगको समन्वयले मात्र यो सम्भव छ ।

साझा प्रयासले मात्रै सम्भव छ 'समृद्ध नेपाल'

"उज्यालो नेपाल" कुनै व्यक्तिको सपना होइन, यो त सम्पूर्ण नेपालीको साझा आकाङ्क्षा हो । यो आकाङ्क्षा पूरा गर्न सबै पक्षले आ-आफ्नो भूमिकामा ईमानदार र सक्रिय बन्नु पर्दछ । बत्ती मात्र होइन, विचार, व्यवहार र नेतृत्व उज्यालो बन्यो भने, मात्र हामी साँचो अर्थमा "उज्यालो नेपाल" को यात्रामा सफल हुनेछौं । यो सबै पक्षको अग्रणी नेतृत्व नेपाल विद्युत प्राधिकरणले लिनु पर्छ ।

निर्माणाधीन मध्य भोटेकोशी जलविद्युत आयोजनाको पावर हाउस

जलवायु परिवर्तनको विश्व परिदृष्य र नेपालको जलविद्युत क्षेत्रमा यसको प्रभाव

रमेश कुमार पाण्डे
सहायक निर्देशक
उत्पादन निर्देशनालय

विषय प्रवेश :

विश्वव्यापी रूपमा तापमान र मौसमको स्वरूपमा लामो अन्तरालमा आउने परिवर्तन नै जलवायु परिवर्तन हो । प्रकृति माथि मानवीय क्रियाकलापले गरेको अतिक्रमणको परिणामका रुपमा समेत यसलाई बुझ्ने गरिन्छ । जलवायु प्राकृतिक रुपमा नै परिवर्तनशील छ तर हालको वैश्विक जलवायु परिवर्तन भने जिवास्म इन्धनको अधिक प्रयोग तथा वातावरण विरुद्ध भैरहेका मानवीय क्रियाकलापका कारण विश्वव्यापी तापमानमा भएको वृद्धिको उपज हो । पछिल्ला वर्षहरूमा मिथेन, नाइट्रस अक्साइड, कार्बनडाइअक्साइड, क्लोरोफ्लोरो कार्बन जस्ता विषाक्त ग्यासको उत्सर्जन दिन प्रतिदिन वायुमण्डलमा बढ्दै गइरहेको छ जसले गर्दा सूर्यको प्रकाश पृथ्वीमा आउने तर परावर्तित विकिरणहरू वायुमण्डलमा रोकिनाले पृथ्वीको तापक्रम वृद्धि हुँदै छ । सन् १९६० को दशकपछि पृथ्वीमा भएको द्रुत औधोगिक विकास, जनसङ्ख्या वृद्धि, जिवास्म इन्धनको अत्यधिक प्रयोग र तिनबाट उत्सर्जित हरितगृह ग्यास, वनजंगलको विनाश भई त्यस्ता ग्यास अवशोषण गर्ने "सिङ्क" को कमी साथै भूक्षय तथा खेतीपाती देखि चिस्यान प्रविधि (रेफ्रिजेरेसन) का गतिविधिबाट हरितगृह ग्यास सिर्जना भई विश्वमा जलवायु परिवर्तन भईरहेको छ ।

जलवायु परिवर्तनको विश्व परिदृष्य:

विश्व मौसम संगठन (WMO) का अनुसार पृथ्वीको औसत तापक्रम सन् १८५०-१९०० को तुलनामा हाल १.५ डिग्री सेल्सियस बढेको छ । त्यसै गरी कोप २१ (पेरिस सम्झौता) ले सन् २१०० सम्म विश्व तापमान वृद्धिलाई १.५ डिग्रीकै सीमाभित्र राख्न सम्झौता गरेको छ । अन्तरसरकारी प्यानलका अनुसार शताब्दीको अन्त्यमा २.५ डिग्री देखि २.९ डिग्री सेल्सियस पुग्ने अनुमान गरेको छ । संकटासन्नता तथा जोखिम विश्लेषण प्रतिवेदन, २०२१ अनुसार करिब ९० प्रतिशत बालीनालीको नोक्सानी जलवायु परिवर्तनजन्य घटनाका कारण हुने गरेको छ । साथै यस्ता कारणले गर्दा कृषि उत्पादन, पशुपालन र मत्स्यपालनमा १०-३० प्रतिशतसम्म ह्रास आएको छ ।

विश्वका हरितगृह ग्यास उत्सर्जन गर्ने देशहरूमध्ये सन् २०२२ मा चीनको हिस्सा सबैभन्दा बढी २५.८१ प्रतिशत त्यसपछि क्रमश अमेरिका, भारत, युरोपियन युनियन रहेका छन् । विश्वका बढी कार्बन उत्सर्जन गर्ने १० राष्ट्रले कूल कार्बन उत्सर्जनको ६० प्रतिशत उत्सर्जन गर्ने गरेका छन् जबकी नेपाल जस्ता कम कार्बन उत्सर्जन गर्ने १०० राष्ट्रहरूले जम्मा ३ प्रतिशत मात्र कार्बन उत्सर्जन गर्ने तथ्याङ्क रहेको छ ।

विश्वमा बढी कार्बन उत्सर्जन गर्ने राष्ट्रले कम कार्बन उत्सर्जन गर्ने राष्ट्रलाई वनजंगल संरक्षण गरेवापत क्षतिपूर्ति स्वरूप रकम प्रदान गर्न सन् १९९७ को क्योटो सम्मेलनबाट विश्वमा कार्बन व्यापार (Carbon Trade) को अवधारण आएको छ भने जलवायु परिवर्तन न्यूनीकरण सम्बन्धमा Investment / Loan वातावरणमैत्री क्षेत्रमा प्रदान गर्नका लागि कोप १७ बाट विश्वमा हरित वित्त (Green Financing) को अवधारणा समेत ल्याइएको छ ।

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जलवायु वित्त १.३ ट्रिलियन आवश्यकता बोध गरिएको साथै सन् २०२५ देखि सन् २०३५ सम्म वार्षिक ३०० विलियन दिने प्रतिबद्धता गरिएको छ । जुन रकम कोप २८ सम्म १०० विलियन थियो । उक्त कोषमा रकम दिने नदिने विषयमा अमेरिकाप्रति शंका, चीनलाई सहयोग प्रदान गराउन नसकिने होकि भन्ने देखिन्छ भने भारतले यो सम्मेलनमा विकासशील राष्ट्रको पक्षमा गंभीर विषय उठान गरेको छ । साथै Peris Agreement ले लिएको विश्वको तापक्रम १.५ डिग्री सेल्सियस कायम राख्ने लक्ष्य पूरा गर्न Nationally Determined Contribution(NDCs) प्रत्येक ५ वर्षमा गर्नुपर्ने प्रावधान बमोजिम सबै राष्ट्रले सन् २०२५ मा NDCs Report पेश गर्ने भनिएको थियो । Small Island Developing State (SIDS) को पक्षमा यो सम्मेलनले जोड दिएको छ । साथै पेरिस सम्झौताको Article ६ (कार्बन बजारसँग सम्बन्धित) को पुर्नव्याख्या गरियो । Mitigation & Adaptation र जैविक विविधता सम्बन्धी जोड दिइयो । पेट्रोलियम पदार्थ उत्पादन गर्ने र बिक्रीमा आश्रित देशहरूको भूमिका भने यस सम्मेलनमा असहयोगी देखिन गयो । यस अघि कोप २८ को पूर्वसन्ध्यामा संयुक्त राष्ट्रसंघका महासचिव एन्टोनियो गुटेरेसले नेपाल भ्रमण गरी नेपालका केही हिमालहरूको अवलोकन गरे पश्चात् नेपालका हिमालहरू रोइरहेको अभिव्यक्ति दिनुका साथै नेपालको हिमाली अर्थतन्त्र जलवायु परिवर्तनको असरले आक्रान्त भएको विचार व्यक्त गर्नुभएको थियो । साथै उहाँले जलवायु परिवर्तनबाट सबैभन्दा बढी प्रभाव नेपाल र अन्टार्कटिकामा परेको विषय समेत व्यक्त गर्नु भएको थियो । उहाँको भ्रमण पूर्व हिमताल फुट्ने, हिमाल पग्लिने समस्याले उक्त समयमा मेलम्चीको बाढीले पीडा निम्तिएको थियो । प्रत्येक कोप सम्मेलनहरूमा नेपालले आफ्नो समूहमा जलवायु परिवर्तनका असरबाट भएको हानी नोक्सानीको क्षतिपूर्ति, जलवायु वित्तमा सहज पहुँच लगायतका मुद्धाको नेतृत्व गर्दै आएको तथा अतिकम विकसित राष्ट्र तथा हिमाली राष्ट्रको आवाज भने उठाउदै आएको छ । अब हुने कोप सम्मेलनमा सहयोग होइन अधिकार खोजिनु जरुरी देखिन्छ ।

कार्बन व्यापार (Carbon Trade) को अवधारणा तथा प्राधिकरणका जलविद्युत आयोजना र Charging Station को कार्बन व्यापारमा भूमिका :

जलवायु परिवर्तन न्यूनीकरणमा सघाउन तथा वन जंगल संरक्षणका लागि विश्वका राष्ट्रहरूलाई प्रोत्साहन गर्नका लागि सन् १९९७ को क्योटो सम्मेलनबाट कार्बन व्यापारको अवधारणा ल्याईएको छ भने यसको लागू भने सन् २००५ बाट भएको छ । कार्बन व्यापारको मुख्य ध्येय Polluter Pay Principle हो अर्थात् बढी कार्बन उत्सर्जन गर्ने देशले बढी क्षतिपूर्ति तिर्नुपर्छ भन्ने रहेको छ । लक्षभन्दा बढी कार्बन कटौती गरेमा Carbon Credit भनिन्छ । त्यसैगरी Global Environmental Facility (GEF) अतिकम विकसित राष्ट्रलाई अनुकूल कार्यक्रम सञ्चालनका लागि खर्च जुटाउन बनाइएको कोष हो । कार्बन व्यापारका लागि Verified Carbon Standard, Clean Development Mechanism & Gold Standard जस्ता मापदण्ड भने कार्यान्वयनमा रहेका छन् । साथै नेपालको १२ जिल्लामा सञ्चिति हुने कार्बन खरिदका लागि विश्वबैंकले प्रतिवद्धता जनाईसकेको छ ।

आ.व. २०८०/८१ को तथ्याङ्क अनुसार नेपाल विद्युत प्राधिकरण उत्पादन निर्देशनालय अन्तर्गत रहेका करिब २० वटा जलविद्युत केन्द्रबाट ५८३ मे.वा, प्राधिकरणका सहायक कम्पनीबाट उत्पादन भएको ४९३ मे.वा र प्राधिकरणको सोलार प्यानलबाट उत्पादित २५ मे.वा. गरी करिब ११०० मे.वा. उर्जा प्राधिकरणकै प्रयत्नमा उत्पादन भएको छ । त्यसै गरी आर्थिक सर्वेक्षण २०८१/०८२ अनुसार नेपालमा प्राधिकरण तथा निजी क्षेत्र समेतको गरी ३६०२ मेगावाट विद्युत उत्पादन भएको तथ्याङ्क छ । यसरी नेपालमा जलविद्युतको विकास मार्फत् वनजंगल संरक्षण र जिवास्म इन्धनको प्रयोग घटाउन प्राधिकरणले अहम भूमिका खेलेको छ । साथै नेपालले सन् २०४५ सम्म कार्बन उत्सर्जन शून्यमा झार्ने गरी संयुक्त राष्ट्रसंघमा प्रतिबद्धता समेत जनाइसकेकोले सरकारद्वारा विद्युतीय सवारीसाधनको प्रवर्द्धन गरिएको परिपेक्ष्यमा ने.वि.प्रा. आफैले ६० भन्दा बढी स्थानमा विद्युतीय चार्जिङ स्टेशन जडान गरेको साथै ४५० भन्दा बढी स्थानमा विद्युतीय चार्जिङ स्टेशन जडान गर्न निजी क्षेत्रलाई सहयोग गरी विद्युतीय ऊर्जाको प्रयोग बढाउन जोड दिएकोले समग्रमा प्राधिकरणको भूमिका कार्बन व्यापारसँग समेत जोडिएको छ ।

जलवायु परिवर्तन र नेपाल:

विश्वमा जलवायु परिवर्तनको असरको दृष्टिले नेपालको स्थान चौथो नम्बरमा रहेको छ । नेपालको भौगोलिक संरचना समुन्द्र सतहदेखि ५९ मिटरको उचाइदेखि विश्वको सवैभन्दा अग्लो शिखर सगरमाथा (८८४८ मि.) सम्म रहेको साथै हिमाली तथा पर्वतीय भूभाग धेरै रहेको कारण जलवायु परिवर्तनको असर नेपालमा बढी देखिएको छ । नेपालको कूल क्षेत्रफल मध्ये करिब ४५.३१ प्रतिशत क्षेत्र वनजंगलले ओगटेको छ । जुन विश्वका अन्य राष्ट्रको तुलनामा औसतमा धेरै बढी हो तर नेपालले नै जलवायु परिवर्तनको महासंकट भोगिरहेको छ। नेपालले सन् १९९४ मा जलवायु परिवर्तन सम्बन्धी संयुक्त राष्ट्र संघीय संरचना महासन्धि (United Nations Framework Convention on Climate Change-UNFCCC) को पक्ष राष्ट्र भएदेखि नै जलवायु परिवर्तन व्यवस्थापनसंग सम्बन्धित कार्यक्रमहरू सक्रियतापूर्वक सम्पादन गर्दै आएको छ । यस क्रममा वि.स. २०६५ मा राष्ट्रिय अनुकूल कार्यक्रम (National Adaptation Programme of Action-NAPA) तयार गरी उक्त कार्यक्रमले पहिचान गरेका जलवायु अनुकूल परियोजनाहरू सञ्चालन गरिएको छ । पर्वतीय मुद्दालाई स्थापित गराउन सन् २०२५ मे १६ देखि १८ सम्म सगरमाथा सम्वाद सम्पन्न भएको साथै वि.स. २०६६ मंसिर १९ मा नेपाल सरकार मन्त्रिपरिषदको बैठक कालापत्थरमा सम्पन्न भएको थियो । नेपालले विश्वमा नै पहिलो पटक जलवायु बजेट कोड शुरु गरी अन्य मुलुकका लागि समेत प्रदर्शन प्रभाव पारेको छ। जलवायु वित्त र प्रविधि ल्याउनका लागि गाउँगाउँसम्म विस्तार भएका सामुदायिक संस्था परिचालन गरी समुदायमा आधारित अनुकूलन कार्यक्रम गर्न सकिन्छ भनी पहल गरिएको छ। योजना डिजाइनका विधि, सूचक र मापदण्डहरूका साथै निर्माणका तौरतरिकालाई पुनः मूल्याङ्कन गरी आवश्यकता बमोजिम परिमार्जन गर्नका लागि पहल शुरु गरिएको छ। नेपालमा जलवायु परिवर्तनले जलविद्युत क्षेत्रमा पारेको प्रभावलाई तोकेर भन्नको लागि आवश्यक अध्ययन नपुगेको तर क्षति भने अपुरणीय नै देखिन्छ। वन तथा वातावरण मन्त्रालयको तथ्याङ्क अनुसार नेपालमा करिब २० लाख भन्दा बढी मानिस जलवायु परिवर्तनको उच्च जोखिममा रहेका छन् । जबकि नेपालले विश्वको ०.०२७ प्रतिशत मात्र हरितगृह ग्यास उत्सर्जन गर्ने गरेको छ भने बाँकी विकसित र विकासोन्मुख राष्ट्रबाट उत्सर्जन हुने गरेको देखिन्छ। मानव सिर्जित क्रियापलापबाट जलवायु परिवर्तनजन्य विपद् बढ्दै गएका छन् । बाढी पहिरो, हिमआँधी जस्ता जलवायुजन्य प्रकोपका कारण नेपालको पर्यटन क्षेत्रमा मात्र वार्षिक करिब २५ अर्बको क्षति हुने अनुमान छ । विश्वका ठूला अर्थतन्त्र भएका मुलुकको बीचमा हुनु, विश्वमै जलवायु परिवर्तनको असर हिमाली तथा सामुद्रिक राष्ट्रमा बढी पर्नु जस्ता विविध कारण नेपाल एक्लैले चाहेर जलवायु परिवर्तन न्यूनीकरण गर्न संभव छैन तर अनुकूलन र न्यूनीकरण तथा क्षति कम गर्न भने सकिन्छ।

जलवायु परिवर्तन न्यूनीकरणमा नेपालले गरेका विभिन्न महत्वपूर्ण व्यवस्थाहरू

राष्ट्रिय जलवायु परिवर्तन नीति, २०७६

वि.स. २०६७ मा जलवायु परिवर्तन नीति लागू गरिए पश्चात् जलवायु परिवर्तन व्यवस्थापनको क्षेत्रमा राष्ट्रिय एवम् अन्तर्राष्ट्रिय आयामहरूमा आएको परिवर्तनलाई प्रभावकारी रुपमा सम्बोधन गर्न उक्त नीतिको कार्यान्वयनबाट प्राप्त सिकाई समेतको आधारमा नयाँ नीति तर्जुमा गर्नुपर्ने आवश्यकता महसुस भएकोले सरकारले यो नीति तर्जुमा गरेको हो। मूलतः नेपालको संविधानले प्रत्येक नागरिकलाई स्वच्छ र स्वस्थ्य वातावरणमा बाँच्न पाउने मौलिक हकको प्रत्याभूति गर्दै दिगो र वातावरण अनुकूल विकास, नविकरणीय ऊर्जाको प्रवर्द्धन, औद्योगिक तथा भौतिक विकासबाट वातावरणमा पर्ने जोखिमको न्यूनीकरण, यातायात क्षेत्रमा वातावरण अनुकूल प्रविधिलाई प्राथामिकता एवम् पर्यावरण अनुकूल पर्यटनको विकास जस्ता जलवायु परिवर्तन व्यवस्थापनसँग सम्बन्धित अवधारणाहरूलाई राज्यका नीतिको रुपमा स्वीकार गरेको छ। मुलुक संघीय संरचनामा गएको र सो अनुरूप जलवायु परिवर्तनका मुद्दाहरूलाई तीनै तहका नीति तथा कार्यक्रमहरूमा एकीकृत गर्दै जलवायु परिवर्तन न्यूनीकरण अनुकूलनसँग सम्बन्धित कार्यक्रमहरू प्रभावकारी रुपमा सञ्चालन गर्न एवम् जलवायुमैत्री विकासद्वारा नेपाल सरकारले लिएको "समृद्ध नेपाल सुखी नेपाली" को अवधारणालाई टेवा पुऱ्याउन यो नीति ल्याइएको पाइन्छ।

जलवायु परिवर्तन न्यूनीकरण तथा अनुकूलन राष्ट्रिय कार्यान्वयन योजना (वि.स.२०८०-२०८७)

विश्वव्यापी चुनौतीको रूपमा रहेको जलवायु परिवर्तनलाई सम्बोधन गर्नका लागि जलवायु परिवर्तन सम्बन्धी महासन्धि, क्योटो अभिसन्धि र पेरिस सम्झौता कार्यान्वयनमा रहेका छन् । यी कानूनी संयन्त्रको नेपाल पक्ष राष्ट्र भएकाले पेरिस सम्झौताको प्रावधान बमोजिम हरितगृह ग्यासका उत्सर्जन न्यूनीकरण गर्न तथा जलवायु अनुकूलन सम्बन्धी परिमाणात्मक र नीतिगत लक्षहरू रहेको राष्ट्रिय निर्धारित योगदान (NDC) नेपाल सरकारले वि.स. २०७७ मंसिरमा उक्त महासन्धिको सचिवालयमा पेश गरेको थियो साथै यसलाई कार्यान्वयन गर्नका लागि तर्जुमा गरिएको जलवायु परिवर्तन न्यूनीकरण तथा अनुकूलन राष्ट्रिय कार्यान्वयन योजनालाई नेपाल सरकारले वि.स. २०८० श्रावण १६ मा स्वीकृत गरिसकेको हुँदा राष्ट्रिय आवश्यकता र अन्तराष्ट्रिय प्रतिबद्धतालाई ध्यान दिई तयार भएको एन.डी.सी. कार्यान्वयन योजनाको प्रभावकारी कार्यान्वयन गरी जलवायु परिवर्तनको कारण संकटासन्न अवस्थामा रहेका र जलवायु तथा जलजन्य विपत्बाट पीडित जनसमुदायमा परेको प्रतिकुल प्रभावलाई न्यून गरी सहज जीविकोपार्जनमा सहयोग पुऱ्याउने उद्देश्यले यो कार्यान्वयन कार्ययोजना ल्याइएको हो ।

कालापत्थर बैठक र सगरमाथा संवाद

वि.स. २०६६ मंसिर १९ गते सगरमाथाको आधारशिविर कालापत्थरमा नेपाल सरकार मन्त्रीपरिषद्को बैठक बस्यो । उक्त बैठकले वातावरणीय/जलवायु परिवर्तनले सवैभन्दा धेरै प्रभाव हिमालय पर्वतलाई पारेको निष्कर्ष निकालेको थियो । डेनमार्कको कोपनहेगनमा हुन लागेको संयुक्त राष्ट्रसंघीय वातावरणीय शिखर सम्मेलनको १ हप्ता अघि भएको उक्त बैठकले १० बुँदे "सगरमाथा घोषणापत्र" जारी गर्दै विश्वको ध्यानाकर्षण गराएको थियो ।

साथै "पृथ्वीको भविष्य सुनिश्चित होस्, मानव जातिको भविष्य सुनिश्चित होस्" यसका लागि नेपाल सरकारको पहलमा सन् २०२५ मे १६ देखि १८ सम्म काठमाण्डौमा सगरमाथा संवाद आयोजना भयो । २५ बुँदे घोषणापत्र जारी गर्दै समापन भएको सगरमाथा संवादमा जलवायु परिवर्तन र हिमाली क्षेत्रको संरक्षणका विषयहरू समावेश छन् । "सगरमाथा कल फर एक्सन" घोषणापत्रमा पेरिस सम्झौता बमोजिमको विश्वको तापक्रम १.५ डिग्री सेल्सियस सीमाभित्र कायम राख्न आवश्यक उपायहरू प्रस्तुत गरियो । जलवायु परिवर्तन, पर्वत र मानव भविष्यबारे गरिएको छलफल ऐतिहासिक रहेको छ । जसमा हिमाल बचाउने प्रतिबद्धता, हरित प्रविधिको प्रवर्द्धन, विकासशील राष्ट्रहरूलाई सहुलियत, वित्तीय सहयोग तथा जलवायु न्याय (Climate Justice) का पक्षमा ठोस मागहरू राखिएका छन् । सगरमाथा संवादको यस संस्करणले नेपाललाई अन्तराष्ट्रिय मञ्चमा जलवायु नेतृत्वदायी राष्ट्रको रुपमा स्थापित गरेको पाइएको छ ।

तीनै तहका सरकारबाट जलवायु परिवर्तन न्यूनीकरणका लागि भएका सकारात्मक प्रयासहरू :

पछिल्लो तथ्याङ्क अनुसार नेपालका ८ स्थानीय तहमा जलवायु नमूना कार्यक्रम सञ्चालन भैरहेको छ । कर्णाली प्रदेशका ३५ स्थानीय तहमा नेपाल जलवायु परिवर्तन सहयोग कार्यक्रम कार्यान्वयनमा छ । बागमती, कर्णाली र सुदूरपश्चिम प्रदेशका १० स्थानीय तहमा इकोसिस्टममा आधारित अनुकूलन कार्यक्रम सञ्चालनमा रहेको, वि.स. २०७९ चैत्रसम्म २४१ स्थानीय अनुकूलन तथा जलवायु उत्थानशील विकास योजना कार्यान्वयनमा रहेका छन् । तराईका १३ जिल्लाको कार्बन उत्सर्जन न्यूनीकरण कार्यक्रम दस्तावेज स्वीकृत भई सन् २०१८ देखि कार्यान्वयनमा रहेको छ । वि.स. २०७९ चैत्रसम्म मुलुकभर २९ वायु गुणस्तर मापन केन्द्रहरू सञ्चालनमा रहेका छन् । स्थानीय अनुकूलन योजना (Local Adaptation Plans for Action-LAPA) तर्जुमा पालिका संख्या वि.स. २०८० सम्म ३५० रहेका । त्यसै गरी नेपाल सरकारले मध्यमकालीन खर्च संरचना (MTEF) मा जलवायु बजेट कोडको व्यवस्था गर्नुका साथै तीनै तहले जलवायु बजेटको प्रबन्ध गरेका छन् ।

त्यसै गरी Reducing Emission From Deforestation & Forest Degradation (REDD) अवधारणा समेत कार्यान्वयनमा आएको छ । संघीय वनमन्त्रीको अध्यक्षतामा Apex Body, वन मन्त्रालयका सचिवको अध्यक्षतामा REDD Working Group साथै वन मन्त्रालयका सहसचिवको अध्यक्षतामा REDD Cell समेत क्रियाशिल रहेका छन् । नेपालमा ANSAB, ICIMOD र FECOFUN ले संयुक्त रुपमा REDD नमूना कार्यक्रम कार्यान्वयनमा ल्याएका

छन् । NORAD को आर्थिक सहयोगमा प्रथम चरणमा कयरखोला (चितवन), चुर्नावती (दोलखा) र लुदीखोला (गोरखा) मा यो कार्यक्रम सञ्चालनमा रहेको छ ।

नेपालको जलविद्युत क्षेत्रमा जलवायु परिवर्तनको असर तथा रोकथाम सन्दर्भमा :

नेपालका अधिकांश जलविद्युत केन्द्रहरू प्रथम स्तरका नदीहरू (हिँउ पग्लिई बन्ने नदीहरू) को जलस्रोतमा निर्भर रहेका छन् (जस्तै : गण्डकी, भोटेकोशी, खिम्ती आदि) । हिँउ पर्ने चरित्रमा फेरवदल, हिँउको कमी र हिमतालको संख्यामा वृद्धि यी नदीका उपल्लो जलाधारमा देखिएका परिवर्तनहरू हुन् । जसका कारण ड्याम, पावर हाउस, ट्रान्समिसनलाइन जस्ता संरचनामा क्षति पुग्ने गरेको साथै सेडिमेन्टेसन (गाद जम्ने) का कारण टर्वाईनमा असर पार्ने र क्षमता घटाउने गरेको पाईन्छ । साथै सुख्खा मौसममा पानीको सतह अधिक कम भई उत्पादन समेत घट्ने गरेको पाईएको छ । जलवायुजन्य क्षतिको कारण मर्मत र पुनर्निर्माण लागत समेत बढेको छ ।

यही मिति २०८२ असार २४ गते चीनको सीमावर्ती क्षेत्रमा अत्यधिक वर्षाको कारण हिमताल विस्फोट भई नेपालको रसुवा जिल्लामा बाढी आउँदा उक्त क्षेत्रमा पर्ने रसुवागढी, साञ्जेन, त्रिशुली जलविद्युत केन्द्र, माथिल्लो त्रिशुली ३ ए जलविद्युत केन्द्र लगायतमा धेरै क्षति पुगेको छ । त्यसै गरी वि.स. २०७८ को बाढीका कारण माथिल्लो तामाकोशी जलविद्युत आयोजनाको लागि भण्डार गरिएका केही पार्टपूर्जा लगायतका सामग्रीहरू बाढीले बगाएको, मेलम्ची बाढीका कारण ईन्द्रावती ३ लगायतका साना जलविद्युत केन्द्रहरूमा क्षति पुऱ्यायो । त्यसै गरी विभिन्न समयमा आएका बाढीका कारण मध्य मोदी जलविद्युत आयोजना, मादी जलविद्युत, अरुण र तमोर नदीमा निर्माण भएका आयोजनाहरूमा धेरै क्षति पुगेको पाईन्छ । त्यसैगरी अन्नपूर्ण बेसक्याम्प हिमपहिरो, मनाङ र मुस्ताङमा गएका हिमपहिरो, थोराङलापास हिमपहिरो, खुम्बु हिमपहिरो, लाङटाङ हिमपहिरोका कारण नेपालका नदीहरूमा बाढी आई विभिन्न जलविद्युत आयोजनालाई क्षति पुऱ्याएका उदाहरणहरू प्रसस्त रहेका छन् ।

पानी पर्ने चरित्र २०/२५ वर्ष अघिको जस्तो नभई आँकलन गर्नै नसकिने गरी परिवर्तन भएको, हिउँ पग्लिई आउने नदीका उपल्ला एवम् तिनका मध्यपहाडी जलाधार र वर्षाले सिञ्चित गर्ने नदीका जलाधारमा पोखरी, सिमसार र वनजंगलको विनाश, जथाभावी सडक निर्माण, कंक्रिट सतहमा बढोत्तरी, खेती प्रणालीमा आएको परिवर्तन तथा नदीका पिँध र किनारामा अन्धाधुन्द उत्खनन जस्ता कारणले पनि पानीको बहावमा प्रभाव परेको छ । जसले गर्दा विद्युत उत्पादनको संरचना निर्माणमा विगतमा गरिने जलवायु परिवर्तनको असर प्रक्षेपण २५/३० वर्षसम्म गर्ने परम्परागत प्रणालीमै आमुल परिवर्तन गर्नुपर्ने आवश्यकता देखिएको छ । नेपालको एकमात्र जलाशययुक्त आयोजना इन्द्रसरोवरमा पछिल्ला वर्ष जलसतह घट्दै गएको, जलाधारमा पानी कम परेर इन्द्र सरोवर नभरिएका दृष्टान्तहरू छन् । विगतमा कुलेखानी जलविद्युत केन्द्रलाई पिक आवरमा नभई बेस लोडमा चलाइएको पनि पाइन्छ । वर्षाको परिणाम, जलाशयको आयतन र बिजुली युनिट उत्पादनको अन्तरसम्बन्धले जलवायु परिवर्तनको प्रभाव आँकलन गर्न उपयोगी हुने देखिन्छ । प्रसारण र वितरण प्रणलीमा विगतमा बाढीपहिरोले स्विचयार्ड, प्रसारण लाइन र वितरण प्रणालीलाई नोक्सान गरेका थुप्रै अनुभव रहेका छन् । प्रसारण लाइनका टावरहरूमा क्षतिभई पुननिर्माण नयाँ ठाँउमा गर्नुपर्ने हुँदा स्थानीयस्तरका विवादले पुननिर्माण समयमा हुन नसकेका र बिजुली आपूर्तिमा समस्या सिर्जना भएका दृष्टान्त समेत छन् ।

नेपालमा निर्माण भइसकेका, हुँदै गरेका र प्रस्तावित जलविद्युत् प्रणालीहरूलाई जलवायु परिवर्तनले पार्ने असर र जोखिमको गहन अध्ययन अनुसन्धान थाल्नु जरुरी भैसकेको छ । जलवायुको असर, वर्षा र हिउँ पर्ने तौरतरिका र चरित्रमा भरपर्ने हुँदा तिनको अनुगमनका लागि जल तथा मौसम विज्ञान विभागले मापन गर्ने यन्त्रको सङ्ख्या वृद्धि गर्नुपर्ने तथा जलवायु परिवर्तनको विज्ञान र जोखिमबारे अनुसन्धान गर्ने निकायले बौद्धिक र संस्थागत लगानी एवम् जनशक्ति विकास गर्नु आवश्यक छ । क्लाइमेट मोडलहरूको स्थानीयकरण गरी जलवायु परिवर्तनले पार्ने जोखिम आँकलन गर्ने विधिको विकास र तथ्याङ्कको अभावले आउने अनिश्चिततालाई उचित तरिकाले सम्बोधन गर्नुपर्नेछ । जसका लागि जल तथा मौसम विज्ञान विभाग, जलस्रोत तथा सिँचाइ मन्त्रालय, विद्युत विकास विभाग, नेपाल विद्युत प्राधिकरण, जल तथा ऊर्जा आयोग, लगानी बोर्ड, बिमा समिति, स्थानीय सरकार र समुदायका प्रतिनिधि र स्वतन्त्र

विद्युत उत्पादकहरूका बीचको सहकार्यले यो प्रयास सार्थक बन्न सक्छ । विद्युत विकासका बहुराष्ट्रिय बैंकहरू र दातृ निकायहरूको संलग्नता पनि उपयोगी हुनेछ । जलवायु अनुकूलन र डिजाईनलाई पनि समयसान्दर्भिक गराउँदै लैजानुपर्ने बेला आईसकेको छ । अब लोड व्यवस्थापन पनि जलवायु परिवर्तन अनुसार परिमार्जन गर्दै लैजान आवश्यक छ । जलस्रोतका वैकल्पिक स्रोतको पनि व्यवस्थापन गरेर परिपुरण गर्दै लैजानुपर्छ । जलविद्युत उत्पादनमा पर्ने जलवायु परिवर्तनको असर न्यूनीकरण गर्न जलाशय, अर्ध जलाशय र नदी प्रवाही आयोजनाको मिश्रित उत्पादनमा जानुपर्ने देखिन्छ । साथै जलवायु अनुकूलन (Climate Resilient) डिजाइन अपनाउने, जल तथा मौसम पूर्वानुमान प्रणाली सुधार गर्ने, Glacial Lake Outburst Floods (GLOF) र पहिरोको जोखिम मूल्याङ्कन गर्ने, वैकल्पिक उर्जाको विकासलाई प्रवर्द्धन गर्नुपर्ने आवश्यकता छ ।

सरकारले नेपालको स्वच्छ ऊर्जालाई प्रसारण लाइन मार्फत् ग्राहकसम्म पुऱ्याउने कार्यमा मात्र ध्यान नदिई हरित हाइड्रोजनको विकासका लागि पाइलट प्रोजेक्ट थालनी गर्ने तयारीमा छ जसका लागि ग्रीन हाइड्रोजन नीति, २०८० समेत ल्याइएको छ । विद्युत उपयोग गरी हरित हाईड्रोजन, एमोनिया र मल कारखाना लगायत सञ्चालन गर्ने उद्देश्य रहेको छ । विश्व नै हरित पूर्वाधारतर्फ गईरहेकोले जलवायु परिवर्तनको संभावित असर लगायतलाई विश्लेषण गरेर हाइड्रोजनको विकास र विस्तारमा अघि बढ्नु आजको आवश्यकता हो । यसका लागि काठमाण्डौ विश्वविद्यालयले अग्रसरता समेत लिएको पाईन्छ । नेपाल आयल निगमले काठमाण्डौ विश्वविद्यालयसँग हाईड्रोजन उत्पादन सम्बन्धी एक परियोजनामा सहकार्य गरेको छ साथै काठ्माण्डौ विश्वविद्यालयले Green Hydrogen Lab संग आर्थिक सहयोगको सहकार्य गरेको छ ।

जलवायु परिवर्तनबाट जलविद्युतगृह संरक्षण गर्न बनेका राष्ट्रिय तथा अन्तर्राष्ट्रिय कानूनहरू :

राष्ट्रिय कानून तथा नीतिहरू :

१) जलवायु परिवर्तन नीति, २०७६ : जलविद्युत र ऊर्जा क्षेत्रमा जलवायु उत्थानशील योजना र प्रविधि अपनाउने व्यवस्था ।

२) राष्ट्रिय जलस्रोत नीति, २०७७ : पानीको बहुउपयोग र स्रोत संरक्षणमा जोड दिने साथै जलाशय/जलविद्युत आयोजना वातावरणमैत्री बनाउने ।

३) वातावरण संरक्षण ऐन, २०७६ : कुनैपनि जलविद्युत आयोजना निर्माण अघि EIA/IEE गर्नुपर्ने बाध्यकारी व्यवस्था ।

४) विपत् जोखिम न्यूनीकरण तथा व्यवस्थापन ऐन, २०७४ : पूर्वसूचना प्रणाली, विपद् व्यवस्थापन संरचना सुदृढ गर्ने ।

अन्तर्राष्ट्रिय कानून तथा मापदण्डहरू

१) पेरिस सम्झौता, २०१५ :

जलवायु परिवर्तन न्यूनीकरणका लागि राष्ट्रिय योगदान (NDC) को प्रतिबद्धता । नेपालले NDC अन्तर्गत दिगो ऊर्जा उत्पादन प्रवर्द्धन, जलवायु अनुकूल संरचना निर्माण गर्ने योजना अगाडि सारेको छ ।

२) विश्व बैंक/एडिबी का मापदण्डहरू : जलविद्युत आयोजना संचालनमा वातावरणीय र सामाजिक सुरक्षा उपायहरू अवलम्बन गर्नुपर्ने ।

३) सेन्डाई फ्रेमवर्क (सन् २०१५-२०३०) : जलविद्युत संरचनामा पूर्व सतर्कता प्रणाली, जोखिम नक्साङ्कन अनिवार्य बनाउने ।

प्राविधिक मापदण्ड तथा दिशानिर्देशहरू:

१) Climate Resilient Hydropower Guideline (World Bank, ADB, ICIMOD आदि)

२) Hydropower Sustainability Assessment Protocol (HSAP) : जलवायु जोखिम मूल्याङ्कन समावेश ।

३) Environmental and Social Impact Assessment Guidelines : (Nepal/ADB/IFC)

अन्त्यमा, जलवायु परिवर्तन समकालीन विश्वको साझा समस्या भएको छ । जलवायु परिवर्तनमा नेपाल जस्ता अल्पविकसित मुलुकको कुनै पनि हात नरहेको भएता पनि यसको दुस्प्रभावबाट सबैभन्दा बढी प्रभावित भने नेपालजस्ता अल्पविकसित मुलुकहरू भएका छन् । जलवायु परिवर्तलाई रोक्न सक्ने अवस्थामा हाम्रो जस्तो मुलुकको क्षमता नरहेको

हुँदा अनुकूलनका उपायहरू अवलम्बन मार्फत् यसको असर न्यूनीकरणमा अग्रसर हुनु हाम्रो निर्विकल्प बाध्यता हो । Climate Justice कायम गर्नका लागि विश्व एकै ध्रुवमा रहनु आजको आवश्यकता हो । साथै नेपालको जलविद्युत क्षेत्रले स्वच्छ ऊर्जा माफत् नेपालको पर्यावरणीय सन्तुलन कायम गर्न तथा जिवास्म इन्धनको प्रयोगमा कटौती गरी जलवायु परिवर्तन न्यूनीकरणमा गुणात्मक सहयोग पुऱ्याउन सक्छ ।

सन्दर्भ सामग्री

१) विकिपिडिया : जलवायु परिवर्तन शीर्षक

२) नेपाल पूर्वाधार अनलाइनमा मिति २०७९ चैत्र ३० मा प्रकाशित लेख तथा विज्ञहरूको टिप्पणी

३) कान्तिपुर दैनिकमा मिति २०७८ पौष ६ मा प्रकाशित अजय दीक्षितको आलेख

४) वन तथा वातावरण मन्त्रालयबाट विभिन्न समयमा प्रकाशित प्रतिवेदनहरू

५) नेपालको संविधान, २०७२

६) राष्ट्रिय योजना आयोग तथा राष्ट्रिय प्राकृतिक स्रोत तथा वित्त आयोगबाट प्रकाशित प्रतिवेदनहरू

७) आर्थिक सर्वेक्षण २०८१/८२

८) आ.व. २०८२/८३ को नेपाल सरकारको बजेट वक्तव्य

९) हालसम्मका कोप सम्मेलनहरूका प्रतिवेदन तथा घोषणापत्रहरू

१०) राष्ट्रिय जलवायु परिवर्तन नीति, २०७६

११) "सगरमाथा कल फर एक्सन" घोषणापत्र, २०२५

११) UNFCCC का वार्षिक प्रतिवेदनहरू

१२) नेपाल सरकारको वार्षिक बजेट तथा Medium Term Expenditure Framework -MTEF

१३) Sendai Framework for Disaster Risk Reduction (2015-2030)

निर्माणाधीन अपर अरुण जलविद्युत आयोजनाको कर्मचारी आवास

विद्युत सुरक्षा प्रणालीको प्रभावकारी व्यवस्थापन

आनन्द मण्डल
ईन्जिनियर
Borang-Naubise (Ratmate)
220 kV Transmission Line Project

१) पृष्ठभूमि

स्वस्थ विद्युत प्रणाली कुनै पनि देशको सशक्त अर्थतन्त्रको मेरुदण्डको रूपमा मानिन्छ, किनभने यसले विद्युत प्रयोगकर्ताहरूलाई अविच्छिन्न विद्युत आपूर्तिको पहुँच सुनिश्चित गर्छ, जसले गर्दा उद्योगहरू र ग्राहस्थ ग्राहकवर्ग आवासीय घरपरिवारहरूले बिना रोकटोक आफ्ना गतिविधिहरू निरन्तर सञ्चालन गर्न सक्छन् । विद्युत प्रणालीका घटकहरूको (Power System Components) सुरक्षा यस सन्दर्भमा अत्यन्त महत्त्वपूर्ण हुन्छ, ताकि विश्वसनीय विद्युत आपूर्ति कायम रहोस् र विद्युत प्रणालीका संयन्त्रहरूलाई थप क्षतिबाट जोगाउन सकियोस् । यसले रोकथामात्मक मर्मत (Preventive Maintenance) गर्न सक्ने अवस्था बनाउँछ, जसले अन्ततः विद्युत प्रणालीका घटकहरूको आयु (Equipment Lifespan) लम्ब्याउन मद्दत गर्दछ । यसै सन्दर्भमा यस लेखमा, उच्च भोल्टेज प्रसारण सवस्टेशन (High-voltage Substation) का प्रमुख घटकहरू खास गरी Line Bay र Transformer Bay मा प्रयोग गरिने उपकरणहरूको सही Placement र Orientation को बारेमा चर्चा गरिनुको साथै सुरक्षा प्रणाली (Protection System) हरू जडान गर्ने क्रममा अवलम्बन गर्नुपर्ने कार्यहरूको बारेमा पनि संक्षिप्त चर्चा गरिएको छ ।

२) विद्युत सवस्टेशन

विद्युत सवस्टेशन विद्युत प्रणालीको एक अभिन्न प्राविधिक संरचना हो, जहाँ भोल्टेज, करेन्ट, लगायत विद्युतका विभिन्न परिमाण (Electrical Parameters) हरूको रूपान्तरण, नियन्त्रण, प्रसारण, र वितरण प्रक्रिया उचित तरिकाले सम्पन्न गरिन्छ । यस लेखमा मुख्य रुपमा उच्च भोल्टेज प्रसारण सबस्टेसनको सम्बन्धमा केन्द्रित गरिएको छ, किनभने यसले विद्युत प्रणालीको संरचनामा सबैभन्दा ठूलो हिस्सा ओगटेको हुन्छ । तसर्थ, प्रसारण सवस्टेशनको स्वस्थता (Healthiness) अत्यन्त आवश्यक हुन्छ, जसले सम्पूर्ण ग्रिडको स्थायित्व (Stability) र विश्वसनीयता (Reliability) सुनिश्चित गर्दछ ।

सामान्यतया तथा प्रसारण सवस्टेशन त्यहाँ अवस्थित बसबार (Busbar) संरचनाको स्वरूप (Orientation) को आधारमा वर्गीकृत गरिन्छ, जुन निम्न प्रकारहरूमा विभाजित हुन्छन् ।

क) Single Bus System

ख) Single Bus with Bus Sectionalizer System

ग) Main and Transfer Bus System

घ) Double Breaker Bus System

ङ) Double Breaker Bus with Bus Sectionalizer System

च) One and Half Breaker Bus System

छ) Double Bus System with Bypass Isolators

ज) Ring Main Bus System

झ) Mesh Bus System यस लेखमा विशेष रूपमा लाइन तथा ट्रान्सफरमर बे (Line and Transformer Bay) मा प्रयोग गरिने सुरक्षा संयन्त्र (Protection Setup), साथै तिनीहरूमा प्रयोग गरिने उपकरणहरूको सही स्थान निर्धारण (Placement) र स्वरूप (Orientation) को बारेमा चर्चा गरिएको छ ।

२) प्रसारण सवस्टेशनको Line Bay

सामान्यत सवस्टेशनको Line Bay मा Incoming अथवा Outgoing लाइनबाट Bus तर्फ हेर्दा Fig. 1 मा देखाइए अनुसार सबभन्दा पहिला Lightning Arrester (LA), Capacitive Voltage Transformer (CVT), Line Isolator, Current Transformer (CT), Circuit Breaker (CB), Bus Isolator हुँदै सवस्टेशनको Bus सँग जोडिन्छ ।

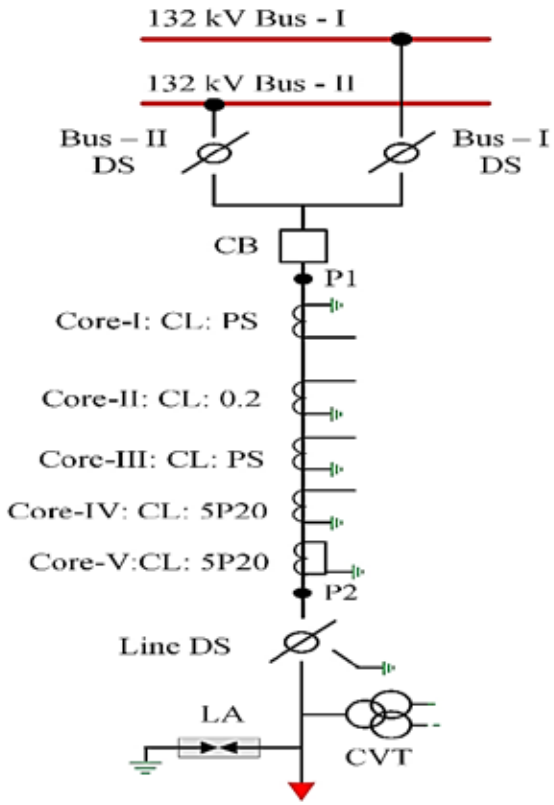

Fig. 1: SLD of 132 kV Line Bay.

प्रसारण लाइनमा कतै Lightning Strike भएको छ भने त्यसलाई Line Conductor मार्फत सवस्टेशन प्रवेशमा निषेध गर्न सर्वप्रथम Lightning वा Surge Arrester को प्रबन्ध गरिएको हुन्छ ।

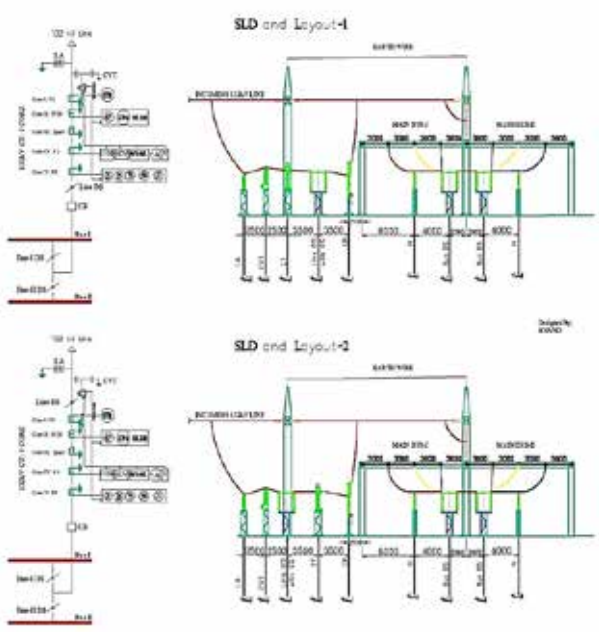

Fig. 2: SLD and Layout for the Placement of CT and CB in Line Bay.

CVT तथा CT को प्रयोग सवस्टेशनमा Measurement, Metering तथा Protection कार्यहरूको लागि गरिन्छ, जसको बारेमा विस्तृत चर्चा पछि गरिएको छ । Line Isolator मा Earth Switch को जडान अत्यन्तै महत्त्वपूर्ण हुन्छ, किनभने यसले लाइनमा रहेको Charging current दबाउन वा Earth तर्फ पठाउन मद्दत गर्दछ । सवस्टेशनको Line Bay मा जडान हुने Protection Setup को बारेमा चर्चा गर्नुपूर्व CT र CB को सही Placement को बारेमा थप प्रस्ट हुनुपर्छ, जुन Fig. 2 मार्फत बुझाउन खोजिएको छ । पहिलो SLD र Layout ले देखाउँछ कि CT र CB बीचमा Line Isolator राखिएको छ, जबकि दोस्रो SLD र Layout मा CB र CT एउटै स्थानमा अवस्थित छन् । मैले यी दुवै प्रकारका संरचनाहरू उच्च भोल्टेज प्रसारण सवस्टेशनहरूमा देखेको छु, तर कुन संरचना उपयुक्त हो?

यस सन्दर्भमा Line Protection Relay र Busbar Protection Relay हरूको Detection Zone, CT बाट शुरू हुने भएकोले, CT लाई CB को नजिकै, विशेष गरी लाइन साइडमा राख्नु राम्रो हुन्छ । त्यसैले यी दुई उपकरणहरू नजिकै हुनु फाइदाजनक हुन्छ ।

CVT को कुरा गर्दा, यसलाई लाइनको प्रवेश विन्दु (Line Entry Point) मा राखिनु उपयुक्त हुन्छ, किनभने यसले

लाइनको अर्को पट्टिबाट लाइन Energized भएको अवस्था जनाउने संकेत दिन सहयोग पुऱ्याउँछ ।

त्यसै गरी, CT को Primary side मा रहेको **P1 terminal** सवस्टेशनको Busbar तर्फ राख्नु र **P2 terminal**, Bus बाट टाढा (लाइन तर्फ) राख्नु राम्रो अभ्यास मानिन्छ । CT मा आवश्यकता बमोजिम Metering तथा Protection core हरूको व्यवस्था गर्न सकिन्छ, र यी CT का Core हरूको Accuracy Class अनुसार यसको उपयोग विभिन्न Protection Functions को लागि गरिन्छ (विस्तृत अध्ययनको लागि IEC-61869) ।

यस सन्दर्भमा अर्को महत्त्वपूर्ण कुरा के पनि हो भन्दा Power System सुरक्षित गर्ने प्रयासमा हामी प्राय: CT हरूको संरक्षणलाई नजरअन्दाज गर्छौं (जसरी बत्तीको मुनि अँध्यारो हुने गर्छ) । यहाँ लेखकका केही अनुभव व्यक्त गर्न खोजिएको छ ।

धेरै जसो Protection SLD मा CT core को छनोट Randomly गरेको देखिन्छ जहाँ तोकिएको Protection Function को लागि केवल Accuracy Class लाई मात्र ध्यान दिइन्छ तर Core को Correct Position लाई नजरअन्दाज गरिन्छ । उदाहरणको लागि, Fig. 3 मा १३२ के.भी. लाइनको सामान्य चित्र देखाइएको छ, जहाँ दुवै संरचनाले लाइनको लागि उस्तै स्तरको सुरक्षा प्रदान गर्छन्, तर तीमध्ये चित्र (B) CT को Core हरूको सुरक्षा पनि ध्यानमा राखेको छ ।

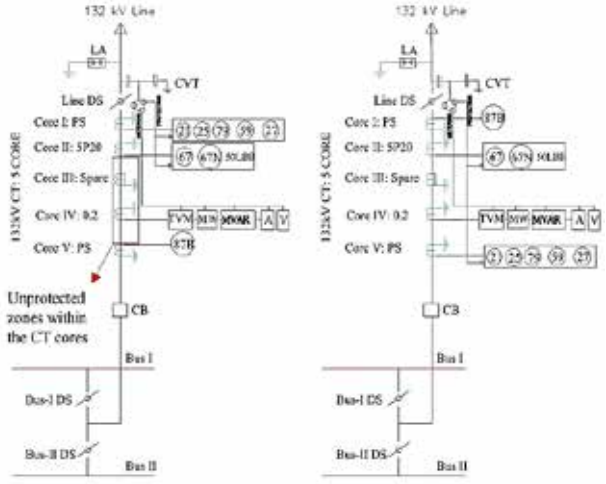

Fig. 3: Illustration of Unprotected Zone in CT.

तसर्थ यहाँ के भन्न खोजिएको हो भने, लाइनको विपरीत दिशामा रहेका Component हरूको सुरक्षा (जस्तै 87B - Busbar Differential Protection) को लागि लाइन तर्फको CT Core (Core I) प्रयोग गर्नुहोस् र लाइनको सुरक्षा (जस्तै 21-Distance Protection, 59- Overvoltage Protection, 27-Undervoltage Protection, 67-Direction Overcurrent Protection, 67N-Directional Earthfault Protection, इत्यादि) को लागि सवस्टेशन तर्फको CT Core (Core V) प्रयोग गर्नुहोस्, जसले गर्दा CT Core हरूको बीचमा कुनै पनि Unprotected Zone नहोस् ।

Fig. 3 को बायाँ भागमा देखाइए अनुसार CT core हरू सही तरिकाले चयन नगर्दा CT को Core हरू बीचमा Unprotected Zone रहन जान्छ, जसले गर्दा CT Failure पनि हुन सक्छ । तसर्थ, Protection System को Basic Philosophy सम्बोधन हुने गरी Overlapping Zone को सुनिश्चितता गरी दायाँ भागमा देखाइए अनुसार CT core हरूको सही चयन गर्न सके राम्रो अभ्यास मानिन्छ ।

अझ, यो पनि राम्रो अभ्यास हो कि CT को Star Point त्यो Zone तर्फ राख्नु जुन तर्फ Protection System प्रयोग गरिएको छ । उदाहरणको लागि, Distance Protection (21) लाइनको लागि हो, त्यसैले यसको लागि प्रयोग भएको CT Core को Star Point लाइन तर्फ राख्नुपर्छ, भने Busbar Differential Protection (87B) सवस्टेशनमा रहेको Bus को लागि हो, त्यसैले यसको लागि प्रयोग भएको CT Core को Star Point सवस्टेशनको Bus तर्फ राख्नुपर्छ ।

प्रसारण सवस्टेशनमा उच्च भोल्टेज (High Voltage) का लाइन तथा ट्रान्सफर्मरहरू बाहेक Local Supply को लागि मध्यम भोल्टेज (Medium Voltage) लेभलका विभिन्न लाइन तथा ट्रान्सफर्मर फिडरहरू रहेका हुन्छन्, जसमा सामान्यता प्रयोग हुने Protection तथा Metering Setup Fig. 4 मा देखाइएको छ ।

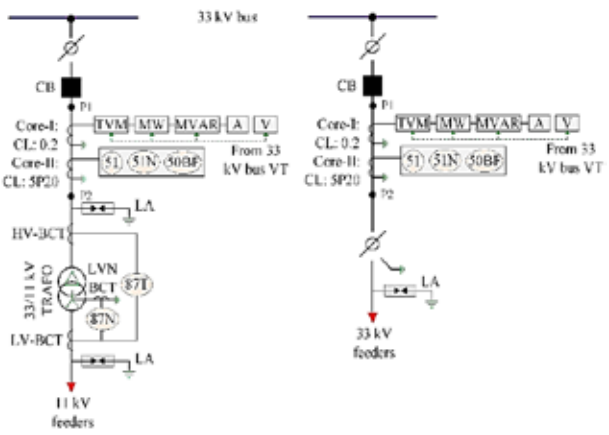

Fig. 4: SLD of 33 kV Line and Transformer Feeder.

२) प्रसारण सवस्टेशनको Transformer Bay

Power Transformer विद्युत प्रयोगकर्ता (End Users) को नजरबाट सबभन्दा महत्त्वपूर्ण तथा सवस्टेशनमा उपलब्ध हुने उपकरणहरू मध्ये सबैभन्दा महंगो उपकरण हो । यसले भोल्टेजलाई Step-up र Step-down गर्ने दुवै कार्य गर्छ भन्ने कुरा सर्वविदितै छ । तसर्थ यसको सुरक्षा पनि यो हिसाबले एकदम महत्त्वपूर्ण हुन जान्छ । Fig. 5 मा देखाइए अनुसार 132/33 kV, 30 MVA Power Transformer को Primary Protection को लागि 87T-Transformer Differential Protection को प्रयोग गरिन्छ भने Backup Protection को लागि सामान्यतया Over-current तथा Earth-fault Protection को प्रयोग गरिन्छ ।

यस बाहेक, Differential Protection का मुख्य आवश्यकताहरू निम्नानुसार रहेका छन ।

क) Triple pole with individual phase indication.

ख) Unrestrained instantaneous high-set over current units, not operating during inrush.

ग) Magnetizing inrush proof feature achieved through intentional time delay.

घ) Have an adjustable or multi-bias setting and adjustable operating current.

ङ) Operating time not greater than 30 milli seconds at 5 times of setting.

च) Facility for ratio and phase angle correction.

यसै गरी Y type winding मा लागु हुने, Restricted Earth Fault Protection का मुख्य आवश्यकताहरू निम्नानुसार रहेका छन् ।

क) Single pole type.

ख) Operating sensitivity of at least 10% of nominal current.

ग) Provision of suitable non-linear resistor to limit the peak voltage during in-zone faults in case of high impedance type.

घ) Shall be high or low impedance principle type.

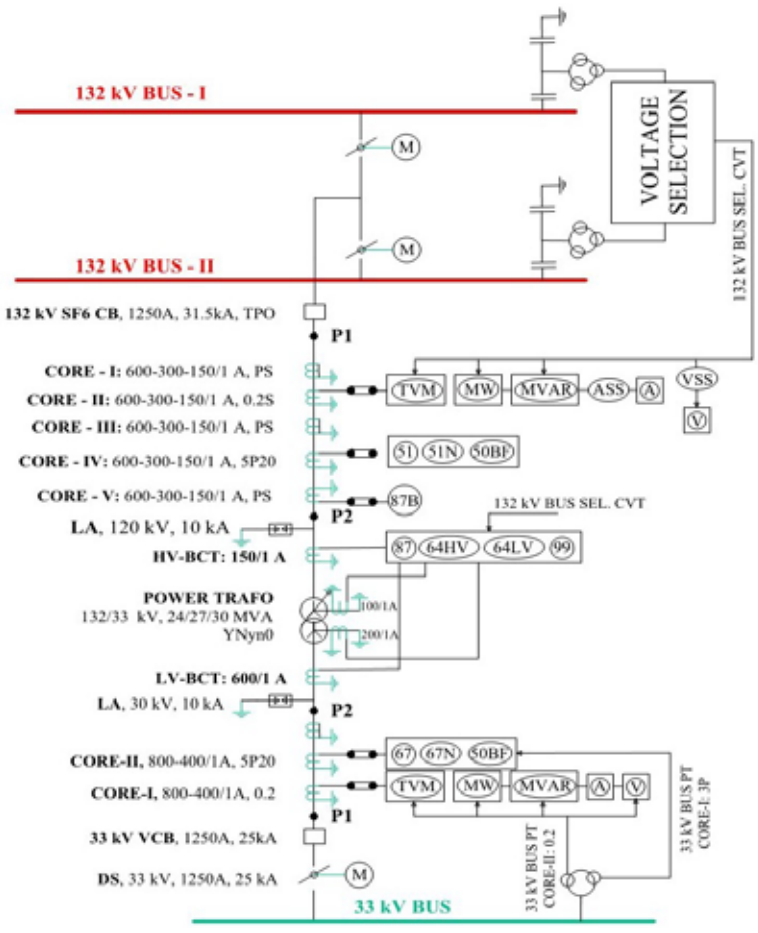

Fig. 5: SLD for Protection of Power Transformer.

कतिपय ठाउँमा Power Transformer को Primary Protection लाई Duplication पनि गरिएको पाइन्छ, सामान्यतया यो गर्न जरुरी छैन तर ४०० के.भी. भोल्टेज लेभलमा जडान हुने ट्रान्सफरमरको हकमा Protection and Monitoring लाई दुई वटा Group मा विभाजन गर्न सकिन्छ । २२० के.भी. भोल्टेज लेभलको हकमा भने यो सवस्टेशनको महत्व अनुसार गर्न सकिन्छ । Group Protection जडान भएका ट्रान्सफरमरमा भने अलग्गै DC source को व्यवस्था गर्नुपर्छ ।

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धादिङ्ग जिल्ला स्थित रूबी उपत्यकामा गरिएको विद्युतीकरण

5G र डिजिटल नेपालको यात्रा

यादव नेपाल
सहायक कम्प्युटर अधिकृत
कानून विभाग, ने.वि.प्रा.

सूचना प्रविधिको विकासले आज मानव जीवन धेरै सहज भएको छ । यस क्षेत्रमा आउने नयाँ नयाँ प्रविधिको प्रयोगले तथा मानिसहरूबीच सम्पर्कको सहजताले संसार एउटा गाउँको रूपमा रूपान्तरण हुँदै गएजस्तो हामीले अनुभूति गर्दै गएका छौं । यस सन्दर्भमा तिनै विकसित सूचना तथा सञ्चारको प्रविधि मध्ये 5G प्रविधिको सामान्य परिचय तथा नेपाल सरकारले ल्याएको डिजिटल नेपाल फ्रेमवर्क सम्बन्धमा यसले पार्ने प्रभावको बारेमा चर्चा गर्न लागिएको छ ।

हामी आजभोलि बजारमा मोवाइल खरिद गर्न गयौं भने 5G Compatible लिने हो/होइन भनेर सोध्ने गरिन्छ । 5G Compatible उपकरणहरू केही अन्यको तुलनामा महँगा पनि पर्ने गर्छन् । के हो त यो 5G प्रविधि ? नेपालको सन्दर्भमा कुरा गर्ने हो भने मोवाइल नेटवर्कमा 4G प्रविधि प्रचलनमा रहेको छ । केही वर्षअघि नेपाल 3G बाट 4G प्रविधिमा गएको हो । तर अहिले आउन लागेको 5G प्रविधि के मोवाइल नेटवर्कमा मात्रै सीमित छ त ? AI को क्षेत्रमा यसले के कस्तो प्रभाव पार्ला ? त्यस्तै नेपाल सरकारले सूचना प्रविधिको उच्चतम प्रयोग गरी देशको आर्थिक तथा सामाजिक समृद्धिमा सहयोग पुऱ्याउन ल्याएको कार्यक्रम डिजिटल नेपाल फ्रेमवर्क २०७६ को विकासमा यसले पुऱ्याउन सक्ने योगदान बारेमा यस लेखमा सामान्य चर्चा गरिने छ ।

5G प्रविधि भन्दा हामी सामान्य रूपमा 4G को विकसित रूप भनेर बुझ्ने गर्छौं । तर यो यतिमा मात्र सीमित छैन । यो एक क्रान्तिकारी प्रविधि हो जसले हाम्रो डिजिटल संसारसँगको अन्तरक्रियालाई पूर्ण रुपमा बदल्ने क्षमता राख्छ । अथवा यो केवल गतिको सामान्य वृद्धि मात्र होइन, यो एक इन्टरनेट प्रयोग गर्ने तरिकालाई मात्र नभै यसले हाम्रो पूरै समाज, उद्योग र जीवन शैलीलाई नै बदल्ने क्षमता राख्छ ।

यहाँ एउटा जिज्ञासा उठ्न सक्छ, के 5G प्रविधि मोवाइलहरूको लागि मात्र हो त ? यसको उत्तर बिल्कुल होइन । मोवाइल फोन यस प्रविधिको फाइदा लिने र सबैभन्दा देखिने उपकरण मात्र हो । जसरी एउटा राजमार्ग केवल एउटा कुनै सवारी साधनको लागि मात्र बनाएको होइन त्यहाँ त बस, ट्रक, जीप, कार सबै प्रकारका सवारी चल्छन्, त्यस्तै गरी 5G प्रविधि केवल स्मार्ट फोनलाई छिटो बनाउन मात्र आएको होइन, यो त एउटा आधारभूत पूर्वाधार हो जसमाथि भविष्यका अनगिन्ती प्रविधि र उद्योगहरू निर्माण हुनेछन् । मोवाइल फोन त त्यो इकोसिस्टमको एउटा सानो हिस्सा मात्र हो ।

5G प्रविधि के हो भन्ने सम्बन्धमा केही परिभाषाहरू यस्ता छन् ।

5G मोवाइल चिपसेट तथा सपोर्टिङ समान बनाउने क्वालकम कम्पनीले यस प्रविधिको बारेमा यस्तो परिभाषा दिएको छ ।

"5G is more than just the next generation of wireless; it is a unified platform that is more capable than 4G. It will elevate the mobile experience to new levels, but its true potential is in its ability to connect virtually everyone and everything together, including machines, objects, and devices, with extreme speed, low latency, and high reliability."

टेलिकम्युनिकेशन सम्बन्धी अन्तर्राष्ट्रिय युनियनले 5G प्रविधि हुनका लागि निम्नलिखित शर्तहरू तोकेको छ ।

ITU's definition is not a sentence but a **set of technical specifications**, including:

- **Peak Data Rate:** Up to **20 Gbps** downlink and 10 Gbps uplink.
- **User Experienced Data Rate:** 100 Mbps downlink and 50 Mbps uplink everywhere.
- **Latency:** As low as **1 millisecond (ms)** for critical communications.
- **Connection Density:** Ability to support **1 million devices** per square kilometer.
- **Mobility:** Maintaining seamless connections at speeds up to 500 km/h (e.g., on high-speed trains).
- **Energy Efficiency:** A significant reduction in network energy consumption.

Why it's famous: This is the ultimate benchmark. If a technology doesn't meet the IMT-2020 requirements, it cannot technically be called 5G.

माथिका परिभाषाहरू अध्ययन गर्दा के थाहा हुन्छ भने उल्लिखित शर्तहरू पूरा भए मात्र यो प्रविधिलाई 5G भनिन्छ । यसले प्रविधिको प्रयोगको नया उचाइबाट अनुभव गराउँछ । यसले मानिस मानिस बीचको सम्बन्धलाई मात्र नभई, मानिस र मेशिन तथा मेशिन र मेशिन बीचको सम्बन्धलाई अभूतपूर्व गति, विश्वसनीयता र क्षमताका साथ प्रस्तुत गर्दछ ।

5G प्रविधिका तीन महत्त्वपूर्ण र मुख्य विशेषता निम्नानुसार छन् ।

क. अत्यन्त तीव्र गति (eMBB-Enhanced Mobile Broadband)

यसको गतिको कुरा गर्ने हो भने ठाउँ परिस्थिति हेरी यो 4G भन्दा करिब १० देखि १०० गुणासम्म छिटो हुन सक्छ । जस्तै केही सेकेण्डमै (HD- High Definition) पूरा चलचित्र डाउनलोड गर्न सक्नु, बिना कुनै बफरिङ (Buffering) 4k/8k भिडियोको आनन्द लिन सक्नु, क्लाउड गेमिङ तथा VR र AR जस्ता उच्च ब्याण्डविथ चाहिने एप्लिकेशनहरू सहज रुपमा चलाउन सकिने आदि ।

ख. न्यूनतम ढिलाई (URLLC - Ultra Reliable Low-Latency Communication)

ल्याटेन्सी भनेको तपाईंले कुनै डिभाइसलाई आदेश दिएपछि त्यसले प्रतिक्रिया दिन लगाउने समय हो । जस्तै तपाईंले 4G नेटवर्कमा कुरा गर्दा तपाईंले गरेको कुरा अर्को व्यक्तिसम्म पुग्न ४०–५० मिलिसेकेण्ड लाग्छ भने 5G मा यो समय करिब १ मिलिसेकेण्ड वा त्योभन्दा कम हुन सक्छ । यो भनेको रियल टाइम वा तत्काल प्रतिक्रिया जस्तै हो । यस्ता विशेषताको कारण स्वचालित कार, जसले कहीं तुरुन्त ब्रेक लगाउनु पर्ने अवस्थामा अथवा एउटा डक्टरले रिमोट सर्जरी गरेको बेला आदि अवस्थामा धेरै महत्त्वपूर्ण हुन्छ ।

ग. एकै पटक धेरै उपकरणहरू जोड्ने क्षमता (mMTC-Massive Machine Type Communication)

5G ले एकै पटक हजारौं, लाखौं मेशिनहरूलाई जोड्ने क्षमता राख्छ । अथवा यस नेटवर्कले प्रति वर्गकिलोमिटरमा १० लाखभन्दा बढी उपकरणहरूलाई एकैसाथ जोडेर सूचना आदान-प्रदान गर्ने क्षमता राख्न सक्छ । 5G को यो विशेषताले इन्टरनेट अफ थिङ्स (IoT) को अवधारणलाई वास्तविकतामा बदल्नलाई वरदान साबित हुनेछ ।

यहाँनेर इन्टरनेट अफ थिङ्स (IoT) भनेको केहो भन्ने प्रश्न उब्जिन सक्छ । (IoT) भनेको हाम्रा दैनिक जीवनका हरेक वस्तुहरू जस्तैः- घरका बत्ती, फ्रिज, टि.भी., गाडी उद्योगका मेशिनहरू, खेतका सेन्सरहरू फ्याक्ट्रीका रोबोटहरू, बिना तार नै एक आपसमा जोडिएर काम गर्न सक्छन्, यी उपकरणले निरन्तर डाटा संकलन, आदान प्रदान गरी प्रणालीलाई स्वचालित, बौद्धिक र प्रभावकारी बनाउन सक्छन् । स्मार्ट शहर, स्मार्ट घर, स्मार्ट कृषि जस्ता अवधारणहरू यही विशेषतामा आधारित छन् ।

5G ले कम्प्युटर नेटवर्क र प्रविधिलाई पार्न सक्ने प्रभाव

१. क्लाउड कम्प्युटिङ : क्लाउडमा आधारित Application हरूलाई अझ प्रभावकारी बनाउँछ। डिभाइस र क्लाउड सर्भरबीच डेटा आदान प्रदान तुरुन्तै र प्रभावकारी रुपमा हुन्छ ।

२. एज कम्प्युटिङ् : एज कम्प्युटिङ् भनेको केन्द्रीय क्लाउडमा डेटा पठाउनुको सट्टा डेटा उत्पन्न हुने श्रोतको नजिकै डाटा प्रोसेस गर्ने विधि हो । 5G को प्रयोगले डिभाइस र नजिकको सर्भरवीच तत्काल भरपर्दो सञ्चार सम्भव गराउँछ। यसले गर्दा स्वचालित कारहरू, स्मार्ट फ्याक्ट्रीहरू प्रभावकारी रूपमा चल्छन् ।

३. कृत्रिम बुद्धिमत्ता AI र मशिन लर्निङ् ML : यसले AI र ML का लागि आवश्यक पर्ने ठूलो मात्रामा डेटालाई छिटो र प्रभावकारी रूपमा स्थानान्तरण गर्न मद्दत गर्छ । अन्य सम्बन्धित र प्राविधिक शब्दहरू आवश्यकतानुसार चर्चा गरिदैं जानेछन् ।

5G को उत्पत्ति र विकास

सन् १९८० को दशकमा पहिलो पुस्ता 1G बाट शुरु भएको मोवाइल प्रविधिको विकासको क्रममा तत्कालीन अवस्थामा आवाजलाई मात्र यसले समर्थन गर्दथ्यो । १९९० को दशकमा आएको दोस्रो पुस्ता 2G मा SMS, MMS जस्ता सुविधाहरू थपिँदै आए । तेस्रो पुस्ता सन् २००० को दशकको शुरुवातमा आएको 3G प्रविधिले मोबाइलमा इन्टरनेटको ढोका खोल्यो । चौथो पुस्ता 4G, सन् २०१० को दशकमा यो प्रविधि प्रचलनमा आयो जसमा डेटा केन्द्रित एप्सहरू प्रचलनमा आए । 3G को तुलनामा यसको डेटा ट्रान्समिसन राम्रो रहेको पाइन्छ जुन हालसम्म हाम्रो देशमा प्रचलनमा छ । 5G प्रविधि कतिपय देश जस्तै दक्षिण कोरियामा सन् २०१९ देखि र अमेरिका अष्ट्रेलिया र केही युरोपियन देशमा त्यसपछि प्रचलनमा छन् । छिमेकी मुलुक भारत र भुटानमा समेत यो प्रचलनमा आइसकेको छ भने नेपालमा परीक्षणको क्रममा छ ।

नेपाल विद्युत प्राधिकरणमा 5G प्रविधिको प्रयोग

देशको ऊर्जा क्षेत्रको मेरुदण्डको रूपमा रहेको ने.वि.प्रा. को कार्यकुशलता र विश्वसनीयताले समग्र औद्योगिक र आर्थिक विकासमा प्रत्यक्ष प्रभाव पर्छ । यस्तो महत्वपूर्ण निकायलाई आधुनिकीकरण गर्न 5G प्रविधि शक्तिशाली औजार हुन सक्छ । ने.वि.प्रा. मा यस प्रविधिबाट हुनसक्ने सहयोगहरूमा -

१. स्मार्टग्रिडको स्थापना र सञ्चालन

स्मार्टग्रिड एउटा स्वचालित एवं बौद्धिक (Intellectual) ऊर्जा सञ्जाल हो जसले विद्युत उत्पादन देखि उपभोक्ताको घर सम्मको सम्पूर्ण प्रणालीलाई वास्तविक समयमा निगरानी र नियन्त्रण गर्दछ । 5G को न्यून ढिलासुस्ती (Low Latency) ले ग्रिडमा जडित हजारौं सेन्सर र उपकरणबाट प्राप्त डेटालाई AI को मद्दतले तुरुन्तै विश्लेषण गर्ने, फल्ट स्वचालित रूपमा पत्ता लगाउने र बिजुलीलाई वैकल्पिक मार्गबाट पठाएर विद्युत अवरुद्ध हुनबाट जोगाउने काम गर्छ ।

२. स्वचालित मिटर रिडिङ्

5G ले स्मार्ट मिटरिङ प्रणालीलाई व्यापक र प्रभावकारी बनाउन मद्दत गर्दछ । यस प्रविधिबाट लाखौं घर तथा उद्योगमा जडित स्मार्ट मिटरहरूलाई एकैसाथ नेटवर्कमा जोडिन्छ तथा ग्राहकले आफ्नो मोबाइलबाटै वास्तविक समयमा विद्युत खपत हेर्न र बिल भुक्तानी गर्न सक्ने मात्र होइन, कुनै मिटरमा छेडखानी भएमा वा विद्युत चोरीको प्रयास भएमा प्रणालीले तुरुन्तै पत्ता लगाउँछ । मिटर रिडिङ गर्न रिडर घर घरमा जानु नपर्ने अवस्था हाल महाराजगंज तथा रत्नपार्क वितरण केन्द्रमा पनि प्रयोगमा आइसकेको छ ।

३. प्रभावकारी मर्मतसंभार र सुरक्षा

नेपाल जस्तो विकट भौगोलिक अवस्था भएको, उच्च पहाडी क्षेत्रमा लाइन मर्मत गर्न वा सवस्टेशन निर्माण गर्नुपर्दा 5G सक्षम ड्रोनहरू प्रयोग गरेर नियमित निगरानी र सुरक्षित मर्मतसंभार गर्न सकिन्छ । ड्रोनहरूबाट लिइएको उच्च गुणस्तरको भिडियो र डेटा विश्लेषण गरेर संभावित समस्याहरू पहिचान गर्न तथा प्राविधिकहरूले AR को सहायताले टाढाबाटै विशेषज्ञहरूसँग सल्लाह लिई मर्मतका कामहरू गर्न सक्छन् ।

४. विद्युत चुहावट नियन्त्रण

वास्तविक समयमा डेटा विश्लेषण गरेर कुन क्षेत्र वा कुन मिटरमा अस्वभाविक रूपमा विद्युत खपत भैरहेको छ वा चोरी भैरहेको छ भन्ने भइरहेको कुरा सजिलै पत्ता लगाउन सकिन्छ। यसबाट विद्युत चुहावट नियन्त्रण गर्न मद्दत हुन्छ ।

५. उपभोक्ता सेवामा सुधार

हाल भै रहेको डिजिटल सेवा, अनलाइन पेमेन्ट सेवामा सुधार, तत्काल उपभोक्ता गुनासो समाधान, चार्जिङ् स्टेशनको उचित व्यवस्थापन, सुदृढ सञ्चार, प्रभावकारी HRIS प्रणाली आदि विभिन्न क्षेत्रमा 5G प्रविधिको प्रयोगले प्राधिकरणको कार्यक्षमताको वृद्धि गर्न, सेवा प्रवाहलाई अझ प्रभावकारी बनाउन र समग्र ऊर्जा व्यवस्थापनलाई सुदृढ गर्न महत्त्वपूर्ण भूमिका खेल्न सक्छ। व्यवस्थापनले पनि यस्ता विषयमा उचित र प्रशिक्षित जनशक्तिको समय सापेक्ष व्यवस्थापन गर्नु पर्छ।

डिजिटल नेपाल फ्रेमवर्क र 5G सम्बन्ध

नेपाल सरकारले वि.स. २०७६ मा सार्वजनिक गरेको डिजिटल नेपाल फ्रेमवर्क एक महत्त्वकाङ्क्षी राष्ट्रिय योजना हो। कार्यान्वयन पक्ष एकदम फितलो रहे पनि यसको मूल उद्देश्य डिजिटल प्रविधिको अधिकतम उपयोग गरी विकास र समृद्धिका लक्ष्यहरू हासिल गर्ने, सार्वजनिक सेवा प्रवाहमा सुधार ल्याई सरल र सहज बनाउने, आर्थिक वृद्धिदर हासिल गरी नागरिकको जीवनस्तरमा गुणात्मक परिवर्तन ल्याउने हो। यसले ऊर्जा, स्वास्थ्य, शिक्षा, कृषि, पर्यटन, वित्त, शहरी पूर्वाधार आदि ८ वटा प्रमुख क्षेत्रहरूमा डिजिटल प्रविधि प्रयोग गरेर समुन्नत अर्थतन्त्र निर्माण गरी समृद्ध नेपाल र सुखी नेपाली बनाउने सोच लिएको छ।

यसले डिजिटल पूर्वाधारको निर्माण तथा प्रभावकारी सार्वजनिक सेवा प्रवाहको लागि उच्च गतिको इन्टरनेट कनेक्टिभिटी त भनेको छ तर त्यस्तो पूर्वाधार निर्माण गर्न एउटा बलियो, र भरपर्दो सूचनाको द्रुत राजमार्ग जहाँ सूचना रुपी गाडीहरू बिना अवरोध, बिना जाम अत्यन्तै द्रुत गतिमा दौडन सक्छन्। 4G प्रविधिले डिजिटल सेवाहरूको ढोका त खोल्यो तर परिकल्पना गरिएका अधिकांश स्मार्ट सेवाहरू जस्तैः– उच्च स्तरको टेलिमेडिसन, स्मार्ट सिटी, स्मार्ट फ्याक्ट्री, स्मार्ट कृषि, स्मार्ट यातायातको व्यवस्थापन आदिको प्रभावकारी उपयोग गर्नका लागि हाल नेपालमा प्रयोगमा रहेको 4G को गति अत्यन्तै कम हुन्छ। यस्ता सेवाहरूलाई वास्तविकतामा बदल्न 5G को उच्च गति, न्यून विलम्बता र बृहत कनेक्टिभिटी आवश्यक हुन्छ। डिजिटल नेपालको जग भनेकै देशव्यापी, भरपर्दो र तीव्र गतिको इन्टरनेट हो। 5G यही जगलाई सुदृढ बनाउने प्रविधि हो। डिजिटल नेपाल फ्रेमवर्क २०७६ मा पनि 5G नेतवर्क विस्तार गर्ने भनेर चर्चा गरिएको भए पनि व्यवहारिक रुपमा चाँडो कार्यान्वयनमा ल्याउनु जरुरी छ।

5G को प्रयोगले नेपालमा क्षेत्रगत रुपमा हुनसक्ने संभावनाहरू

१. **स्वास्थ्य क्षेत्र** : नेपालको भौगोलिक विकटताका कारण ग्रामीण क्षेत्रमा विशेषज्ञ र स्वास्थ्य सेवाको पहुँच अत्यन्त कमजोर छ। 5G प्रविधिको प्रयोगले उच्च गुणस्तरको टेलिमेडिसन सेवा सम्भव बनाउँछ यसमा दुर्गम क्षेत्रमा भएका स्वास्थ्यकर्मीहरूले शहरका विशेषज्ञ डाक्टरहरूसँग सजिलै वास्तविक समयमा भिडियो परामर्श गर्न सक्छन्। भविष्यमा AI को समेत प्रयोगले रिमोट मनिटरिङ र रोबोटिक सर्जरी जस्ता उन्नत प्रविधिहरू समेत सम्भव हुन सक्छन्।

२. **शिक्षा क्षेत्र** : कोभिड १९ को बेलामा शुरु भएको अनलाइन शिक्षा प्रणालीलाई अझ प्रभावकारी बनाउन सक्छ। विद्यार्थीले बिना कुनै अवरोध लाइभ कक्षामा भाग लिन सक्छन्। विद्यार्थीहरूले कक्षा कोठामै बसेर AR/VR को माध्यमबाट जटिल वैज्ञानिक अवधारणहरूलाई जीवन्त रुपमा बुझ्न सक्छन् अथवा बुझाउन सकिन्छ। भर्चुअल ल्याबमा प्रयोगहरू हेर्न, विशेष ठाउँहरूको भर्चुअल भ्रमण गर्न सकिन्छ। 5G को पहुँचले दुर्गम क्षेत्रका विद्यार्थीहरूलाई पनि शहरका उत्कृष्ट शिक्षकहरूसँग अनलाइन कक्षा लिन र विश्वस्तरीय शैक्षिक सामग्रीमा पहुँच राख्न सक्षम बनाउँछ।

यहाँ AR भन्नाले अग्मेन्टेड रियलिटी (Augmented Reality) र VR भन्नाले भर्चुअल रियलिटी (Virtual Reality) बुझाउँछ। AR को मद्दतबाट कुनै कुरालाई मोडल बनाएर हेर्न सकिन्छ, रसायन शास्त्रका विद्यार्थीले AR को प्रयोगबाट विभिन्न रसायनहरू मिसाउँदा के हुन्छ भनेर वास्तविक जोखिमबिना प्रयोग गर्न सक्छन्। त्यस्तै सिकाइलाई खेल जस्तो बनाएर विद्यार्थीको रुचि बढाउन सकिन्छ। AR ले वास्तविक संसारमा डिजिटल जानकारी थपेर हाम्रो अनुभवलाई अन्तरक्रियात्मक बनाउँछ। यसको प्रयोगले अनलाइन किनमेल गर्दा,

फर्निचर वा लुगा घरमै कस्तो देखिन्छ भनेर जाँच्न सकिन्छ साथै शिक्षा, स्वास्थ्य क्षेत्रमा जानकारीलाई जीवन्त बनाएर सिक्न र काम गर्न सजिलो बनाउँछ ।

VR : यो यस्तो प्रविधि हो जसले तपाईलाई पूर्ण रुपमा एक डिजिटल संसारमा डुबाउँछ । यसको लागि एक विशेष हेडसेट लगाउनु पर्छ जसले तपाईंको पूरै आँखालाई छोप्छ । हेडसेट भित्रको स्क्रीनले तपाईंलाई ३६० डिग्रीको भर्चुअल संसार देखाउँछ । यसको मद्दतले घरमै अथवा एकठाउँमा बसेर संसारका पर्यटकीय स्थलहरूको अवलोकन गर्न, पाइलटहरूको प्लेन उडाउने ट्रेनिङ, डाक्टरहरूको अपरेशन आदिको ट्रेनिङ, अथवा दुर्गममा बसेर पनि त्यस्ता तालिम लिन सकिन्छ । यसमा VR लाई उच्च गुणस्तरको ग्राफिक्स र भिडियो चाहिन्छ र यसमा उच्च गतिको नेट 5G भएमात्र यो प्रभावकारी हुन सक्छ ।

४. **कृषि :** खेतबारीमा जडान गरिएका सेन्सरहरूले माटोको चिस्यान, तापक्रम र पोषक तत्त्वको वास्तविक समयमा जानकारी दिन्छन् । ड्रोनमार्फत बालीको स्वास्थ्य निगरानी गर्न, सटीक रुपमा मल र कीटनाशक औषधि छर्किन सकिन्छ, जसले उत्पादन बढाउँछ र लागत घटाउँछ । किसानहरूले बजारको यथार्थ जानकारी तत्काल पाउन सक्छन् र उचित निर्णय गर्न सक्छन् । यसले परम्परागत कृषि प्रणलीलाई आधुनिकीकरण गर्न ठूलो मद्दत गर्छ ।

५. **वित्तीय क्षेत्र :** यसले डिजिटल भुक्तानीलाई अत्यन्त छिटो बनाउने, मोवाइल बैंकिङ् क्यूआर कोड भुक्तानी, अनलाइन कारोबारहरू तुरुन्तै सम्पन्न हुने, दुर्गम क्षेत्रका ग्राहकहरूको लागि वित्तीय सेवा सुलभ हुने हुन्छ अथवा वित्तिय सेवालाई आधुनिकीकरण गर्ने, सञ्चालन लागत घटाउन र देशका हरेक कुनामा वित्तीय सेवा पुऱ्याउन महत्वपूर्ण भूमिका हुनेछ ।

३. **पर्यटन :** उच्च गतिको इन्टरनेटले पर्यटकलाई सजिलो सुरक्षित र प्रविधियुक्त अनुभव दिन सक्छ । 5G को माध्यमबाट Virtual Reality VR Augmented Reality AR प्रविधि प्रयोग गरेर पर्यटकले ऐतिहासिक स्थलहरू, हिमाल आदिको अवलोकन गर्न सक्छन् । डिजिटल भुक्तानी, स्मार्ट सूचना बोर्ड लाइभ स्ट्रिमि ङ सेवाहरू सहज हुन्छन् । यसरी 5G ले नेपालको पर्यटन क्षे त्रलाई स्मार्ट, सुरक्षित र अन्तर्राष्ट्रिय स्तरमा प्रतिस्पर्धी बनाउन मद्दत गर्छ।

यस्तै सार्वजनिक सेवा छिटो छरितो बनाउने, नागरिकता, राहदानी र अन्य सरकारी काम अनलाइनबाटै छिटो र झन्झटमुक्त बनाउन, स्मार्ट शहर अवधारण अन्तर्गत स्वचालित ट्राफिक व्यवस्थापन, सुरक्षा निगरानी र प्रकोप व्यवस्थापन जस्ता कुराहरूलाई सहज तरिकाले छिटो गर्न योगदान पुऱ्याउन सक्छ ।

यसरी डिजिटल नेपाल फ्रेमवर्कको सफलताको लागि सूचना तथा सञ्चारको क्षेत्रमा आउन लागेका प्रविधि 5G र अझ AI समेतको संयोजनबाट एउटा शक्तिशाली आधार बन्न सक्छ। 5G ले तीव्र गतिको इन्टरनेट प्रणाली जसलाई हाम्रो शरीरसँग तुलना गर्दा स्नायु प्रणाली र AI ले त्यसबाट प्राप्त डेटालाई विश्लेषण गर्ने मस्तिष्कको रूपमा काम गर्दछ।

चुनौतीहरू

यी प्रविधिहरू राम्रोसँग स्थापना गर्न सकिए त सोच अनुसारको उपलब्धि पनि होला तर कार्यान्वयनमा ठूला चुनौतीहरू छन्:-

१. ठूलो लगानीको आवश्यकता पर्छ जस्तै अप्टिकल फाइवर, टावर तथा उपकरणहरू धेरै महँगा हुन्छन्।

२. नेपालको विकट धरातलीय स्वरूप भएको हुँदा सघन नेटवर्क र टावरहरू स्थापना गर्नु जटिल र खर्चिलो।

३. दक्ष जनशक्तिको अभाव 5G जस्तो जटिल प्रविधि जडान र मर्मतसंभार गर्न आवश्यक इन्जिनियर र प्राविधिकहरूको अभाव

४. यस प्रविधिबारे सरकारको स्पष्ट नीतिको अभाव

५. 5G सक्षम उपकरणको अभाव र पाइहाले पनि महँगो।

६. साइबर सुरक्षा र गोपनीयताको चिन्ता : 5G प्रविधिमा धेरै उपकरणहरू जोडिने हुँदा डेटा चोरी र साइवर आक्रमणको चिन्ता भइरहने।

७. डिजिटल साक्षरता र जनचेतनाको कमी।

समाधानका सम्भावित उपायहरू

१. सरकारले लगानी मैत्री वातावरणको सिर्जना गर्नुपर्छ। सार्वजनिक निजी साझेदारीको रणनीति अपनाउन सकिन्छ।

२. पूर्वाधारको साझा प्रयोग गर्ने वातावरण बनाइयो भने लागत घटाई विस्तार छिटो हुन्छ।

३. सरकारबाट फ्रिक्वेन्सीको बाँडफाँड, मूल्य निर्धारण र इजाजत प्रक्रियाबारे स्पष्ट सरकारी नीति आउनु पर्छ।

४. विश्वविद्यालयका पाठ्यक्रमहरूमा नयाँ प्रविधिहरूबारे सैद्धान्तिक बढी र व्यावहारिक कम होइन कि, सम्भव भएसम्म व्यावहारिक रूपमा पनि उपयुक्त प्रशिक्षणको व्यवस्था गर्ने।

५. एकै पटक सबै ठाउँमा नयाँ प्रविधिको प्रयोग सम्भव नभए चरणबद्ध रूपमा जस्तैः- पहिले केही प्रमुख शहरहरूमा लागू गर्ने र परिणाम हेरी विस्तार अन्यत्र लागू गर्दै जाने।

६. 5G चल्ने उपकरणहरूको आयातमा सहजता कायम गर्ने।

७. बलियो साइबर सुरक्षा नीति बनाउने।

८. डेटा संरक्षण ऐनको प्रभावकारी कार्यान्वयन गर्ने

९. अन्य निकायसँग आवश्यक समन्वय गर्ने।

१०. व्यापक जनचेतना र डिजिटल साक्षरताका कार्यक्रममा जोड दिने।

उपसंहार

देशमा विकास तथा आर्थिक समृद्धि आफैं आउने कुरा होइन। यसको लागि सुझबुझ साथ गरिएको लगानी, त्यो देशमा दक्ष जनशक्ति र प्रविधिको विकास अत्यन्त महत्त्वपूर्ण कुरा हुन्। नेपालले पनि सूचना तथा प्रविधिको क्षेत्रमा आएको क्रान्तिकारी परिवर्तनलाई आत्मसात गरेर, प्रविधिको यथा सम्भव प्रयोग गरी आफूलाई विकासको बाटोमा अग्रसर गराउन सक्छ। विश्वका प्रमुख विकसित देशहरूले प्रयोगमा ल्याइसकेको र नेपालमा पनि प्रयोगमा आउन लागेको सूचना तथा सञ्चारको क्षेत्रमा विकास भएको प्रविधि हो 5G।

5G सञ्चार प्रविधिको एउटा नयाँ पुस्ता मात्र होइन, नेपालका लागि विकासको परम्परागत मोडललाई पछि पार्दै डिजिटल राजमार्गमा फड्को मार्ने एक ऐतिहासिक अवसर हो। यसबाट ऊर्जा क्षेत्रमा ग्रिडको कुशल व्यवस्थापन, प्रभावकारी स्मार्ट मिटरिङ, प्रभावकारी मर्मतसंभार, चुहावट नियन्त्रणमा ठूलो सहयोग पुग्छ। यसले सरकारको डिजिटल नेपाल फ्रेमवर्कको सपनालाई यथार्थमा परिणत गर्ने क्षमता त राख्छ नै, अझ त्यो भन्दा प्रविधिमा अगाडि बढेर स्मार्ट स्वास्थ्य, शिक्षा, कृषि, उद्योग, पर्यटनदेखि सुशासन सम्मका हरेक क्षेत्रमा यसले सकारात्मक र क्रान्तिकारी परिवर्तन ल्याउने अपार सम्भावना बोकेको छ। यसलाई AI सँग जोडेर हेर्ने हो भने 5G ले AI को लागि आवश्यक डेटाको विशाल र तीव्र प्रवाह सुनिश्चित गर्दछ भने AI ले 5G नेटवर्कलाई बुद्धिमान स्वचालित र कुशल बनाउँछ।

यस्ता प्रविधि नेपाल जस्तो विकासोन्मुख देशमा प्रयोगमा ल्याउनु अत्यन्त चुनौतीपूर्ण त छ नै, यस्ता चुनौतीहरूको सामना गर्नलाई एक दूरदर्शी नीति, बलियो सार्वजनिक निजी साझेदारी, रणनीतिक र चरणबद्ध कार्यान्वयन तथा नागरिकको सहभागिता अनिवार्य छ। यदी दृढ इच्छाशक्तिका साथ समन्वयात्मक रूपले सही योजना सहित अघि बढ्ने हो भने एक्काइसौं शताब्दीको डिजिटल दौडमा नेपाललाई एक सक्षम राष्ट्रको रुपमा उभ्याउन सकिन्छ र समृद्ध नेपाल बन्ने सपना साकार हुन सक्छ।

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उदिपुर २२० के.भी. सबस्टेशन

Electricity Futures and Derivatives: Tools for Hedging Energy Prices

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Introduction

Naturally endowed with a potential of over 83,000 MW, out of which 42,000 MW is considered to be economically feasible, Hydropower does have massive potential in the Nepalese context. The whole installed capacity of around 3600MW holds the major generational approach, dominated by hydropower. The major shift from their power-deficient country would look into the major approach where it is a net electricity exporter during the wet seasons. This exports the approach aspect for electricity for India and aims to expand its regional market to Bangladesh and beyond. There, rapid electrification is also on the way, and over 95% of households have electricity access. Their demand is expected to grow due to an increase in urbanization and the adoption of electrical appliances.

Hydropower Increased the Nepalese context is often regarded as 'White Gold', which is a key driver for revenue generation, energy security, and industrial growth. On being able to develop it sustainably, it does hold huge prospects and potential for Nepal's Economy.

Derivatives in the Nepalese context are simply financial contracts whose value is determined through underlying assets like stocks, bonds, currencies, commodities, interest rates, or market indexes. Generally, they are used for hedging risk for speculative purposes, seeking profit from the whole set of price movements (Branger., et al, 2010). They are generally considered to be futures, options, forwards, and swaps. The whole context of derivatives in the Nepalese context looks into the aspect because Nepal's entire financial market is still developing, and the market is not yet formally structured like that of advanced economies. Although NEPSE has been dealing with cash and spot-based transactions, there are informal derivatives practices that take place in commodity trading or for hedging through banks anywhere. They are a powerful financial tool for covering up risk and for managing risk. Also, they are powerful enough for market-based growth. They do represent a strong opportunity for modernizing the set of financial systems with careful planning, education, and regulation practices as well.

An important reason why diversification is important in the Nepalese context is that Nepali businesses can protect themselves from any form of fluctuations in foreign exchange rates, interest rates, or commodity prices. It equally helps in determining future price trends of commodities like oil, gold, or agricultural products, too. Introducing derivatives hereby can work for creating a deep financial market approach, through which foreign investors get attracted, and there can be an improvement in liquidity as well.

Electricity Derivatives

Electricity cannot be stored easily like other commodities. It must be produced and then should be consumed almost instantly. This creates price volatility because of demand and supply. Here, derivatives therefore help market participants to manage risk in their way. To overcome this, electricity derivatives can be a new concept. They are just the financial contracts whose values are based on the price of electricity because they allow suppliers, producers, and large consumers to hedge the risk of fluctuating prices (Barone-Adesi and Gigli, 2002). Since derivatives are contracts whose values derive from underlying assets, in this case of Electricity Derivatives, Electricity turns out to be the underlying asset. So, simply understanding, electricity derivatives are financial contracts whose prices are based on the price of electricity in the market.

Example: A factory would require electricity every day. If the price suddenly jumps for them, during winter, and electricity has to be consumed through fuels, their cost would increase, and profits might fall. In such a case, electricity derivatives would help to lock the price today to be sold in the future.

Understanding the work practices

Electricity derivative is not about delivering electricity physically, but about settling price differences. Primarily, the power producer signs a future contract for selling 10 megawatt hours of electricity at Rs 5000 MWh for next month. So if the actual market price moves to Rs 6000, they would miss out on extra profit, but upon protection, the price drops to Rs 4000. The financial contract hereby pays the differences, ensuring a stable amount of revenue, which would stabilize the prices.

Types

Electricity Forward Contracts

A forward contract can be referred to as a custom agreement between two parties for buying or selling some specific amount of electricity on a future date. This form of contract is private and can be flexible enough, as it is not traded on the exchange market. They can also be tailored or customized as per the requirements of both sides regarding volume, delivery time, and price (Kholodny, 2000). Apart, they are used mostly by power producers, large industrial consumers, or utilities for hedging price risks. It benefits both buyer and seller in its way.

Example: A metal factory can realize that they would require 1000 MWh next month. So, they can simply sign a contract with the hydro plant to buy electricity at NPR 20 per unit beforehand. So, whether there is a shortage of electricity (increased price) or an overflow of electricity (decreased price), they both would stick to this price as it brings certainty among them.

Electricity Futures Contracts

A futures contract can simply be regarded as that form of forward which is a standardized agreement and is traded on an organized exchange for the buying or selling of electricity, setting a price for a specific future period. They are traded on different power exchanges like Nord Pool in Europe, NYMEX in the United States, or even Indian Energy Exchange futures in India. They are standard contracts by nature and have fixed dates. They are settled in a financial manner with participants who would rarely exchange any differences regarding actual electricity there.

Example: If a trader buys an electricity future contract for next month at $50 per MWh, the real spot price would rise to $55, where the trader's profit would be the whole set of differences.

Electricity Options

Option provides the right, but not any sort of obligation, for buying or selling electricity at some agreed price before the specified

date. They are used more for a flexible set of hedging. Here, they make payment for the premium, seeking upfront for their right. It is preferred if someone wants to benefit while the price moves in a favorable manner. They are suitable for risk managers and traders. They are flexible by nature, as per the requirement.

Example: If a factory buys a call option to make a purchase of electricity at Rs 9 per unit, and if the price increases to Rs 12, they can make use of this option and save money. But if the price falls to Rs 7 per unit, they can allow the option contract to expire.

Electricity Swaps

Electricity swap simply can be understood as the agreement in which two parties manage to exchange cash flows. Here, if one party pays a fixed price, the other would be paying a floating price for electricity, seeking an agreed volume and time. The common aspect here is regarding OTC (Over the counter) power markets. And, it allows companies to switch between fixed and floating price-based exposures. They are useful for renewable energy producers seeking variable output. They can be customized as per the requirement, and it is generally used by producers or large buyers. There won't be any form of cash settlement here.

Example: A wind farm would agree to swap with a whole industrial buyer where the wind farm would get paid a fixed price with stable revenue. An industrial buyer would be paying market price and would also receive payments from the swap if market prices go up, for stabilizing their cost as well.

In Nepal's Context

Nepal is immature regarding derivative markets. Nepal also lags in terms of a powerful exchange market with real-time spot price discovery. Further, it is dominated largely by long-term PPAs, and there is no daily price volatility for trading electricity. Futures and Options require strict regulation and would require strong, clear houses. So, in the absence of a time pricing mechanism and pricing standards, futures and options might not be suitable at this point in the Nepalese market. Swaps do have potential, but because Forwards are simple bilateral contracts and are highly flexible, Electricity forwards are more practical in Nepalese contexts. This could be a practical starting point in the Nepalese context from its layer (Pandey, 2024).

Forward does not require any complex exchange-based platform at first. They can turn out to be bilateral agreements between the Nepal Electricity Authority (NEA) and independent power producers here. They are already similar, and Nepal's making long-term Power Purchase Agreements is just a replication of forward contracts for 15 to 30 years, signifying that they are equally meaningful here. Apart from considering Nepal's plan to export more hydropower to India and Bangladesh, forward contract helps buyers and sellers lock in prices and manage currency market risks as well. And, in all, Forwards are rather easier to introduce in comparison to the future or options, making it more feasible and practical from Nepal's perspective.

Benefits

Nepal's electricity supply is highly dependent upon hydropower, which fluctuates with seasons. There is excess electricity in wet times where the prices are low, and during the dry season, there come around shortages with high prices and a set of load shedding risks. Considering them, the following are the major benefits that can be extracted from it:

- Price Risk Management: All the parties who are involved - producers, distributors, and large consumers can work for hedging against unexpected price spikes here.
- Revenue Stability: Small or medium independent power producers (IPPs)

can manage to secure a stable revenue by selling future production at their pre-agreed prices, which clearly reduces the impact of price drops during surplus time.

- Encourages Long Term Investment: There will be more predictable cash flows, making hydropower and transmission projects more bankable.
- Supports Cross-Border Trade: Aiming to export electricity to India and Bangladesh, their strength can also be standardized electricity futures or swaps there.
- Enhances Market Efficiency: The derivative market hereby intends to encourage better pricing discovery for signaling future supply-based demand expectations.
- Protects Customers: There will be large industrial and commercial consumers who can protect themselves from sudden tariff hikes. Predictable energy costs would all help the process, allowing them to make it easier to plan operational budgets.

Be it by facilitating renewable integration or seeking variable renewable energy like solar, which would be added, the derivatives would help balance supply-based demand mismatches. The grid operators would allow for hedging against their unexpected generation shortfalls there. Electricity derivatives would add depth for Nepal's nascent commodities and seek out their financial markets here. Energy Exchange can also gain traction there. So, if the hydropower company were to seek a certain portion of its expected monsoon surplus, the whole fixed price through a forward contract would be with a power-based trader as well.

Challenges and Problems

There certainly lies a different set of challenges that would bring ease to the process. There is also a lack of a mature power market as Nepal is operating bilateral Power Purchase Agreements (PPAs), and there is no fully functional day-ahead spot market or real-time electricity trading platform. A small number of active power producers and buyers all intend to limit market-based participation as well, and in the absence of enough buyers or sellers, the derivative instruments will not have sufficient trading volume for functioning in an efficient way. There is an absence of awareness and expertise as well, and there are also lagging aspects regarding financial literacy. Apart from Nepal, it lacks a dedicated regulatory framework for electricity derivatives. There is no centralized energy exchange that is fully operational either. At one end, there is currency and settlement risk, and seasonal volatility of supply is another issue that brings uncertainty into the picture.

Conclusion

The whole set of development of electricity derivatives in Nepal possesses a huge potential for transforming the whole nation's energy-based sector. Considering the seasonal variation in electricity supply, considering their price volatility and risks of shortages, these form of derivatives. They would all ensure stability of income for hydropower producers, around the price of production there. Considering such seasonal variation in whole electricity supply, their price volatility and risk-based shortages, derivatives would offer a powerful tool for managing the whole set of uncertainty as well. There certainly lie huge challenges as Nepal turns out to be an underdeveloped power market that lacks regulatory frameworks and limited financial and technical literacy (Lucia and Schwartz, 2000). There lies weak infrastructure and poor coordination among the stakeholders. So, unless Nepal establishes a clear legal and regulatory foundation, develops technical infrastructure, and works for building institutional capacity, the whole market-based liquidity seeks ways for the implementation of electricity derivatives, which turns out to be difficult enough. So, for enjoying the full benefit of electricity derivatives, Nepal needs to work from a very foundational stage itself.

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निर्माणाधीन तनहुँ जलविद्युत कम्पनीको बाँध क्षेत्र

Uniting Nepal through federalism: A SWOT Analysis of Constitution of Nepal

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Abstract

The Constitutional safeguards, in federal nation, are only as strong as in their implementation for protecting unity and integrity by means of empowering inclusion, managing identity, nationality, security and governing with justice. The Constitution of Nepal strategically balances federalism with unity, and diversity with integrity. Nepal's Constitution offers robust provisions to protect national unity, sovereignty, and security, both in letter and spirit. However, true protection of these ideals depends not just on legal clauses, but on political will, inclusive governance, institutional capability, and civic engagement.

1. Conceptual Understanding:

The Constitution of Nepal was crafted after a long political transition, including a decade-long armed conflict, abolition of monarchy and the establishment of a federal democratic republic. One of its central aims is to safeguard national unity, territorial integrity, sovereignty, independence and national security. These principles are reflected throughout the constitution, and multiple institutions, legal provisions, and mechanisms are embedded to defend them. However, the practical use and effectiveness of these provisions remain subject to interpretation, political will, institutional capacity and evolving threats.

Federalism is a mode of government that combines a general level of government with provincial or local level of sub-unit government while dividing the powers of governing between the two or more levels of governments. In a narrow sense, federalism refers to the mode in which the polity of a state is organized internally, while in broadest sense the political scientists use this term federalism preferring to a multi-layer or pluralistic concept of social and political life.

According to Daniel Ziblatt[1] there are four competing theoretical explanations for adopting a federal system in a sovereign nation throughout the world.

1 Ziblatt, Daniel (2008) Structuring the State: The Formation of Italy and Germany and the Puzzle of Federalism, assessed on 4th April 2025.

a. **Ideational theories**: This theory dealt that among subunit populations, a greater ideological commitment to decentralist ideas makes federalism more likely to be sought and adopted.

b. **Cultural-historical theories**: This theory talked that in societies with culturally or ethnically fragmented populations, federalized subunits are more likely to be favored and adopted.

c. **Social contract theories**: It dealt that federalism emerges via a bargaining process between the center and a periphery. Here, the center is not powerful enough to dominate the periphery, but the periphery is not powerful enough to secede from the center.

d. **Infrastructural power theories**: It said that federalism is likely to emerge for the subunit population that already has highly developed infrastructures. i.e. they already are a constitutional, parliamentary, and administratively modernized state.

The Professor KC Wheare[2] has mentioned following six factors in modern federations:

- ❖ A sense of military insecurity & of the consequent need for common defense,
- ❖ A desire to be independent of foreign power & a realization that only through union could independence is secured,
- ❖ A hope of economic advantage from union,
- ❖ Some political association from communities concerned prior to their federal union,
- ❖ Geographical neighborhood &
- ❖ Similarity of political institutions.

He further asserted that the federal result is only possible by these factors and federalism sustained by blending these factors with common language, race or religion or a sense of common nationality. For instances, the post 1890's Australia is a campaign of people of the colonies a feeling as all Australians as well as Victorians or Queenslanders or like.

The constitution of Nepal clearly depicts the criteria for allocating power[3] among three tier of government exclusively in schedule 5, 6 and 8 while concurrently in schedule 7 and 9. Accordingly, the task that need national integrity, currency and monetary policy, national security and defense, regulation, setting of standards, external relations, interprovincial nature of work including project and infrastructure, research and development for federal government. The provincial level government worked in the area of development of infrastructure, execution of development projects, and regulation of provincial level function, coordination among local level with the province, programs and project encompassing more than one municipality and district. The local level governments are assigned with such task that delivers the services, execution of local development works and regulation of local services and activities.

The constitution of Nepal has well adopted federalism from political side by dividing sovereign power into three level of government. The adoption of disintegration model of federalism has challenged by administration

2 Wheare , K.C, Federal Government. (4th ed.). London : Oxford University Press.(1963)
3 Constitution of Nepal, art. 59(1).

of federalism along with centralizing tendency of few traditional political parties for being expensive and giving the fear of seceding the nationality into many separate and self determined unit of government. The traditional political parties demanding referendum in against federalism by showing incompetency of sub national federal governments. Such form of challenging seems to be developed intensely if not addressed soon through constitutional amendment or political consensus by protecting the value of federation in Nepal.

1.1 National Unity:

The concept of national unity in a federal setup refers to the sense of collective identity, shared purpose, and solidarity among the diverse states or regions of a country, even while they retain significant political and administrative autonomy. It is about maintaining cohesion and a unified national identity, despite the decentralized distribution of powers that characterizes federalism.

In a federal system, power is constitutionally divided between a central (national) government and regional (state/provincial) governments. Each level of government has autonomy in certain areas, which allows for local self-governance while remaining part of a larger political entity.

Federal setups often exist in diverse societies, where differences in language, culture, ethnicity, or religion are pronounced. The national unity is both a goal and a challenge. Without a strong sense of national unity the regions may push for autonomy beyond federal limits national identity diluted & political instability may arise. National unity ensures that while regions enjoy autonomy, they still feel part of a larger nation, uphold shared values and institutions & participate in collective goals. Many nations has maintained their national unity in their own ways like **India**, with its diverse population, the federal system allows linguistic and cultural autonomy while promoting unity through common institutions and a shared constitution. In **United States of America**, the states have autonomy, but their identity and institutions (e.g., presidency, federal courts) unify the country and **Canada** applied balance between Quebec's distinct identity and national unity has been a defining feature of its federalism.

But, the challenges faced by nation while implementing federalism may face ethnic or linguistic nationalism in specific regions or economic inequality among states or political conflicts between central and regional governments or Secessionist movements by taking caste or racial groupings etc. For solving such types of tensions many nations has carefully practiced and preserved both diversity and unity as per their need or organic ways. So, national unity is not about uniformity; it is about cohesion in diversity. It requires a delicate balance between regional autonomy and national integrity that is achieved through mutual respect, constitutional commitment, and inclusive governance.

1.2 Territorial Integrity:

Territorial integrity refers to the principle that a state has the right to maintain its existing borders and territory against external aggression or internal division. It implies that no part of a country can be separated or taken away without its consent, and that the country's physical boundaries are legally protected and inviolable. The most remarkable reason

for territorial integrity is for preservation of national sovereignty, for ensuring political stability, for protecting national resources and identity, for promoting international peace & order etc. The legal basis of territorial integrity was explained in international law also. The important international documents that dealt about territorial integrity are United Nations Charter, where the provisions that prohibit the use of force against the territorial integrity or political independence of any state and other international treaties and conventions respect for territorial integrity. These instruments has recognized globally through various agreements, reinforcing non-intervention and peaceful coexistence. But, the issue of territorial integrity in federal nation was challenged by either external aggression (invasion or military occupation by another country) or internal separatism (ethnic, religious or regional groups demanding independence) or border disputes (conflicts with neighboring countries over unclear or contested boundaries) or terrorism and insurgency (armed groups seeking to weaken national unity).

1.3 National Security:

Security is an imperative issue for the survival of any state. Lack of security is a compromise on the peace and well-being of state and its inhabitants. At the macro-level, state security must be geared towards ensuring territorial integrity and sovereignty. The concept of security is all-encompassing and is required for combating food insecurity, lack of housing, poor health and education system, natural disasters, terrorism and extremism.

The Concept of Security in its traditional sense represents as military security. But in modern respect it referred to the threats against the crucial values of states like territorial integrity and political sovereignty through improved national weapons and armament mechanisms, strategic alliances, military deployment, adversarial management, nuclear weapons, etc. However, the widening of the concept of security envelop political, economic, and environmental and identity as contemporary determinants of state security. The other dimension of security accounts for human beings. The term human security understands and analyses global vulnerabilities along with challenging the traditional determinants of national security, especially military security, by arguing that security must be assessed at human level instead of national level. That is the human security entails not just procurement and development of arms but development of human beings, their livelihood and community.

National security is a sensitive and a multifaceted issue. Every country is built on its originality and priorities. Security of a nation encompasses sovereignty, national integrity, social, economic, cultural, and humanitarian aspects. National security is affected by the foreign policy of the nation, policy on internal peace and order, ideas on social security and implementation. National security also covers issues like protecting the citizens of one's country and maintaining reasonable secrecy regarding national interests. Wagle[4] opined that Nepal is now in the process of transforming from a feudal and unitary state into a plural, democratic, multi-ethnic, federal, and secular one … the definition of national unity

4 Wagle, G. S. (2009). "National Security Policy and Role of National Security Council", in Bhattarai, R. & Cave, R. (eds.) Changing Security Dynamics in Nepal: A Collection of Essays, Kathmandu: Nepal Institute for Policy Studies.

and security has widened (so) national security policy needs to be refined in changed political landscape, safeguarding Nepal's national values and identity, based on national consensus following comprehensive consultation with various stakeholders in society.

2. SWOT Analysis of National Unity, Territorial Integrity, and National Security in Nepal

2.1 Strengths:

The Preamble of the Constitution[5] expressed the commitment to safeguard the freedom, sovereignty, territorial integrity, national unity, independence and dignity of Nepal. It sets a normative foundation for unity and sovereignty as non-negotiable national values. The Constitution[6] declares that Nepal as an independent, indivisible, sovereign, secular, inclusive, democratic, socialism-oriented, federal democratic republican state." It also emphasizes indivisibility and sovereignty as foundational elements.

The Constitution[7] also specifies the territory of Nepal that comprises the 125,000 square kilometers existing before the promulgation of this Constitution. It also provides a legal shield for territorial integrity and basis for boundary disputes (e.g. Lipulekh, Kalapani). The Constitution [8]also talked about the Citizenship, National Flag, Anthem, Emblem and Language by establishing national symbols and identity essential for unity in diversity and Promoting Nepali as the official language but protects linguistic pluralism. The constitution, in its part five, has provisioned about the Directive Principles, Policies, and Obligations of the State to address the unity and security of Nepal.

National Unity[9] strengthened through protecting sovereignty, integrity, independence, and dignity and developing a harmonious society through mutual respect of diversity. The political and governance policy was designed by emphasizing the participatory democracy, decentralization, and good governance as tools for national cohesion. The defense and security policy[10] has mandated to maintain national unity and integrity along with protection of borders, ensure peace and order, and develop national security forces under democratic control by means of loyalty to the Constitution.

The Constitution has also made provision of Nepal Army and National Security Bodies for national unity, territorial integrity and national security within the Nepal. Nepal Army[11], as a security institution, worked as national army under democratic civilian control, deployed only as per council of ministers' recommendation and committed to national independence, integrity, and sovereignty of nation. Similarly, National Security Council[12] working for advising government on national security and army deployment chaired by prime minister including

5 *Id* at Preamble
6 *Id* at art.4
7 *Id* at art.5
8 *Id* at art. 6 to 9
9 *Id* at art.51(1)
10 *Id* at art.51(4)
11 *Id* at art.267
12 *Id* at art. 266

key ministers and army chief of government of Nepal. The national Security Council was central to strategic security decisions but is often politically influenced and lacks an independent strategic doctrine.

The Constitution[13] provisioned for constitutional amendments and territorial Integrity. For any change to territory of state have required 2/3rd majority in federal parliament and consent of affected province**.** This provision has provided strong constitutional safeguards against arbitrary boundary changes in territory of Nepal. Similarly, the judicial provision[14] has empowered court to strike down laws and actions that threaten national unity or violate constitutional principles and settle disputes among different levels of government.

2.2 Weaknesses:

The most remarkable challenges faced by federal Nepal is weak implementation of federal constitution since its promulgation. Mostly such challenges observed by delay implementation of administrative federalism, centralized mindset, sluggish bureaucracy, political meddling, and reluctance of functioning of intergovernmental institutions like inter provincial council, national coordination council, provincial coordination council etc. The major hurdles while maintaining unity in diversity in federal Nepal observed are:

Centralization of Security: The provinces lack control over security that weaken autonomy in crisis of security issues.

Political Manipulation: The national symbols and unity are politicized due to identity politics and state restructuring debate or naming of provinces

Border Disputes: The article 5 of constitution clearly mentioned the legality issues. But due to weak diplomatic policies and strategic infrastructure challenged the borders with neighboring nations experienced in Kalapani case.

Civil-Military Ambiguity: While constitutionally under control, the army has occasionally exerted informal political influence, especially in post-conflict transitions.

Implementation of Inclusion: Though constitutionally recognized principle, but the exclusion of marginalized groups and domination of creamy layers in power structures fuels discontent and threatens unity

National Security Policy: There lacks clear, publicly debated strategic doctrine or long-term planning on security policy.

2.3 Opportunities:

Nepal is a landlocked federal state and is often regarded as a yam between two boulders. Politically, it means that Nepal must strategize itself in a way that prevents it from being attacked by either of the two powerful states by maintaining a positive attitude and foster friendship and cooperation with its neighbors, diplomatically balance them and grow with their support. At a global arena, Nepal needs to keep its doors open to the changing times for security of nation.

The article 51 of the Constitution of Nepal covers the policy of national unity and security. As per the Constitution, Nepal shall pursue the policies relating to national unity and national sovereignty to keep the national unity intact, while protecting the freedom, sovereignty,

13 *Id* at art. 274

14 *Id.* at art. 133, 139 & 144.

territorial integrity and independence of Nepal. It also aims to promote the national unity while developing mutual cooperative relations between the Federal Units by maintaining mutual cohesion, harmony and solidarity between different castes, religions, tribes, cultures and communities. Apart from these, it also aims to maintain law and order by developing a national security system and guarantee the overall human security system. Based on national security policies, the security organs will be made which would include the Nepal Army, Nepal Police and Armed Police Force with competent and strong professionals. The policy also aims to make proper use of the knowledge, skills and experience of former public employees in the interest of the nation and keep the citizens ready and competent to serve the nation as and when necessary.

The Constitution of Nepal has made several important provisions to maintain national unity, ensure territorial integrity, and safeguard national security. Nepal being a newly federalized and multi-ethnic state, the Constitution aims to balance ethnic and regional diversity with the unity and sovereignty of the nation.

2.3.1 National Unity:

The preamble of the constitution expressed a commitment to unity in diversity, embracing the multi-ethnic, multilingual, multi-religious, and multicultural nature of Nepali society. It also declared Nepal as an independent, indivisible, sovereign, secular, inclusive, and democratic country.

All citizens are equal under the law, with common Nepali citizenship. The Article 10 of constitution expressed that No Nepali citizen shall be denied the right to obtain citizenship. Similarly, the national symbols (flag, anthem, language) are emphasized to promote shared identity among nationalities.

The article 6 & 7 of constitution of Nepal has expressed official language and recognition of diversity that Nepali, in Devanagari script, is the official language of the federal government and all languages spoken by the people of Nepal are considered national languages. The constitution also prohibits secession and declared that Nepal as an indivisible, sovereign nation. No provision allows for secession or division based on ethnicity, region, or language.

2.3.2. Territorial Integrity:

The Constitution of Nepal has ensured the territorial integrity through independent, sovereign, indivisible nation along with federal structure that does not permit any state or province to secede or claim separate status. The central federal government empowered to hold the strong authority over matters related to national borders, defense, and foreign policy, ensuring full control over territorial integrity.

The article 4 of Constitution of Nepal has described that Nepal as an independent, sovereign, secular, inclusive, democratic, socialism-oriented, federal democratic republican state. It reaffirms the indivisibility of the nation, regardless of federalism.

Nepal also practiced federalism without fragmentation i.e. Nepal is divided into three tiers of government (federal, provincial, and local). The provinces cannot secede or act outside the constitutional framework. The schedule 5 of constitution provisioned power to control over national boundaries by federal government. The regulation of internal boundaries mentioned in article 56-57 that has clearly defined the jurisdiction between the federation, provinces,

and local governments. It also clarified that any changes to internal boundaries must follow constitutional procedures and cannot threaten national unity.

2.3.3. National Security:

The article 267 of Constitution of Nepal dealt that the Nepali Army operates under the control of the federal government. The President is the Supreme Commander-in-Chief, ensuring national unity in security matters. The National Security Council has provisioned in article 266 of constitution of Nepal with a structure, functions and duty of it that advice the government on national security and deployment of the army. It was headed by the Prime Minister, including key ministers and the Chief of Army Staff.

The emergency provisions was mentioned in article 273 of constitution that provide the ground for declaring state of emergency by the President, on the recommendation of the federal government, in case of war, external aggression, armed rebellion, or extreme crisis. During the time of an emergency, the federal government can assume greater powers to ensure unity and security.

The border security and foreign policy is under the domain of federal government. The Schedule 5, List 1 of Constitution of Nepal has provisioned that the central federal government control the issues of foreign affairs, defense, immigration, and border security. It also prevents provinces or local units from entering into agreements that could compromise sovereignty or security.

2.4 Threats:

Identity politics: It increases an identity politics by dividing the national unity and integrity.

Minority Rights: Federalism protects the rights of the minority through law of diversity by hindering the majoritarian value in democratic society.

Cultural Diversity: The federal form of government would be strong if cultural diversity is defined and mutual tolerance was taken as granted through ethnic, linguistic or religious bases or geographical base.

Political Test: Federation let down the new political and constitutional innovation as well as test. The Innovation brought in one sovereign nation may result different issues like the European Union has tied 12 countries into one and has been representing a special political test.

Economic Stress: The constraint on local revenue generation and lack of sufficient support from outside result economic problem to run the multiple level governments. It increase stress on limited resources.

3. Recommendations:

The effective and efficient functioning of Nepalese federal constitution or federalism is possible by strengthening national unity, territorial integrity and national security that may require following considerations:

Decentralize Security Mechanisms: The sub national federal government i.e. provinces and local levels must be empowered with adequate policing, policy frameworks, predefined right and duty, enhanced capabilities, utilization of natural resources and disaster-response capabilities.

Institutionalize National Security Strategy: The National Security Council should develop and periodically update a comprehensive National Security Doctrine.

Democratize Symbols and Identity: The promotion of inclusive nationalism rather than a monolithic identity model is required to democratize the identity and symbols embedded in constitution of Nepal.

Improve Border Management: The continuous and regular endeavor of diplomatic, infrastructural, and legal measures need to be ensured for protecting the territorial claims and border disputes issues.

Strengthen Judicial Oversight: The use of constitutionally guaranteed litigation and judicial review required to protect constitutional principles actively for federalist provisions. The access to justice and speedy case clearing system should be adopted to give justice at large.

Address Internal Discontent: The promises made on ethnic inclusion, equitable development, and identity recognition under federalism must be ensured by policy dialogue, national consensus and political priority.

4. Conclusion:

The Constitution of Nepal strategically balances federalism for unity, diversity with integrity. Through a strong central framework on key matters like defense, citizenship, and foreign policy, it protects territorial integrity and national security. Simultaneously, it acknowledges ethnic and regional identities to foster inclusive national unity. The judiciary of Nepal has also playing vital role for maintaining unity in diversity by using lens of justice and equality of treatment among diverse section of Nepal. Nepal's Constitution offers robust provisions to protect national unity, sovereignty, and security, both in letter and spirit. However, true protection of these ideals depends not just on legal clauses, but on political will, inclusive governance, institutional capability, and civic engagement.

सुनकोशी जलविद्युत केन्द्रको पेनस्टक

Electricity Development in Nepal : Laws & Reforms

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History of Electricity Development

Nepal's history of electricity generation can be traced back from 1911 A.D., with the construction of Pharping Hydropower Station (500 kW) located near Kathmandu Valley. The second hydropower Sundarijal Hydropower Station (640 kW) was constructed in 1939 after 28 years. Since then, hydropower projects in Nepal have been constructed through bilateral and multilateral support as the government prioritized hydroelectricity infrastructure development through its periodic development plans and legislations. The Electricity Act, 2049 welcomed the private sector for construction of hydropower, transmission and distribution of electricity. As a result, many Independent Power Producers (IPPs) came in the generation sector.

Present Status of Electricity Development

Nepal has been a power surplus country since 2021 during wet season and energy deficiency in the dry season is increasing year by year as most of the hydropower are of RoR type and they generate full capacity in wet season and produce almost one third of energy in the dry months compared to wet months as the water flow in the river decreases. The surplus energy in the wet season can be exported to India and it could be imported back to Nepal in dry months i.e. when we are energy deficient, using the concept of energy banking.

Total hydropower installed capacity in the world reached to 1412 GW in 2023 (IHA, 2024). In South Asia region, Bangladesh India and Pakistan fossil fuels are important energy sources on the other hand Nepal and Bhutan relay on hydropower (R Vaidhya et al, 2020). The huge potential of hydropower in Nepal and Bhutan can be used to meet growing electricity need of South Asia. Water resources are one of the most important natural resources of Nepal and it is one of the richest countries in terms of water resources availability in the world. In the form of snow covers, rivers, springs and lakes, water resources are abundant throughout the country (WEPA). Though there is huge potential of renewable energy worldwide only 27 % of world population obtains electricity from renewable energy (Poudyal R, Loskot P et al, 2019).

Nepal's estimated water resources is 225 billion m3/km2/year. It is four times higher than

world's average (World Bank, 2016). There are altogether 6,000 rivers in Nepal with cumulative length of 45,000 km. There are about 24 rivers that are more than 100 km long and 1000 rivers longer than 10 km in length. The major river system of Nepal i.e Koshi, Gandaki, Karnali and Mahakali and their tributaries are snow fed and their flow regimes are governed by melting of snow and glaciers (WEPA). As a result, river flow is perennial and even in the dry season they have sustained flow.

Nepal has huge potential of hydropower, but about two percent of the 83,000 MW (technically possible) of hydropower is currently harnessed. 42,000MW is feasible with no environmental hazards (ICH, 2019). The available potential could not be achieved due to political instability, inability to attract FDIs and delay in project execution in the last decades. Nepal's huge potential in hydropower can be utilized to enhance its economic growth not only increasing internal consumption also fulfilling increasing energy demand in South Asia.

The power system in Nepal is dominated by Run-Of-River (ROR) hydropower plants. There is a shortage of storage type hydropower plants. The surplus energy available will increase from month of April to November and thereafter starts to decrease in each fiscal year. Nepal became a power surplus country for the wet season after the 456 MW Upper Tamakoshi Hydropower Project, largest power plant, came into operation in July 2021. Nepal has surplus energy generation especially in the wet season as other RoR plants are also being add up in the system. In the wet season during 2022 Nepal's spill energy reached up to 500 MW. On the other hand, Nepal had to import about 2,826 GWh of Energy in the dry season of 2021 (NEA, 2022). This clearly shows that Nepal has imbalance nature of demand and supply. To be specific electrical demand seems to increase slightly in the dry season on contrary generation seems to be reduced almost by greater than one third of installed generation capacity. Nepal's seasonal surplus, daily surplus and peak shortage of power/energy are expected to be balanced by utilizing energy exchange and energy trading with India and Bangladesh.

Legal Provisions

Constitution of Nepal, Article 51(f) Clause 3, mentions ensuring reliable and affordable energy supply and proper utilization of energy by generation and development of renewable energy for the fulfillment of citizen's basic needs. Nepal needs sufficient energy supply to achieve this goal.

Nepal Electricity Authority Act 2041 was formulated and Nepal electricity Authority was established in 2042 with the main aim of involving in Generation, Transmission and Distribution of electricity in reliable and adequate manner. Electricity Act 2049 came in to existence after feeling the need of private sectors involvement in the hydropower sector. Hydropower Development Policy was published by the government in 2058 which explains different provisions related to hydropower development and Distributions and Transmission of electricity in effective and efficient manner. After feeling the need of regulatory body in the electricity sector Electricity Regulation Commission was formed under the act of Electricity Regulation Commission Act in 2074.

Need of New Electricity Law

Previously, the electricity projects were either owned by the unitary government or private party (domestic or foreign investor), but with the advent of the constitution that mandates authority of the sub national governments to administer their own electricity projects, a wholesome electricity legislation that takes on the spirit of sustainable federalism as well as ensures the availability of affordable and consistent energy was necessary.

It was essential to adopt a new legislation that helped establish a structure where the sub national governments could develop their own energy projects as the present constitution of Nepal states that Electricity is the concurrent power of all government. In pursuit to achieve such aspirations, the Ministry of Energy, Water Resources and Irrigation has prepared the Electricity Bill. The bill has been put forward with the objective of distributing the rights and responsibilities among the federal institutions for developing and implementing electricity development projects. Also, with the view of making electricity accessible to every citizen of the country, the Bill attempts to enhance the electricity development projects through a competitive model to fulfill the growing demand for energy in the country.

Prospects of New Electricity Bill

Electricity Bill has been put forward with the objective of making electricity accessible for every citizen of the country. The Bill was brought forward mainly with the objective of fulfilling the need of a legislation that distributes the rights and responsibilities among the federal institutions and creates coordination among them in regards to electricity development projects. As Electricity Act 2049 was formed when country was practicing central government system, this Bill aims to decentralize licensing authority among different layers of governments under federal structure. The Electricity Bill holds great prospects for electricity development in the country however; it also misses out on certain provisions that can be a challenge for electricity development under the federal structure. Such prospects and challenges for the bill are briefly discussed in the sections below

As mentioned in Section 3 of the Bill, all three tiers of governments can develop and operate projects based on the production capacity of the project. The local governments have been provided authority to develop and operate projects with capacity up to 3 Mega Watts, the provincial governments with production capacity ranging from 3 Mega Watt to 20 Mega Watts while the authority lies with the federal government regarding projects above 20 Mega Watts. Likewise, Section 11 of the Bill provides rights to grant license to each tier of government based on the proposed capacity of hydro plant.

Production Capacity	Authority to Grant License
Upto 3 MW	Local Government (Municipality/ Village Council)
3 MW to 20 MW	Province Government
Upto 3 MW using two or more rivers or inter-provincial in nature	Province Government
Upto 20 MW using two or more rivers or inter provincial nature	Secretary of Ministry of Energy, Water resources and Irrigation
More than 20 MW and excluding above provisions	Secretary of Ministry of Energy, Water resources and Irrigation

Table 1: Authority to grant license for different capacity of hydropower

The Electricity Bill has a separate section (Section 5) for rural electrification and maintains that rural electrification process can be initiated with individual or coordinated action of all three tiers of governments. By maintaining a sole provision for rural electrification, the Bill has granted authority to subnational governments to initiate their own electricity development projects as per their need. For this purpose, the subnational governments can request technical support from the federal government and are even allowed to use the electricity royalty received.

The Hydropower Development Policy, 2001 had maintained a provision of granting one generation license term for hydropower projects based on the nature of the projects. Projects supplying for internal demand were granted license for a term of 35 years while export oriented projects were granted for 30 years. The new Bill, however, prescribes a maximum license period of 50 years. To that extent a one-time 35-year license is granted in the first instance which is then renewed for 15 years, for projects generating electricity through dams and 40 years for projects without the use of dams. Similarly, the Bill ensures a competitive model for granting licenses to all electricity projects. However, according to the Directive, related with the License of Electricity Projects, provision for competitive bidding is limited to projects included in the project bank.

Comparison of Electricity Bill with the Electricity Act 1992

The electricity bill seems to be more progressive than present electricity act prevailing in the country. The present bill has addressed wider perspectives of electricity sector and it has aimed to make electricity sector more competitive and efficient. Few comparisons among two are presented in the table below.

Subject	Electricity Act 1992	Electricity Bill
Granting License	Nepal Government has right to grant license of hydropower developments	All three level of government has right to grant license
Rural Electrification	Such provisions were not in the act	All three levels of governments can together or alone involve in rural electrification works
Royalty	Rs 100/KW per annum and 2% of average tariff per unit for 15 years from the date of generation of electricity for commercial purpose	Only written as specified in the bill (the amounts shall be cleared in the Regulation
Validity of License	Survey of Electricity: 5 years Generation, transmission or distribution: 50 years	Electricity generation through dams: 50 years Electricity generation without the use of dams: 40 years Other manners of electricity generation: 25 years Transmission, distribution and trade: 25 years
Competition on Generation	No such provision	Hydropower Development shall be based on competition

Subject	Electricity Act 1992	Electricity Bill
License	Any entity can be given multiple licenses of generation, transmission and distribution	No multiple licenses for same entity
Provisions on Captive and cogeneration	No such provisions	No license is required for Captive and cogeneration methods of production of electricity
National Load Dispatch Center	No such provisions	National Load Dispatch Center shall be established for management of generation, transmission and distribution of electricity

Challenges

Electricity Bill faces certain challenges for implementation. Below are the identified challenges in the proposed bill.

- Challenges regarding inter-jurisdictional water streams: The Proposed Bill gives right to the province to solve the issues related to water resources among local government bodies. The concern authority of province responsible for such activity is not mentioned. However the Bill gives authority to the Secretary of Ministry of Energy, Water Resources and Irrigation for solving issues related to water resources sharing between provinces.

- Challenges Regarding Transfer of Ownership: In Section 17 of Electricity Bill, it is mentioned that after the end of the license term of the project, the ownership of electricity infrastructure shall be transferred to Nepal Government or any institution that will be stated by the Nepal Government. The local and provincial governments are given authority to provide licenses for development of hydro projects but the transfer of ownership to Nepal Government will hamper the rights of the subnational governments. Since the subnational governments are given the authority to provide licenses, the ownership of the projects after license expiration must also be transferred to the respective governments as the Constitution of Nepal in Schedule 6 and 8 grants power to provinces and local level regarding province level electricity and local level electricity respectively.

- Challenges of administration: The Electricity Bill does not mention whether the subnational governments are provided the autonomy of determining the fees and concessions for other charges that may arrive or prevail for the developers.

- The Bill focuses only on hydropower and use of water resources. Bill is failing to recognize the growing opportunities present in the alternative energy sources. The provinces which have less hydro electricity generation capacity could face it problematic. Provisions related to other alternative energy sources need to be added in the bill.

- The Bill's lack of acknowledgement of Alternative Energy Promotion Centre (AEPC) that promotes the use of alternative energy technology for rural electrification may bring about issues in the development of alternative energy in the country.
- The proposed Electricity Bill holds provisions that provide the government and any government chosen institution a discretionary authority to award projects to a foreign developer without competition. This might lead to miss management of the projects. Cheaper projects may go to the hand of foreigners and Nepalese developers may be forced to choose more costly projects.
- The Electricity Bill also fails to incorporate projects that fall under the jurisdiction of Investment Board of Nepal. As per the Public Private Partnership and Investment Act, 2019, the projects having capacity of more than 200 MW shall be implemented by the Investment Board but the Bill fails to incorporate such projects.

Reforms

Few reforms that could make the electricity bill more competitive and result oriented and help the electricity sector to foster in the country are listed below.

- The provision regarding charging of license fees by sub national government should be stated in the bill.
- The concern authority of province responsible for solving the issues between the local bodies regarding the use of water should be stated in the law.
- As the local and provincial governments are given authority to provide licenses for development of hydro projects, the provision of transfer of ownership to these sub national government after completion of license period should be stated in the law.
- The Bill should provide the provision of other alternative energy resources like solar, wind etc. regarding the study of environmental impacts and other technical standards.
- The Bill's should acknowledge Alternative Energy Promotion Centre (AEPC) that promotes the use of alternative energy technology for rural electrification and make it more strong institution for rural electrification purpose.
- The provisions of giving hydropower project to foreign developer without competition should be reconsidered as this might de motivate domestic hydropower developer.
- The provision regarding land acquisition especially for transmission line construction and use of Right of Way should be mentioned in the new law.
- The use of government land and forest land for construction of hydropower and transmission line should be further simplified. Tree cutting approval procedure for construction of projects should be simplified.

- The provision regarding license holding period of private hydropower should be clearly stated in the new act.
- The provision regarding giving compensation to the small hydropower plant if they are replaced by bigger storage power plant should be stated in the new law.

Conclusion

As the formulation of new policy, rules and regulations are ongoing process, they obviously need correction and modifications as per the situation and changed circumstances. As the country has adopted federalism since long time, the old acts and policies should be changed or modified as per the orientation of constitution. The present Electricity Act was commenced about 40 years ago so it needs modifications and it should be in line with the present Constitution of Nepal. The present constitution of Nepal has kept the Electricity sector as concurrent power of all the levels of government and new act should be formulated accordingly. The new act should be able to address the present problems of electricity sector and should play positive role in the hydropower development of the country which is the natural resources available abundance in the country and its effective use for production of electricity could lead the country in the path of development and prosperity.

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Green Bonds in Nepal: Unlocking Sustainable Finance for a Greener Future

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Introduction

Nepal is highly vulnerable to the impacts of climate change due to its diverse geography, fragile ecosystems, and climate-sensitive economy. The country is already experiencing a range of climate-related challenges, including Rising Temperatures, Glacial Melt, Glacial Lake Outburst Floods (GLOFs), Erratic Rainfall, Landslides and Floods, Heatwaves in the Terai etc. These challenges are compounded by limited infrastructure, low adaptive capacity, and a high dependence on natural resources. Addressing them requires urgent investment in climate-resilient development, early warning systems, and sustainable financing mechanisms like green bonds.

Nepal's journey toward environmental sustainability and climate resilience hinges on its ability to mobilize sustainable financing. As a country highly vulnerable to climate change, Nepal requires substantial investment in renewable energy, climate-resilient infrastructure projects, provisions for disaster preparedness, and green innovation.

In June 2025, Nepal validated its Integrated National Financing Framework (INFF) Financing Strategy, a landmark initiative aimed at aligning financial flows with national development and environmental priorities. The strategy covers three major transformative themes, Pro-employment growth, Climate Resilience and Alignment with Sustainable Development Goals (SDGs). This framework encourages the use of innovative financial instruments such as green bonds, climate funds, and public-private partnerships to bridge the financing gap and accelerate progress toward Nepal's 2030 Sustainable Development Goals (SDGs) targets.

A major milestone was the $60 million green bond issuance by NMB Bank, supported by IFC, British International Investment (BII), and MetLife. This investment is expected to create around 8,000 jobs, support electric vehicle adoption and solar energy development and finally strengthen Nepal's domestic capital markets. This investment was made possible by the strong collaboration between International Finance Corporation (IFC) and the Government of Nepal, to enhance the country's capital markets through strategic policy developments and regulatory reforms. It marks two others first in the history of the country's financial sector: the first thematic bond issuance in Nepal's capital markets, and the first private placement of a local issuer's bond by international investors, paving the way for future issuances.

Sustainable financing not only enables Nepal to reduce its carbon footprint but also helps build a resilient economy that can withstand climate shocks. It ensures that environmental goals are not sidelined but integrated into the core of national development planning. Green

Bonds are governed by frameworks such as the Green Bond Principles (GBP) issued by the International Capital Market Association (ICMA), which ensure transparency, accountability, and environmental integrity. Issuers must clearly define eligible projects, track the use of funds, and report on environmental impact. Globally, Green Bonds have become a vital tool for financing the transition to a low-carbon economy. They attract a growing pool of environmentally conscious investors, including development banks, pension funds, and Environmental, Social and Governance (ESG) focused institutions.

In the context of Nepal, Green Bonds offer a promising avenue to fund climate-resilient infrastructure and renewable energy projects, aligning with national goals under the Sustainable Development Goals (SDGs) and the Nationally Determined Contributions (NDCs) to the Paris Agreement.

What are Green Bonds?

Green Bonds are a type of fixed-income instrument specifically designed to raise capital for projects that deliver environmental benefits. Like traditional bonds, they offer regular interest payments and return the principal at maturity, but the key distinction lies in their use of proceeds, which are exclusively allocated to green projects. Under Green Bonds projects typically includes renewable energy (solar, wind, hydro), energy efficiency, clean transportation, sustainable water and waste management, climate adaptation and resilience.

These bonds function like traditional bond investors receive fixed returns over time—but they are distinguished by their environmental purpose and transparency requirements. Issuers must disclose how the funds are used and report on the environmental impact of the financed projects.

Global Context

Since the first Green Bond was issued by the World Bank in 2008, the market has grown exponentially. By 2024, the global Green Bond market had surpassed $2 trillion in cumulative issuance, with major contributions from governments, corporations, and multilateral institutions. Key frameworks guiding Green Bond issuance include Green Bond Principles (GBP) by the International Capital Market Association (ICMA), European Union Green Bond Standard and Climate Bonds Standard by the Climate Bonds Initiative

Countries like China, the United States, Japan and members of the European Union are leading issuers, using Green Bonds to fund their transition to low-carbon economies. These instruments are also increasingly popular among Environmental, Social and Governance (ESG) focused investors, who seek both financial returns and environmental impact.

Japan has introduced the world's first government-labeled transition bonds, known as Japan Climate Transition Bonds of ¥20 trillion (approx. $144 billion USD) over the next decade as part of its broader Green Transformation (GX) strategy. These bonds are designed to finance projects that support a gradual and credible transition toward a carbon-neutral society by 2050 including Hydrogen and ammonia fuel infrastructure, energy efficiency upgrades in heavy industry, carbon capture and storage (CCS), fuel switching technologies etc. The main purpose of this is to fund public-private investments in sectors that are currently carbon-intensive but are committed to long-term decarbonization. For developing countries like Nepal, Green Bonds offer a strategic opportunity to mobilize climate finance, attract international investment, and accelerate sustainable development.

Key Features of Green Bonds

- **Earmarked for Environmentally Friendly Projects:** The proceeds from Green Bonds are exclusively used to finance or refinance projects that deliver clear environmental benefits. These may include renewable energy (solar, wind, hydro), energy efficiency, clean transportation, sustainable water and waste management, climate change adaptation etc.

- **Interest and Principal Repayment Structure:** Investors receive fixed or floating interest payments (coupons) over the life of the bond. The principal amount is repaid at maturity. The financial risk and return profile are like conventional bonds, making them attractive to a broad range of investors.

- **Transparency and Reporting:** Issuers are expected to clearly define eligible green projects, track and report on the use of proceeds and provide regular updates on the environmental impact of funded projects.

- **Third-Party Verification:** Many Green Bonds are reviewed by independent third parties to ensure alignment with recognized standards such as the ICMA Green Bond Principles or the Climate Bonds Standard.

- **Market Appeal:** Green Bonds attract ESG-focused investors and institutions seeking to align their portfolios with sustainability goals, often resulting in high demand and competitive pricing.

- **Alignment of Green Bonds with SDGs:** Green Bonds directly support SDG 7 by financing: renewable energy projects such as solar, wind, and hydropower, energy efficiency improvements in buildings, industries, and public infrastructure and clean energy access in rural and underserved communities. By channeling capital into clean energy, Green Bonds help reduce reliance on fossil fuels, lower energy costs, and expand access to sustainable power sources.

  Green Bonds are a key tool for SDG 13 as they fund climate change mitigation projects that reduce greenhouse gas emissions. Support climate adaptation efforts like flood control, resilient agriculture, and early warning systems. They also promote accountability through impact reporting, ensuring that financed projects contribute measurable progress toward climate goals.

Green Bond Regulatory Framework in Nepal

The **Securities Board of Nepal (SEBON)** plays a central regulatory role in the issuance and oversight of Green Bonds in Nepal. Its responsibilities include:

Regulatory Approval

SEBON grants formal approval for the issuance of Green Bonds under the Securities Registration and Issuance Regulations, 2073. In May 2025, SEBON approved Nepal's first-ever Green Bond issuance worth NPR 5 billion with a seven-year maturity to the Nepal Infrastructure Bank Limited (NIFRA), marking a significant milestone in the country's sustainable finance journey

Ensuring Environmental Integrity

SEBON mandates that the proceeds from Green Bonds be used exclusively for environmentally friendly and sustainable development projects. These must be aligned with The Nepal Green Finance Taxonomy 2024 (issued by Nepal Rastra Bank) and The Green Bond Principles (GBP) of the International Capital Market Association (ICMA)

Transparency and Monitoring

Issuers are required to maintain transparency in fund utilization and provide regular reporting on the environmental impact of the financed projects. SEBON ensures that these standards are upheld to build investor confidence and market credibility.

Market Development

By facilitating Green Bond issuance, SEBON is helping to develop Nepal's capital market as a platform for sustainable finance. This supports national goals such as Net Zero Emissions and the Sustainable Development Goals (SDGs).

The Government of Nepal has made significant commitments to promote green and sustainable finance in its **FY 2082/83 budget.** Key provisions include:

Policy and Structural Arrangements

In line with the Nepal Green Finance Taxonomy 2024, the budget outlines the development of necessary policy frameworks and institutional structures to facilitate the issuance of Green Bonds and Sustainable Development Bonds

Mobilization of Private Capital

The government aims to mobilize private sector investment through Green Bonds, encouraging environmentally friendly projects in sectors such as renewable energy, clean transportation, and climate-resilient infrastructure

Local Currency-Linked Bonds

To attract international investors while minimizing currency risk, the budget proposes the issuance of local currency-linked bonds in global markets. This is expected to enhance Nepal's access to climate finance and foreign capital

Nepal Green Finance Taxonomy 2024

Launched by Nepal Rastra Bank (NRB) in October 2024, this taxonomy provides a standardized classification system for green investments across sectors such as energy, transport, agriculture, forestry, and construction. Its key objectives include:

- Climate Change Mitigation: Supporting projects that reduce greenhouse gas emissions, such as renewable energy and energy efficiency.
- Climate Change Adaptation: Financing climate-resilient infrastructure and disaster risk reduction.
- Natural Resource Conservation: Promoting sustainable management of forests, biodiversity, and water resources.
- Pollution Prevention and Control: Funding initiatives that reduce air, water, and soil pollution.

The taxonomy helps financial institutions, investors, and regulators identify, assess, and report green investments, ensuring that capital flows toward projects that contribute meaningfully to Nepal's climate and sustainability goals.

ICMA Green Bond Principles (GBP)

The International Capital Market Association (ICMA) Green Bond Principles are globally recognized voluntary guidelines that ensure transparency and integrity in the Green Bond market. They are structured around four core components:

- Use of Proceeds: Funds must be allocated to clearly defined green projects.
- Process for Project Evaluation and Selection: Issuers must outline criteria and decision-making processes.

- Management of Proceeds: Proceeds should be tracked and managed separately.
- Reporting: Regular updates on fund allocation and environmental impact are required.

Nepal's Green Bond frameworks, including the one used for its first public Green Bond issuance, are designed to align with both the Nepal Green Finance Taxonomy 2024 and the ICMA GBP, ensuring credibility and investor confidence.

Nepal Rastra Bank's ESRM Guideline

Guideline on Environmental and Social Risk Management (ESRM) for Banks and Financial Institutions, 2022 issued by Nepal Rastra Bank (NRB), provides a structured framework for Banks and Financial Institutions (BFIs) to identify, assess, and manage environmental and social (E&S) risks in their lending and investment activities

Key Objectives

- Integrate E&S risk considerations into the credit risk management process.
- Ensure that financing decisions are informed by potential environmental and social impacts.
- Promote sustainable and responsible banking practices in Nepal.

This guideline supports Nepal's broader goals of green finance, climate resilience, and sustainable development, and complements instruments like Green Bonds by ensuring that financed projects meet robust environmental and social standards.

Recent Developments in Green Bonds in Nepal

On June 1, 2025, **Nepal Infrastructure Bank Limited (NIFRA)** issued Nepal's first publicly listed Green Bond, totaling NPR 5 billion (approx. USD 36 million) with a 7-year tenure and 6% annual interest rate. The bond proceeds exclusively funded on renewable energy projects. Approved by Nepal Rastra Bank (NRB) and Securities Board of Nepal (SEBON).

Landmark Private Green Bond by NMB Bank

In a groundbreaking milestone for sustainable finance in Nepal, International Finance Corporation (IFC) as anchor investor, along with British International Investment (BII) and MetLife announced an investment of $60 million in the country's first-ever green bond issuance by NMB Bank. The investment is set to drive significant economic growth by backing initiatives like the adoption of Electric Vehicles (EVs) and harnessing Nepal's potential to develop solar energy, both supported by favorable government policies.

These issuances, marking a major step in expanding Nepal's capital market to include climate-aligned financial instruments. These developments reflect Nepal's growing commitment to green finance, climate resilience, and sustainable development.

Role of Nepal Electricity Authority (NEA) in the Green Bond Ecosystem in Nepal

The Nepal Electricity Authority (NEA), as the country's primary public utility responsible for electricity generation, transmission, and distribution, plays a strategic role in Nepal's emerging Green Bond ecosystem through the following grounds.

- **Project Pipeline for Green Financing:** NEA manages and develops large-scale renewable energy projects, particularly hydropower, solar PV, and smart grid infrastructure, which are ideal candidates for Green Bond financing. These projects

align with the environmental criteria set by the Nepal Green Finance Taxonomy 2024 and the ICMA Green Bond Principles.

- **Institutional Capacity and Credibility:** As a government-owned entity with strong operational track records such as ending nationwide load shedding and improving financial performance—NEA offers institutional credibility that can attract both domestic and international investors to Green Bonds.
- **Grid Modernization and Smart Energy Initiatives:** NEA is actively implementing smart meters, SCADA systems, and digital billing, which contribute to energy efficiency and reduced carbon emissions. These initiatives can be financed through Green Bonds, supporting Nepal's climate goals.
- **Export-Oriented Renewable Energy:** With Nepal beginning to export surplus electricity to India and Bangladesh during monsoon months, NEA is positioned to scale up cross-border clean energy trade, which can be supported by Green Bond investments in transmission infrastructure
- **Potential Issuer or Partner:** While NEA has not yet issued its own Green Bond, it could act as a direct issuer of Green Bonds for public infrastructure projects and partner with institutions like Nepal Infrastructure Bank Limited (NIFRA) or NMB Bank to channel Green Bond proceeds into NEA-led initiatives.

NEA's involvement is crucial for ensuring that Green Bonds in Nepal are effectively deployed, technically sound, and aligned with national energy and climate strategies.

Challenges and Opportunities of Green Bonds in Nepal

Nepal faces both challenges and opportunities in promoting green bonds, particularly considering its high climate vulnerability, vast hydropower potential, and evolving sustainable finance landscape.

Challenges

Limited Market Awareness: Many investors and institutions in Nepal are still unfamiliar with Green Bonds and their benefits, leading to low initial demand and cautious participation.

Project Pipeline Readiness: Identifying and preparing a robust pipeline of eligible green projects that meet international standards (e.g., ICMA GBP) remains a challenge for issuers.

Regulatory and Technical Capacity: While SEBON and NRB have made progress, Nepal's financial institutions need to build more capacity and enthusiasm to evaluate, monitor, and report on environmental impacts effectively.

Currency and Investment Risks: Attracting foreign investment in local currency bonds requires mechanisms to mitigate foreign exchange rate risks and ensure investor confidence.

Verification and Reporting Standards: Ensuring transparency through third-party verification and impact reporting is resource-intensive and requires specialized expertise.

Opportunities

Strong Institutional Support: Regulatory bodies like SEBON and NRB, along with international partners such as GGGI, KOICA, IFC, and BII, are actively supporting Green Bond development.

Successful Pilot Issuances: The issuance of Nepal's first public Green Bond by NIFRA and private Green Bond by NMB Bank in 2025 has set a precedent and built market confidence

Alignment with Climate Goals: Green Bonds help Nepal meet its Nationally Determined Contributions (NDCs) and SDG targets, especially in clean energy and climate resilience.

International Investment Attraction: The NMB Bank issuance attracted $60 million from IFC, BII, and MetLife, demonstrating Nepal's potential to mobilize global capital for green development

Public-Private Collaboration: Partnerships between government agencies, banks, and international organizations are creating a supportive ecosystem for scaling up Green Bond issuance.

Call to Action

To fully realize the potential of Green Bonds, coordinated action is needed from all stakeholders:

NEA (Nepal Electricity Authority) should actively explore Green Bond financing for hydropower, solar, and grid modernization projects.

Government agencies must continue strengthening regulatory frameworks and incentivizing green investments.

Investors, both domestic and international, are encouraged to support Nepal's green transition by investing in credible, impact-driven bonds.

Financial institutions and other issuers should build capacity for environmental and social risk management and green project evaluation.

Green Bonds offer more than just capital—they offer a vision: a Nepal powered by clean energy, protected from climate risks, and committed to sustainable development. With the right policies, partnerships, and public engagement, Nepal can become a regional leader in green finance, setting an example for other developing nations.

Conclusion

Green Bonds have emerged as a transformative financial tool that bridges the gap between economic development and environmental sustainability. In Nepal, their introduction marks a pivotal shift toward climate-resilient infrastructure, renewable energy expansion, and inclusive green growth.

By aligning with global standards such as the ICMA Green Bond Principles and national frameworks like the Nepal Green Finance Taxonomy 2024, Green Bonds ensure transparency, accountability, and measurable environmental impact. The successful issuances by NIFRA and NMB Bank in 2025 demonstrate Nepal's readiness to engage with international climate finance and deepen its domestic capital market.

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Private Sector in Nepal's Hydro Power System

Narendra Malla
Engineer

1. New Electricity Act-1992:

The new Electricity Act-1992 opened the door to the private sector for their business in the hydroelectric power generation system. It has ended the monopoly of NEA in the electricity generation sector. The hydropower developing company, domestic or foreign or join venture can get license for 30 years. It has to prepare feasibility report, Detail Project report & environmental related reports & get approval from the concerned authority prior to begin the construction. There are several agreements that the developer should do, out of which the PPA is the major one, which fixes the rates of energy. NEA is the sole buyer of the electricity from the private sector. The government has fixed the rates for RoR & PRoR plants for wet season & dry season. The price for PRoR varies with the hours of supply for peak hours.

2. Contributions of Pvt. Sector in Today's Nepal:

a) Contribution in Electricity Supply:

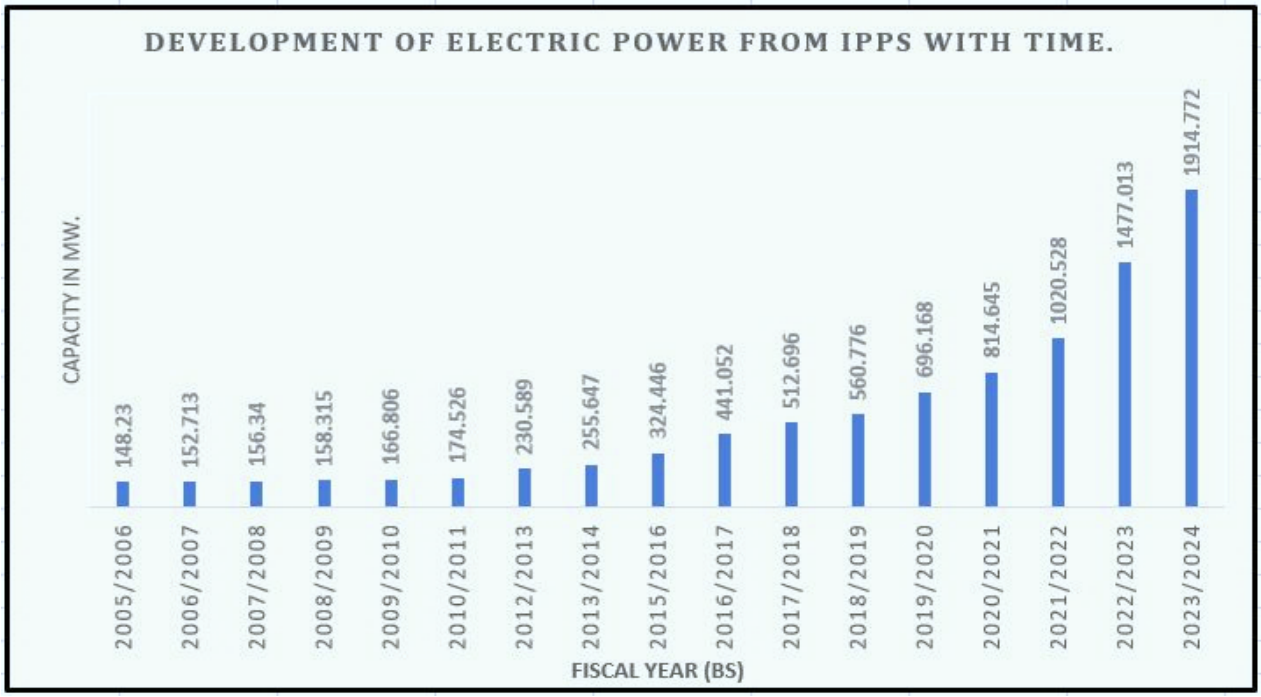

Fig.1: Power development from IPPs.

Many hydropower developing companies got licenses & engaged in generation business. With time, the generation had increased & the supply situation had improved a lot. The chart shows the development of electric power from 148 MW to 1914 MW from the private sector in the last 18 years.

b) Job Employments:

It has created thousands of new jobs for consulting, construction & others relating to hydropower projects every year. The young engineers got the opportunities to get experienced in hydropower related jobs. With short-term skill development training the jobless young people got employed & secured their future in hydropower construction works. The chart attached shows the no. of jobs created in IPPs projects for permanent & temporary positions. The chart shows the jobs created in the hydro power sector from the IPPs is about 2,35,900 in a year. **Fig. 2: Jobs in Hydro Power in IPPs.**

Fig.3: Investment from IPPs.

c) Investment Opportunities: Nepal has entered the era of electricity development with the participation of private sector, which has created the opportunities for the investment in hydro power sector. Khimti Power Plant, 60 MW cap. with Norwegian investment & Bhote Koshi Power Plant, 45 MW cap. with investment from the USA were regarded as the first hydropower projects built with foreign investments.

Since then, more than NRS. 1400 Billion has been invested in the hydropower sector from the Nepali Government side & the private sector together, out of which the private sector occupies more than 80 percent. The Fig. attached shows the investment from the IPPs amounts NRs. 13 Trillion in 319 projects, out of which some are already commissioning the power, some are under construction & the some are in preparatory stage.

d) Skilled Manpower: The development of a hydro power project needs many manpower belonging to the various disciplines from the begin of project planning to the plant operation. The young people employed in the project, get the opportunity to be familiar, learn & practice the various techniques particularly related to the construction works like the tunnelling under the supervision of the senior or the supervisor, that make them skilled. Similarly, for design people the project gives the opportunities to see & learn the site-specific conditions in project design. Only the practice makes a man perfect. It should be regarded as the big achievement that the projects in Nepal nowadays are executed independently from the expatriates & foreign civil contractors.

e) Confidence Building:

The hydropower projects, like other infra-structure development projects but due to the specific characteristics of the construction are more complicated, based on the specific conditions of the site & have to be involved the multi-contractors. The hydropower constructions have underground works like tunneling, underground powerhouse, which are associated with uncertainties due to mainly geological conditions & may need the change of construction methods in the middle of construction. The Nepali contractors are getting experienced with such challenges. This is an important development for doing still bigger projects.

f) Infra-structure Building:

The projects are mostly in the remote areas, which need to be connected to the nearest road head by building the roads in the very beginning to enable the contractor to bring the materials & machines to the site. Building access roads increases the road connectivity & helps to develop the local market for the agricultural products & similar other products.

g) Community Benefit Sharing:

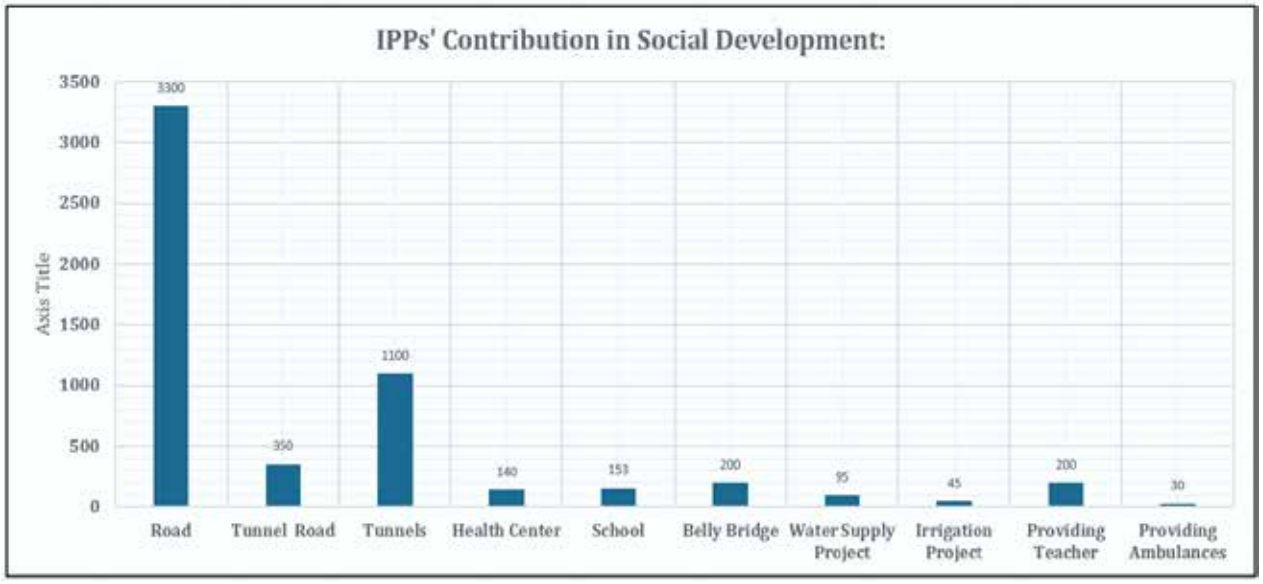

Fig. 4: IPPs contribution in Social Development.

With the construction of access roads in the project area the local people will be benefitted to bring their agricultural products to the market, to access the necessary service centers like hospitals, schools, administration offices etc. For the construction, many people from the various parts of the country come, live & work in the project area, which promotes the development of shops, guesthouses, restaurants & the market. Besides, the project conducts several short-term training programs for skill development to the young people to enable them employed in the project.

h) Revenue Increase:

Total contribution in the revenue collection from the energy sector in the economic production of the country is estimated at NRs.91.43 Billion in the FY 2080/2081. Based on the Electricity Act-

1992, the companies pay the royalty according to the installed capacity & annual energy generation. The following chart shows the growth of the royalty payment from the hydropower companies from NRs. 110 Crores to NRs.350 Crores in the last 10 years period.

1). Up to 15 years of commercial operation:
1.Annual capacity royalty: 1 Lakh NRs. /MW. *2. Energy Royalty: 2% Unit.*
2). After 15 years of commercial operation:
1.Annual capacity royalty: 10 Lakh NRs. /MW. *2. Energy Royalty: 10 % Unit.*

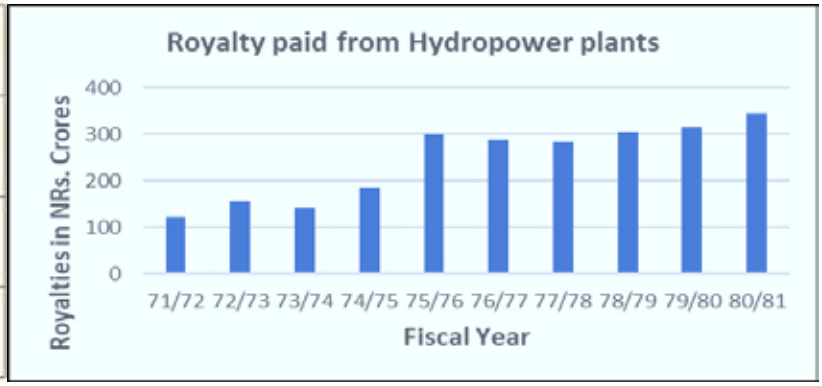

Fig. 5: Royalty from IPPs.

i) Economic Empowerment of people:

1) Sharing of Royalty: The royalty paid by the hydropower companies is distributed as follows:

- Federal Government:46 percent.
- Provincial Government:24 percent.
- Local Government:30 percent.

2) Equity Investment: According to Local Government Act the project affected local communities should be given 15 percent of the company equity share & public should get 10 percent.

3. Risks associated for the private sector:

a) Price Escalation:

The price escalation & the resulting cost increases in the major construction materials like cement & reinforcement steel create problems as the construction of the hydro power projects take relatively long time. Most of the hydro power projects are executed in **EPC-Model**, in which the Cost & time are already locked in the beginning & the payments are done as per the schedule.

b) NEA Payments:

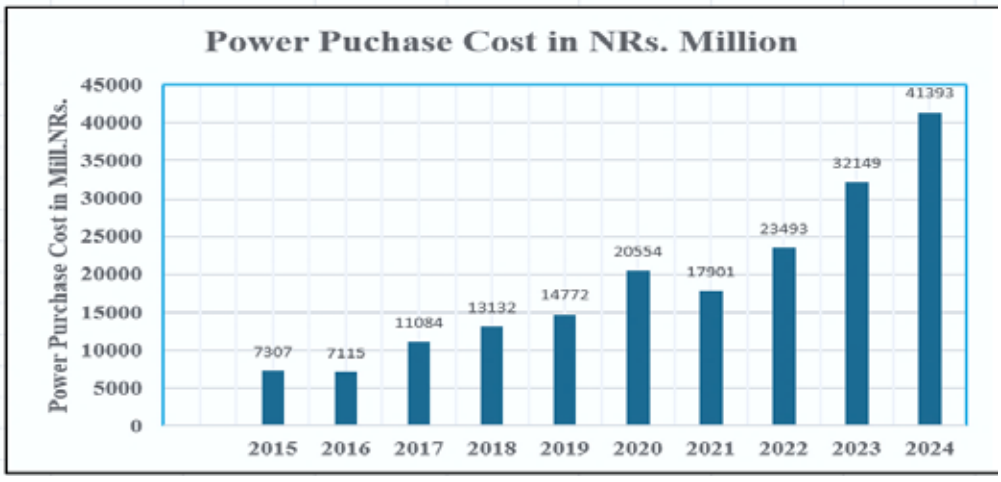

Fig.6: Power purchase from IPPs.

NEA is the only partner that buys the IPPs production at the rate fixed by the government, but the payments & PPA closure are fully dependent on the business of NEA. Any delay in NEA's payment may affect the schedule of debt & interest payment for IPPs.

c) US$ Exchange Rates:

The electrical installations & other electro-mechanical & hydro-mechanical installations for the project will come from the foreign countries, which needs the payment in US$. Any increase in exchange rates of US$ will cause additional financial burden for the project.

d) Design & Construction associated Risks:

The imperfection & inaccuracies in the design & construction of the hydropower project may affect the operation of the plant if they are not treated with proper methods. The project design & construction are very site specific in our Himalayan geology associated with many certainties.

e) Hydrology:

The flows in the rivers vary with the seasons. The hydro projects use the flows for generation of the power, for which the hydrological computations are done using the data from Hydrology & Metrological Dept. & data collected in the site over a certain period. It is very necessary to check the quality of data & methods before the flow for design purposes are recommended. It was noticed in the past that the powerhouse needed to shut down because of very low flow in the river, which is not enough to operate the plant.

f) Geology:

The natural hazards caused by the geological conditions like the landslides & the rock falls in the area where the project structures are located may cause problems in the plant operation. The best way is the identification of such hazards & simply to avoid by selecting the alternatives.

g) Flood Hazards:

Normally, the major & important structures of the hydro power plant are located near by the river, the safety of which depends on the flows. It is not to exclude that big floods may impact their stabilities or may cause hazards like slope failures, heavy scouring or overflooding the structures. It was observed in the past that floods of much higher magnitudes had occurred & damages were done in headworks area.

h) Earthquake Hazards:

Our Country, Nepal is prone to the earthquakes with higher magnitudes due to its geotechnical conditions. Earthquakes being beyond the earlier prediction or avoidance can be only considered in engineering & construction of the project. The earthquake hazards like rock falls need to be taken into consideration while planning & engineering the project.

i) Political Instability associated Risks:

Above all, the political stability is the main one that controls everything. Frequent changes in government team may develop the inconsistencies in policy & practices, which may not be favorable to IPPs. The political stability is the most important & necessary for long-term project with huge investments.

4. Enhancement of the Operational Environment:

(a) Financial Reforms:

- **Access to Low-Interest Financing**: The government should encourage concessional loans and establish a dedicated hydropower development fund to provide low-interest financing for IPPs.
- **Foreign Investment Incentives**: Policies should be streamlined to attract Foreign Direct Investment (FDI) in hydropower, including tax breaks and repatriation of profits.
- **Risk-Sharing Mechanisms**: Establish risk-sharing mechanisms such as guarantees or insurance to protect investors from uncertainties like policy changes or project delays.

(b) Regulatory and Policy Reforms:

- **Stable and Transparent Policies**: Ensure consistency in hydropower policies by minimizing frequent regulatory changes and offering long-term guarantees for investment security.
- **Simplified Licensing Process**: Create a single-window clearance system to expedite approvals for power projects.
- **Flexible Power Purchase Agreements**: Move towards market driven PPAs with competitive pricing and indexation to inflation for better investor confidence.
- **Tax Incentives and Duty Exemptions**: Reduce or exempt customs duties and VAT on hydropower-related imports and construction materials.

(c) Infrastructure Development:

- **Strengthening Transmission Infrastructure**: The government should prioritize the construction of high-capacity transmission lines to prevent energy spillage and improve nationwide distribution.
- **Regional Grid Connectivity**: Strengthen cross-border electricity trade with India and Bangladesh to create a larger market for Nepal's hydropower.
- **Public-Private Partnerships for Infrastructure**: Encourage PPP models for developing transmission networks and access roads to hydropower sites.

(d) Technical and Market Reforms:

- **Diversifying Power Generation**: Promote a mix of reservoir-based, run-of-river, and pumped storage hydropower projects to ensure year-round electricity supply.
- **Grid Modernization**: Implement smart grid technologies and battery storage systems to manage supply fluctuations and enhance reliability.
- **Encouraging Private Power Trading**: Allow private sector participation in electricity trading to create a competitive market beyond NEA's monopoly.
- **Regional Energy Cooperation**: Strengthen agreements with India and Bangladesh to facilitate bulk electricity exports and long-term power contracts.
- **Electricity Distribution:** The government should open door to the private sector in electricity distribution sector, so that a consumer has multiple choices of electricity connection & can have what it is preferred.

e) Social and Environmental Reforms:

- **Community Benefit Sharing**: Ensure local communities receive a share of project benefits, including employment opportunities and infrastructure development.
- **Sustainable Hydropower Practices**: Implement strict environmental standards to minimize ecological damage and ensure sustainable river management.
- **Resettlement and Compensation Policies**: Establish fair and transparent compensation mechanisms for affected communities to reduce conflicts.

5. Improvement in Government's Hydropower related Policies:

Nepal has huge hydropower potential over 83,000 MW but has only developed about 3,000 MW. While recent policies have encouraged private investment and cross-border electricity trade, several challenges still hinder rapid hydropower development. Here's how Nepal's hydropower policies can be improved:

SN	Subject	Issues	Suggest
1.	Strengthening Private Sector Participation.	1. Bureaucratic delays in licensing and approvals. 2. High upfront investment costs and lack of financing options. 3. Limited incentives for private developers.	1. Simplify approval processes by reducing bureaucratic red tape. 2. Establish a one-window clearance system for faster project approvals. 3. Offer tax incentives and subsidies for private hydropower projects. Encourage public-private partnerships (PPP) and joint ventures with international investors.
2.	Improving Power Transmission Infrastructure.	1. Nepal generates surplus electricity during the Monsoon but faces power shortages in winter due to lack of reservoir-based projects. 2. Weak transmission infrastructure causes power evacuation issues—many projects produce electricity that cannot be transported. 3. Limited cross-border transmission lines restrict exports.	1. Invest in high-voltage transmission lines to connect hydropower projects with demand centers. 2. Expand cross-border grid connections with India, China, and Bangladesh to enhance electricity trade. 3. Develop regional transmission hubs to integrate with the South Asian energy market.
3	Shifting Focus to Reservoir-Based Hydropower.	1. Nepal mostly develops run-of-river (RoR) hydropower, which depends on river flow and generates excess electricity in monsoon but fails to supply enough in dry seasons. 2. Lack of reservoir-based projects causes seasonal energy deficits.	1. Prioritize storage and reservoir-based hydropower to ensure year-round electricity supply. 2. Provide financial incentives for developers investing in storage projects. 3. Promote multi-purpose hydropower projects that support irrigation, flood control, and drinking water.

6. Gov.'s Plan to develop 28500-Megawatt Cap. Hydropower Plants

The Government of Nepal declared an ambitious plan to develop the hydropower to **28500 MW** to 2035 AD. According to the studies, the total domestic demand depending on the growth rate, may be as high as 13500 MW. It is assumed that the growth rate will not be less than 7.20 % in average. The power trade with our neighboring country India will grow 15000 MW.

The present infra-structures in the power transmission & distribution system will not be enough to deliver the high power to the consumption centers. Together with the construction of new hydropower projects, building new transmission lines, sub-stations, distribution lines & strengthening the existing structures will be needed to increase the capacity of the system. The preliminary estimate is that it will need about US$ 46.50 Billion for its execution, out which the amount US$ 40 Billion will be needed for power generation projects & US$ 5 Billion will be needed for building new transmission lines, sub-stations & distribution lines. The strengthening works of the existing transmission lines, sub-stations & distribution lines will be needed other US$ 1.5 Billion.

For the programs of social & community development in the project areas, the budget to be spent is equal to about 4 pc of the total project cost, which is equal to 1.86 Billion US Dollars approximately. Such a huge amount will be spent for building the infra-structures, road connectivity, buildings for schools, health posts, providing skill development trainings will contribute to change the economy & lifestyle of the people. Besides, it creates Thousands of new job opportunities for the young people, for which the people come from the various parts of the country. This will promote the small business-like shops, workshops, guesthouses, shops, restaurants, lodges & Hotels. It all will be very effective in improving the economy of the people.

The project provides the opportunity for equity investment in the company for the local communities & public. Royalty sharing to the units of local government will promote the activities like river training, flood protection, erosion control etc. This all will be very effective to bring big changes in the life of the people & conditions of the area.

The development of the projects involves huge construction activities, which need construction materials like cement & steel. It will boost up the industries producing those materials, transportation companies, project consulting services, workshops & business enterprises.

7. Conclusion:

a) **Commitment for timely completion of TRL Construction:** The government of Nepal must concentrate to execute the **Construction of Transmission Line Projects** as per schedule, for which the issues raised by the local people at various times should be addressed in time. It affects the mechanism the IPPs production to get connected with the grid after commissioning the power. It is the NEA's responsibility to construct the required transmission lines for the grid connections to the IPPs power plants.

b) **Frequent Changes in Policies**: The hydropower development is a long-term business with a huge investment in the very beginning. Frequent changes in policies & procedures may distract the

investors. A stable policy is needed, according to which the investors put the money in hydropower. With the frequent changes in the policies the investors will be discouraged.

c) **Multi-national investment friendly atmosphere:** It is obvious that only the internal investment is not sufficient to achieve the goals of making 28500 MW hydropower development, the multi-national investment is very required & will boost up the development. With the necessary amendment in the existing policies & the working procedures Government should make the environment very friendly for the multinational investment, which helps to bring the foreign companies in hydropower.

d) **Market extension**: The government should secure & extend the market for the growing electricity production. There are many projects under construction that are scheduled to commissioning in couple of years. For IPPs, NEA is the only buyer & had to depend on the NEA's business.

e) **More consumption of Electricity**: The exceptionally low value of per capita consumption of electricity should be increased by promoting more consumption with applying new tariff rates. This has become extremely important, as the production from the private sector will be increasing in the coming days with the completion of the projects, that are under construction.

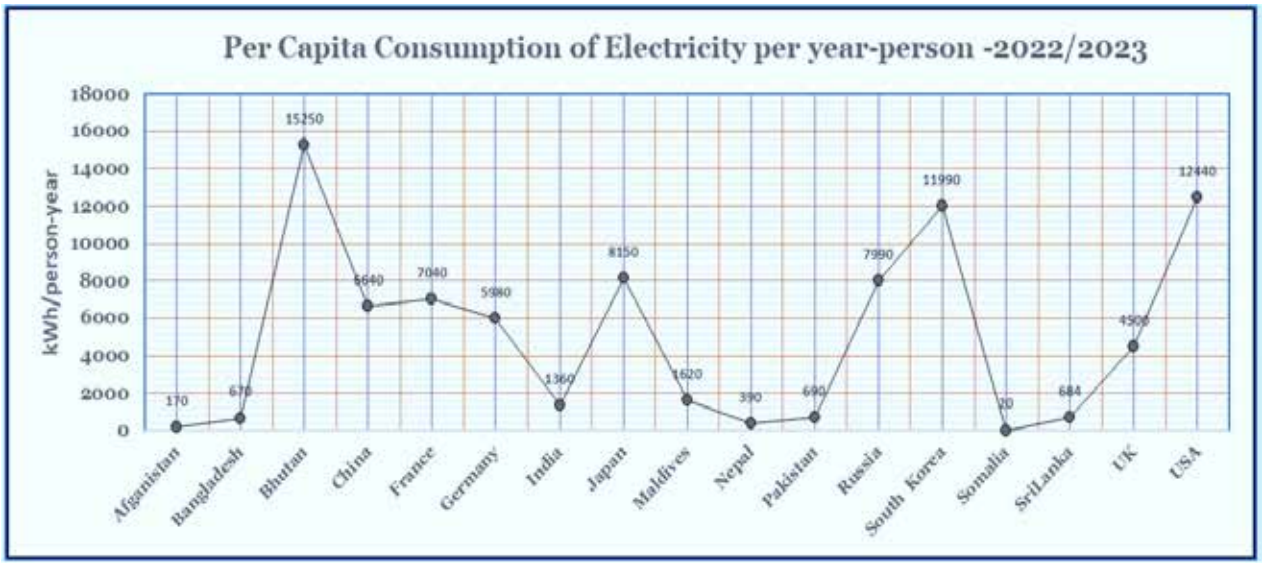

Fig.7: Per Capita Consumption of Electricity, Stand-2022/2023.

The government should be attentive to promote the electricity consumption in the country by adopting the various tariff rates depending on the time. People will be benefitted with reducing the tariff rates for the electricity uses in hospitals, water supply, lift irrigation & possibly industrial sectors during Monsoon time, when there is over production & needs to export to India. It will boost up the consumption in the country.

f) **Power Trade**: Despite the will to develop the X-border exchange of electric power with both the neighbors China & India, only the southern neighbor is privileged with the power trade due to its geographical position & is growing every year but with China it is still limited on the planning only. The required infra-structures are already built in both the

parts of India & Nepal at the required locations for X-border exchange of electricity.

The government of Nepal needs to focus on how to enable the X-border exchange of power with our northern neighbor China, which is extremely important to attract & promote their investment in the hydropower sector.

Fig.8: Import & Export of Electricity.

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Amicable Resolution of Constitution: Dispute in Nepal

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1. What is an amicable settlement?

An amicable settlement is a process where the parties to a dispute find ways to resolve their differences in a friendly and non-contentious way. To achieve an amicable settlement, the parties need to be willing to make concessions for the sake of reaching an agreement. Without the desire to make an effort to settle a legal case, it will be nearly impossible to achieve an amicable settlement. When parties reach an amicable settlement, they will either do it based on their desire to resolve their dispute or will use the services of a mediator or a lawyer to support them in the process. The Parties shall use their best efforts to settle amicably any dispute, controversy or claim arising out of, or relating to this Purchase Order or the breach, termination or invalidity thereof.

In one of the procedures of amicable settlement of construction disputes an independent third party (as a neutral person), in strict confidentiality, conducts a process to facilitate the parties in settling an existing dispute. The role of the independent third party is to remain independent, to stay at “arms-length”, and not to attempt to achieve the best outcome for the one party over the other. Amicable settlement is also a consensual process and there must be a willingness and a mandate by the participants to arrive at an amicable settlement outcome. The parties remain free to withdraw from the amicable settlement procedure at any time and to revert to adjudication, arbitration or litigation, depending on the specific provisions of the construction contract. (Saice, 2021)

2. Methodological setup for amicable settlement in large construction projects in Nepal

In the large construction projects of Nepal, which use FIDIC documents as their contract administrative guide, the Claim process is carried out following Clause 20 (Fidic 99) or Clause 20 & 21 (Fidic 2017). The claim process commences with clauses 20.1,20.2,20.3 and 20.4 of Fidic 1999 before the formal Amicable settlement process mentioned in clause 20.5. A similar approach has been prescribed for Fidic 2017 suites and is discussed in the following paragraphs.

During the period specified in the Contract after notice of dissatisfaction with the DAB decision, amicable settlement procedures have been outlined and practised. However, DAB members do not become involved in the amicable settlement process. There is no fixed procedure prescribed by FIDIC for an amicable settlement, however, a neutral facilitator who independent third party generally assists in the amicable settlement process. Other modes of Alternate Dispute resolution like Conciliation, mediation, and direct negotiation without a facilitator may be the choice. A formal amicable settlement board is not appropriate as it is similar to DAB. The list of possible amicable settlement facilitators could be reached from boards like NEPCA or FIDIC. If the amicable settlement procedure is not successful the case goes to arbitration as stipulated in Clause 20.5 (amicable settlement of Fidic 1999)

However, in Fidic 2017 suites, after the notice of dissatisfaction (NOD) on a Decision is given, a 28-day cooling-off period is mandatory before referring the Dispute to Arbitration, during which the parties shall attempt to settle the differences amicably (Sub-Clause 21.5). However, FIDIC 2017 has been more proactive for Dispute avoidance as DAB has changed to DAAB (Dispute Avoidance and Adjudication Board), which can assist the contracting parties in Dispute avoidance from the beginning, the procedures mentioned in SC 21.3 (Avoidance of Disputes)

3. Public Procurement Regulation (PPR, 2064) approach for amicable settlement

PPR, 2064 has set the procedure for dispute resolution in rule 129 and rule 135. Although there is no provision of Adjudication in the dispute resolution process, and amicable settlement procedures as specified in FIDIC suites of contract before formal arbitration hearings. However, PPR 2064 has tried to solve the disputes earlier to adjudication and arbitration proceedings.

According to rule 129 (Dispute resolution) of PPR 2064 : (1) The procurement contract shall set forth, inter alia, the matters of dispute to be resolved through mutual consent, process for making application for the settlement of a dispute, meeting to be held for mutual consent and process of making decisions, and such a dispute shall be settled accordingly.

Additionally, according to rule 135 (Resolution of the dispute by arbitration): If any dispute that has arisen between the public entity and the construction entrepreneur, consultant or service provider concerning the implementation of the procurement contract cannot be resolved through the process referred to in Rule 129, action shall be initiated for the resolution of such a dispute by arbitration following the prevailing law. (www.ppmo.gov.np)

4. Introduction to FIDIC Contract Suites & Amicable Settlement Provisions

The FIDIC suite of construction contracts is written and published by the International Federation of Consulting Engineers. The FIDIC acronym stands for the French version of the Federation's name (Federation Internationale des Ingenieurs-Conseil). The best known of the FIDIC contracts are the Red Book (building and engineering works designed by the Employer) and the Yellow Book (M&E, building and engineering works designed by the Contractor). The original edition of the Red Book dates back to 1957. In recent years FIDIC has published many new contracts to complement the suite. The first of the new contracts was the Orange Book for design, build and turnkey works published in 1995. In 1999 FIDIC published a revised suite of contracts with updated versions of the Red and Yellow books together with a Green Book as the short form of contract and a Silver Book for turnkey contracts. (www.fidic.org)

In December 2017 FIDIC released its second edition of the Conditions of Contracts for Plant and Design Build ("the 2017 Yellow Book"), the Conditions of Contract for Construction (the "2017 Red Book") and the Conditions of Contract for EPC/Turnkey (the "Silver Book"), together the "2017 Contracts". As expected, FIDIC has made substantial amendments to the dispute resolution provisions from the 1999 Red, Yellow, and Silver Books (together with the "1999 Contracts"), and it has addressed the provisions relating to the "binding but not-final" Dispute Adjudication Board ("DAB") decisions which have been the cause of persistent dispute since the 1999 Contracts were released. (https://www.fenwickelliott.com/)

i. Amicable settlement in FIDIC 1999

Amicable settlement is a **non-adversarial approach to dispute resolution**. In FIDIC 1999, once a notice of dissatisfaction has been given under Sub-clause 20.4, both parties shall attempt to settle the dispute amicably before the commencement of arbitration. Sub-Clause 20.5 requires an attempt at an amicable settlement, not less than 56 days after the date of the notice of dissatisfaction.

ii. Amicable settlement in FIDIC 2017

According to Fidic 2017 (Red, Yellow and Silver book), the mandatory amicable settlement period has been reduced from 56 days to 28 days under the 2017 Contracts. Furthermore, where either party fails to comply with a DAB decision, that failure may be referred directly to arbitration and the amicable settlement period will not apply. This clarifies that the parties' obligation to "promptly" comply with a DAB decision means in less than 28 days. (https://www.fenwickelliott.com/)

iii. Cases of Amicable settlement in Nepal using CIAA rules

In Nepal, the Supreme Court has underscored in landmark rulings *(e.g. Devendra Pradhan on behalf of Hanil Engineering & Construction Co. v. Appellate Court, Patan decided in 2075 BS)* that:

Where a dispute resolution clause requires an attempt at amicable settlement, this step is contractually binding. Proceeding directly to arbitration without engaging in the settlement stage can render the process contrary to the contract's intent and potentially invalidate the award, Pioneer Law.

Therefore, parties using CIAA rules within contracts must be aware that an omission to negotiate could lead to constitutional or enforceability challenges in Nepali courts if the contract prescribes such a step.

5. Merits of Amicable Settlement Process

Amicable settlement is part of the interest-based approach to the process of resolving the dispute. The interests of the parties are addressed in such a manner that they have a better understanding of their rights and obligations regarding the dispute so that they can explore many different potential solutions, and understand each other's perspective towards a win-win solution. The Parties could then take the necessary decisions and actions in their best interest (as well as for the project) so that the construction works could proceed without unnecessary costs and delays, including alterations to the works, an extension of time for completion, mitigating measures regarding the works, suspension or cancellation of the works, if necessary. It could also act as a filter to prevent a dispute from escalating further to the more comprehensive procedures. The outcome is usually determined with the Amicable Settlement Facilitator's knowledge and experience in a relatively cheap, fast and robust manner over a short period, and addresses two critical issues:

I. Whether monetary relief is due to the contractor if he is entitled to that (as positive cash flow is the lifeblood of the construction industry); and

II. It allows the parties to take mitigating measures if conditions, circumstances and situations are experienced which are not favourable to the project and their interest. (Saice,2021)

6. Ethical concerns of amicable settlement

The proceedings in Amicable Settlement are confidential with the facilitator (independent third party) unless otherwise required by law. The respective parties may in private sessions with the Amicable Settlement Facilitator disclose information to the Amicable Settlement Facilitator that must remain confidential. The disclosure of such information to the Amicable Settlement Facilitator may be to justify a party's bargaining position or to request the Amicable Settlement Facilitator to raise certain questions to the other party. To achieve common ground, the parties must

be free to make admissions and concessions which, if the amicable settlement fails, will not be used against them to their prejudice in the subsequent adjudication, arbitration or litigation proceedings.

7. Cost of Amicable settlement in FIDIC Contract suite

In the context of **FIDIC contracts**, the independent third party typically involved in an **amicable settlement** phase is either:

- A **Dispute Adjudication/Avoidance Board (DAB or DAAB)**, or
- A **mediator/arbitrator** is involved after DAB decisions are rendered but before formal arbitration.

FIDIC contracts (like Red, Yellow, or Silver Book) often require parties to attempt **amicable settlement** before proceeding to arbitration (see Clause 20.5 in FIDIC 1999 & Sub-Clause 21.5 in newer editions of FIDIC).

The typical cost varies according to project size and complexity, Project location, Number of Parties involved in dispute resolution. If there is already involvement of the DAB panel, and their further involvement in Dispute avoidance further reduces the cost of the amicable settlement procedure. The flat fee for amicable settlement (although it depends upon case to case) is generally $10,000 to $ 50,000 for large infrastructure contracts.

Nonetheless, under FIDIC, costs for amicable settlement efforts (including mediators or DAAB members) are typically **shared equally between the parties**, unless otherwise agreed.

8. Emergence of new contracting approaches for dispute resolution

The Harmonised FIDIC Book (MDB version) is widely used in donor-funded projects like Tanahu Hydropower (THL). THL has used the Harmonised FIDIC Book of Red & Yellow for Multi Donor requirements (eg ADB in case of Tanahun Hydro). It provides a balanced, MDB-compliant framework. Amicable settlement and DAB mechanisms are preferred tools to resolve disputes before escalating to arbitration. More projects now adopt FIDIC 2017 Editions, and other speciality books (e.g. FIDIC Emerald 2019) are in the market, which are to be used based on the project's nature.

9. Conclusion

Construction disputes are inevitable in large construction projects in Nepal. Thus, the proper procedural approach to minimise or resolve the construction claims is essential. As mandated by both the FIDIC suites of contract and the Public Procurement Monitoring Office of Nepal, it is recommended to apply amicable settlement or mutual consent procedures. Even the Dispute boards or neutral facilitators shall be extensively used to resolve the disputes (as prescribed in FIDIC suite 2017 (SC21.3 (avoidance of disputes)) so that the construction activities go smoothly with proper handling of construction claims and disputes. Overall, it will assist proactively in completing any engineering project within Time, Cost and desired quality.

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Condition Monitoring of Nepalese Hydropower Plant

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Abstract

Hydropower constitutes over 90% of Nepal's electricity generation, serving as the cornerstone of the nation's energy infrastructure. However, maintaining reliable and efficient hydropower operations faces mounting challenges from aging equipment, constrained maintenance capabilities, and extreme environmental factors. Condition Monitoring (CM) offers a proactive, data-driven approach to equipment management, reducing unplanned outages and extending asset lifespan. This paper examines the critical need for CM implementation in Nepal's hydropower sector, analyzing technical requirements, institutional frameworks, and policy recommendations to facilitate adoption. The study highlights how CM can enhance operational reliability as Nepal expands its power generation capacity and regional energy exports.

Keywords: Hydropower, Condition Monitoring, Predictive Maintenance, Nepal Energy Sector, Equipment Reliability

1 Introduction

1.1 Background

Nepal has a vast hydropower potential, with a theoretical capacity exceeding 83,000 MW, making it one of the highest untapped countries globally. The country's topography, steep gradients, and high rainfall make it ideal for hydropower generation. Major river basins like Koshi, Gandaki, and Karnali offer numerous sites for run-of-river and reservoir-based hydropower projects. However, only 3% of this potential has been utilized, with around 2,500 MW of installed capacity. This underdevelopment is due to infrastructural limitations and operational inefficiencies in existing plants. Infrastructural challenges include inadequate transmission networks, limited access to remote project sites, and logistical constraints due to mountainous terrain. Financing remains a bottleneck, as large-scale hydropower projects require significant capital investment and often face political and environmental scrutiny. Many hydropower plants in Nepal are aging, relying on reactive maintenance rather than preventive strategies, leading to frequent forced outages and reduced availability. Systemic inefficiencies reduce energy output and increase O&M costs, discouraging sector investment.

1.2 Current Challenges

Most Nepalese hydropower facilities face the following challenges:

1. **Aging Infrastructure**

   A significant portion of Nepal's hydropower plants were commissioned

over two decades ago, with many facilities surpassing 20 years in service life. Over time, mechanical components such as turbines runner bearings and water submerged turbine parts undergo wear and tear, while electrical components like generators, control systems, and insulation materials degrade. The lack of periodic refurbishment exacerbates deterioration. Older systems often lack the digital instrumentation required for modern condition monitoring, making it difficult to assess real-time performance and predict failures. This aging infrastructure is especially vulnerable in remote areas where maintenance access is limited and replacement parts are scarce or outdated.

2. **Reactive Maintenance Practices**

In many plants, maintenance is still largely reactive—that is, repairs are carried out only after a failure has occurred (Also known as Breakdown maintenance) This approach leads to unplanned outages, higher repair costs, and reduced equipment lifespan. Preventive and predictive maintenance strategies, which are standard in advanced hydropower systems globally, remain underutilized due to limited technical capacity and financial constraints. The absence of systematic data collection further weakens the ability to anticipate component wear, schedule timely interventions, or conduct root-cause failure analysis.

3. **High Forced Outage Rates (Averaging 15–20%)**

Forced outages, or unexpected shutdowns due to equipment failure or safety concerns, are prevalent in Nepalese hydropower stations. According to NEA reports and IPP logs, forced outage rates typically range between 15% and 20% annually, which is significantly higher than global best practices (often below 5%). These outages not only disrupt power supply but also lead to financial losses, reduced water-use efficiency, and increased wear on remaining operational units. Factors contributing to forced outages include turbine cavitation, generator overheating, relay malfunctions, and debris damage from unfiltered water inlets.

4. **Environmental Stresses**

Nepal's unique geography and environment introduce additional operational challenges. Rivers feeding hydropower plants often carry high sediment loads, especially during the monsoon season. Abrasive sediments cause rapid erosion of turbine blades and wear on control gates and penstocks, reducing efficiency and necessitating frequent repairs. Additionally, Nepal lies in a seismically active zone; earthquakes can damage civil structures, misalign rotating equipment, and impair instrumentation. Seasonal flooding, landslides, and glacial lake outburst floods (GLOFs) further threaten plant infrastructure, particularly intake weirs and transmission lines. Without robust monitoring systems, these environmental stresses can severely impact plant reliability and safety.

1.2 The Case for Condition Monitoring

Globally, Condition Monitoring (CM) has proven effective in achieving several benefits:

Condition Monitoring has been widely adopted across the global hydropower industry as a strategic tool for enhancing operational efficiency, minimizing risks, and improving asset management. When implemented effectively, CM systems enable plant operators to continuously track the health and performance of critical components such as turbines, generators, transformers, and bearings. This real-time insight allows for early detection of anomalies—such as excessive vibration, temperature spikes, oil contamination, and electrical insulation breakdown—well before they escalate into critical failures.

Studies from established hydropower markets in Europe, North America, and parts of Asia have demonstrated that CM can yield substantial operational benefits:

- Reducing Maintenance Costs by 25–30%: By shifting from time-based to condition-based maintenance, utilities avoid unnecessary inspections and component replacements. Maintenance is per- formed only when data indicates an emerging issue, optimizing labor and material use.
- Decreasing Unplanned Outages by 40–50%: Continuous monitoring helps detect faults at an incipient stage, allowing timely intervention before failure. This significantly lowers the frequency and duration of unplanned shutdowns, which are often costlier than scheduled downtimes.
- Extending Equipment Life by 3–5 Years: Operating machinery under optimal conditions, combined with early interventions, reduces cumulative stress on equipment. As a result, the service life of components is prolonged, deferring the need for costly replacements and improving return on investment.

These outcomes are not only desirable but essential for developing economies where investment capital is limited, and operational reliability is critical.

Despite these benefits, CM adoption in Nepal remains limited due to technical, financial, and institutional barriers.

In Nepal, the adoption of Condition Monitoring remains sparse and fragmented. Several hydropower plants—particularly those operated by Independent Power Producers (IPPs) and smaller facilities—continue to rely on traditional maintenance approaches. The barriers are multi-faceted:

- **Technical Barriers:** Many older plants were not designed with CM infrastructure in mind, making retrofitting difficult. In addition, there is a shortage of specialized personnel trained in data interpretation, vibration diagnostics, and CM system integration.
- **Financial Constraints:** The upfront cost of implementing CM systems, including sensors, data acquisition systems, software, and training, can be prohibitive—especially for smaller plants or those operating on tight margins.
- **Institutional Challenges:** There is currently no nationwide regulatory framework or policy mandating or incentivizing CM practices. Furthermore, coordination among the Nepal Electricity Authority (NEA), IPPs, and regulatory agencies remains

limited, resulting in inconsistent practices across the sector.

As a result, while the benefits of CM are well recognized globally, Nepal's hydropower sector has yet to fully capitalize on its potential. Addressing these barriers through policy reform, capacity building, and public-private collaboration is essential to unlocking the full value of condition monitoring in the country.

2 Critical Hydropower Components and Failure Modes

2.1 Turbines

Turbines are the heart of hydropower plants, and their operational health directly affects overall plant performance and energy output. These rotating components convert the kinetic and potential energy of flowing water into mechanical energy, which is then transformed into electricity by the generator. Because of their central role, even minor turbine issues can lead to efficiency losses, increased wear on associated systems, or unplanned outages.

Common failure modes in turbines, along with appropriate condition monitoring (CM) techniques, include:

- **Cavitation:** This occurs when localized low-pressure zones within the turbine cause water to vaporize, forming bubbles that collapse violently upon entering higher pressure regions. This phenomenon results in pitting, vibration, and long-term damage to runner blades. It is effectively monitored using vibration analysis and acoustic emission sensors, which can detect early-stage bubble formation and structural stress.
- **Sediment Erosion:** Himalayan Rivers, which feed most of Nepal's hydropower plants, carry high sediment loads, especially during the monsoon season. These abrasive particles wear down turbine surfaces, reducing efficiency and increasing maintenance frequency. Thickness gauging and efficiency tracking are employed to measure material loss and identify performance degradation over time.
- **Runner Imbalance:** Over time, uneven wear, sediment accumulation, or manufacturing defects can lead to mass imbalance in the runner. This causes unsteady rotation, elevated vibration, and stress on bearings and shafts. Vibration spectrum analysis is used to detect imbalances by analyzing frequency signatures indicative of rotor instability.

2.2 Generators

Generators in hydropower plants are critical components that convert mechanical energy from the turbine into electrical energy. They operate under continuous electrical and mechanical stress, often in harsh environmental conditions, making them susceptible to various modes of failure. Ensuring the reliability of generators is essential for maintaining uninterrupted power generation and preventing costly downtimes. Condition monitoring (CM) provides early detection of anomalies, allowing for predictive maintenance and optimized performance.

Common generator issues and associated CM techniques include:

- **Stator Winding Faults:** These faults typically occur due to insulation breakdown, thermal aging, moisture ingress, or electrical surges. They

can lead to short circuits or grounding faults, posing serious risks to generator integrity. Partial discharge (PD) monitoring is a proven method for detecting early insulation failures. PD sensors measure minute electrical discharges within the stator windings, allowing for timely intervention before catastrophic damage occurs.

- **Rotor Eccentricity:** Rotor misalignment or mechanical deformation can lead to uneven air gaps between the rotor and stator, causing magnetic imbalances, vibrations, and efficiency losses. Prolonged eccentricity can result in severe rotor-stator rubs. Air gap monitoring systems continuously measure the uniformity of the air gap, providing insight into mechanical alignment and rotor stability.
- **Bearing Degradation:** Bearings support the rotating shaft and are essential for smooth operation. Over time, they can degrade due to poor lubrication, contamination, or fatigue, leading to increased friction, vibration, and eventual failure. Temperature sensors and vibration trend analysis tools are used to monitor bearing health. Gradual changes in temperature profiles and vibration patterns can signal early wear, allowing operators to schedule timely replacements and prevent secondary damage.

2.3 Auxiliary Systems

Auxiliary systems play a vital role in ensuring the smooth, efficient, and safe operation of the main hydropower plant components—namely turbines and generators. Although often less prominent than the primary equipment, these systems are essential for maintaining operational stability and preventing mechanical and thermal stress. Effective condition monitoring (CM) of auxiliary systems can significantly enhance overall plant reliability, reduce wear on core machinery, and improve response to load variations.

Key auxiliary components and associated CM parameters include:

- **Cooling Systems:** These systems are responsible for dissipating the heat generated by both mechanical and electrical components, particularly generator windings and bearings. A malfunction in the cooling system can lead to overheating, insulation failure, or thermal deformation. CM techniques include monitoring flow rates to detect blockages or pump issues and measuring temperature differentials across cooling circuits to ensure heat is being adequately transferred and removed.
- **Lubrication Systems:** Proper lubrication minimizes friction and wear in bearings, shafts, and other moving parts. Degraded or contaminated oil can cause premature equipment failure. Condition monitoring involves oil quality analysis to detect oxidation, moisture content, and additive depletion, along with particulate content checks to identify metallic or abrasive particles indicating wear. Online oil sensors and periodic lab analyses are commonly used for this purpose.
- **Governor Systems:** The governor regulates turbine speed and output by adjusting water flow, ensuring that generation remains synchronized with grid demand. Faults in the governor system can lead to slow response times, frequency instability, or even

unit trips. CM techniques involve monitoring response time to load changes and analyzing hydraulic pressure fluctuations within the governor mechanism to detect valve sticking, actuator faults, or control loop anomalies.

3 Technical Implementation Framework

3.1 Sensor Deployment Strategy

A structured and well-planned deployment of sensors is fundamental to establishing an effective condition monitoring (CM) framework in hydropower plants. Accurate and timely data acquisition from both mechanical and electrical systems is essential for detecting early signs of equipment deterioration, diagnosing potential faults, and enabling predictive maintenance strategies. The selection and placement of sensors must be based on a clear understanding of the operational behavior and failure modes of individual components.

Mechanical Systems:

- **Accelerometers:** These sensors are typically mounted on bearing housings and other rotating elements to measure vibration levels and frequency spectra. Abnormal vibrations often indicate issues such as misalignment, imbalance, looseness, or bearing degradation. High-sensitivity accelerometers enable early detection of mechanical faults, thereby reducing the risk of catastrophic failure.
- **Proximity Probes:** Installed along shaft lines, proximity probes measure shaft displacement and detect phenomena like shaft whip, run-out, or misalignment. These measurements are particularly important for assessing the health of rotating assemblies and ensuring that dynamic behavior stays within safe operational limits.
- **Strain Gauges:** These are affixed to structural components such as turbine housings, support frames, or draft tubes to measure stress and deformation under load. Strain data is crucial for identifying fatigue-prone areas and for validating structural integrity during high-load or transient conditions.

Electrical Systems:

- **Temperature Sensors:** Placed on stator windings, generator bushings, and transformer cores, these sensors help monitor thermal behavior under varying electrical loads. Overheating is a leading cause of insulation failure and electrical breakdown, so real-time temperature monitoring is vital for preventive maintenance.
- **Partial Discharge Sensors:** These sensors detect minute electrical discharges caused by insulation degradation within generators, transformers, or switchgear. They are key tools for assessing incipient faults in high-voltage components, providing an early warning well before visible damage occurs.
- **Power Quality Analyzers:** These devices monitor voltage and current harmonics, transients, and imbalances that may arise from grid disturbances or equipment anomalies. Poor power quality can accelerate wear on electrical equipment and affect synchronization, especially in grid-connected hydropower plants.

3.2 Data Infrastructure

A robust and scalable data infrastructure is critical to the success of a condition monitoring (CM) system in hydropower plants. CM relies on the continuous collection, transmission, storage, and analysis of high-resolution data from a wide array of sensors deployed throughout the plant. Without a reliable data backbone, even the most advanced monitoring tools cannot deliver actionable insights. Therefore, technical specifications must be aligned with the operational demands of hydropower assets, particularly in geographically challenging regions like Nepal.

Key components of a CM data infrastructure include:

- **Sampling Rate:** For accurate vibration diagnostics and fault detection in high-speed rotating machinery such as turbines and generators, sensor data must be sampled at high frequencies. A minimum sampling rate of 10 kHz is recommended to capture critical frequency components, transient events, and subtle anomalies that lower sampling rates might miss. This ensures that early warning signs—like bearing fault harmonics or cavitation signatures—are properly detected and interpreted.
- **Data Storage:** Given the volume and velocity of sensor data, storage solutions must be both high-capacity and long-term. Cloud-based storage systems offer scalability, centralized access, and integration with machine learning analytics platforms. To support trend analysis, forensic diagnostics, and compliance auditing, a minimum retention period of five years is advisable. This allows operators to track long-term performance degradation and correlate historical data with major events or maintenance records.
- **Communication:** Effective data transmission from sensors to processing units is essential, especially in real-time or near-real-time applications. Fiber-optic communication is preferred due to its high bandwidth, low latency, and resistance to electromagnetic interference. However, given the remote locations of many hydropower plants in Nepal, a satellite communication backup is recommended to ensure uninterrupted data flow in areas where terrestrial infrastructure is limited or vulnerable to natural disruptions such as landslides or floods.

3.3 Analytics Architecture

The analytics layer is the core intelligence of a condition monitoring (CM) system, transforming raw sensor data into actionable insights. It serves as the interface between data acquisition and operational decision-making, and its effectiveness determines the success of predictive maintenance strategies. To manage the complexity and scale of hydropower operations, a hybrid approach using both edge and cloud computing technologies is recommended.

- **Edge Computing:** This involves processing data locally at or near the point of collection—such as within the power plant control room or embedded processing units in field devices. Edge analytics enable real-time anomaly detection, low-latency alerts, and reduced bandwidth requirements for remote sites. This is particularly valuable for critical systems like turbines and generators, where immediate

responses to vibration or temperature spikes can prevent damage.

- **Cloud Computing:** Cloud platforms provide the scalability and computing power necessary for long-term data storage, model training, and complex analytics. In the cloud, large volumes of historical and live data can be processed using machine learning algorithms and rule-based engines to detect patterns, predict failures, and classify faults across multiple plants. These models continuously improve through data feedback loops, enhancing diagnostic accuracy over time.
- **Predictive Algorithms:** Advanced analytics use techniques such as anomaly detection, time- series forecasting, and supervised learning to identify deviations from normal operating behavior. These models can trigger maintenance planning alerts, prioritize tasks based on risk, and support inventory and workforce optimization.
- **Integration with SCADA Systems:** Seamless integration with existing Supervisory Control and Data Acquisition (SCADA) systems ensures that condition monitoring outputs are accessible to operators in real-time. This enables automated alerts, dashboards for visualizing equipment health, and linkage to historical operational data for deeper analysis. SCADA-CM integration is critical for enabling informed operational decisions and closing the loop between monitoring and maintenance action.

Together, this multi-layered analytics architecture enables a shift from reactive to predictive asset management, increasing equipment reliability and reducing lifecycle costs.

4 Institutional Roadmap for Nepal

4.1 Policy Recommendations

To facilitate the widespread adoption of condition monitoring (CM) in Nepal's hydropower sector, a comprehensive set of policy actions is essential. These actions should address regulatory frameworks, financial incentives, and capacity-building initiatives to create a supportive ecosystem for CM deployment and ensure its sustainability in the long run.

Regulatory Mandates:

- **Require CM Implementation for All Hydropower Plants Exceeding 5 MW Capacity:** To standardize the adoption of CM across the sector, it is recommended that hydropower plants with a capacity greater than 5 MW be mandated to implement CM systems. This threshold targets both small and medium-sized plants that may otherwise overlook CM due to cost concerns, while still offering the potential for significant improvements in efficiency and reliability. Mandating CM at this scale will ensure that the majority of operational plants contribute to reducing forced outages and enhancing the stability of the national grid.
- **Conduct Annual CM Compliance Audits:** To ensure that CM systems are being used effectively and consistently, the Nepal Electricity Authority (NEA) should implement annual compliance audits for all plants required to adopt CM. These audits would assess the quality and functionality of monitoring

systems, data integrity, and maintenance practices. By holding operators accountable and establishing performance benchmarks, compliance audits would drive continuous improvement in plant operations and ensure that the system delivers its intended benefits in terms of reliability and cost-effectiveness.

Financial Mechanisms:

- **Provide Tax Credits for CM-Related Investments:** The initial costs associated with installing CM systems—such as purchasing sensors, setting up data infrastructure, and integrating analytics tools—can be prohibitive for many plant operators. To reduce this financial barrier, the government could introduce tax credits or rebates for CM-related investments. These incentives would make the transition to CM more attractive, especially for smaller operators who might hesitate due to upfront costs. A tax credit program could reduce the financial burden and encourage wider adoption of modern monitoring practices.
- **Offer Low-Interest Financing Options for CM Equipment Procurement:** In addition to tax credits, low-interest financing options should be provided specifically for CM equipment procurement. This would enable hydropower companies to spread the cost of these investments over time without incurring high borrowing costs. Financial support could be provided through partnerships between the government, development banks, and private financial institutions, ensuring that access to affordable capital is available for operators in remote or underdeveloped regions.

Capacity Building:

- **Establish Certification Programs for CM at Institutions like CTEVT:** To ensure that Nepal has a skilled workforce capable of managing and maintaining advanced CM systems, certification programs focused on CM should be introduced at vocational and technical institutions such as the Council for Technical Education and Vocational Training (CTEVT). These programs would provide technical training on sensor installation, data analysis, predictive maintenance practices, and troubleshooting. By developing local expertise, Nepal can create a self-sustaining ecosystem that reduces dependency on foreign consultants and improves long-term operational knowledge.
- **Initiate Technician Exchange Programs through the NEA for Hands-on Training:** Practical, hands-on experience is critical for technicians to fully grasp the intricacies of CM systems. The Nepal Electricity Authority (NEA) could spearhead technician exchange programs that allow local personnel to receive on-the-job training at hydropower plants with advanced CM systems in operation. These exchange programs could involve partnerships with international hydropower operators or private firms, offering exposure to best practices, cutting-edge technology, and troubleshooting techniques. By building practical knowledge and expertise, Nepal can ensure that CM systems are effectively utilized and maintained.

4.1 Implementation Phases

A phased implementation strategy for the adoption of condition monitoring (CM) in

Nepal's hydropower sector ensures that the deployment of new technologies is both scalable and manageable. This approach allows for lessons to be learned in each phase, with adjustments made to overcome challenges as the program progresses. The phased strategy is designed to gradually integrate CM systems into the national hydropower network, starting with pilot projects and moving toward full sector-wide implementation.

Phase 1: Pilot (2024–2025)

- **Launch 3–5 Demonstration Projects in Diverse Geographic and Operational Settings:** The first phase of implementation focuses on pilot projects to showcase the benefits and feasibility of CM in various operational contexts. These demonstration projects will be strategically selected to represent a range of geographical, environmental, and operational challenges faced by hydropower plants in Nepal. The aim is to identify site-specific issues—such as sediment erosion in Himalayan plants or extreme weather conditions in the Mid-Hills—and tailor CM solutions accordingly. By running these pilots, the government and stakeholders can gain valuable insights into the technical, financial, and operational aspects of CM deployment, allowing for refinements before broader roll-out. Furthermore, these demonstration projects will serve as educational tools for industry players, providing tangible evidence of CM's effectiveness.

Phase 2: Expansion (2026–2028)

- **Extend CM Systems to Cover 50% of Nepal's Installed Hydropower Capacity:** Following successful demonstration projects, the second phase involves scaling the adoption of CM to cover 50% of Nepal's installed hydropower capacity. This phase will focus on plants that have shown the greatest potential for improved operational efficiency and reduced downtime through CM. The strategy will prioritize plants with aging infrastructure and high forced outage rates, as these will benefit most from predictive maintenance and condition-based monitoring. The expansion phase will require significant coordination between plant operators, regulatory bodies, and financial institutions to ensure that sufficient funding and resources are allocated for system deployment across a larger number of plants. Training programs for technicians and plant personnel will be scaled up, and operational guidelines will be refined based on the experiences gained in the pilot phase.

Phase 3: Maturation (2029 and Beyond)

- **Full Integration of CM Technologies Across the Sector, Including Legacy Plants:** The final phase will focus on the full integration of CM technologies across the entire hydropower sector, including legacy plants that may not yet have the latest monitoring technologies. This phase aims to establish CM as the standard practice for plant operation and maintenance in Nepal. By 2029 and beyond, it is expected that all hydropower plants, regardless of size or age, will implement some form of condition monitoring. This universal adoption will improve the overall reliability, efficiency, and sustainability of Nepal's energy infrastructure. Efforts

will include retrofitting older plants with modern sensors, software, and data systems. In addition, further integration with grid management systems and SCADA platforms will enable more intelligent, responsive management of energy production, leading to more stable power generation and better alignment with national energy demands.

5 Economic Justification

5.1 Cost-Benefit Analysis

An economic assessment provides a compelling justification for the adoption of condition monitoring (CM) systems in Nepal's hydropower sector, highlighting both cost efficiency and long-term returns. The initial investment in CM systems is a key consideration, but it is important to recognize that these systems will not only enhance the reliability and lifespan of critical equipment but also generate substantial savings in maintenance and downtime costs over time. A careful cost-benefit analysis reveals that the financial returns from adopting CM can be significant, making it a worthwhile investment for hydropower operators.

Investment Component: Basic CM System

- **Estimated Cost:** USD 15–20 per kW
  - The basic CM system includes fundamental monitoring technologies, such as vibration sensors, temperature monitoring, and basic data logging. This cost covers sensor deployment, basic data collection infrastructure, and essential analytics tools for early fault detection and performance optimization.
- **Payback Period:** 2–3 years
  - The payback period for a basic CM system is relatively short, ranging from 2 to 3 years. This quick return is due to the significant reduction in unplanned outages, improved operational efficiency, and extended asset lifespan that the system enables. By identifying issues early, plants can avoid costly breakdowns and reduce unscheduled downtime. Furthermore, operators can optimize their maintenance schedules, thereby reducing the frequency and cost of reactive repairs. In many cases, these cost savings will quickly offset the initial investment.

Investment Component: Advanced CM System

- **Estimated Cost:** USD 30–40 per kW
  - The advanced CM system builds upon the basic setup by incorporating more sophisticated technologies, such as machine learning-based predictive maintenance, advanced vibration and strain monitoring, and real-time cloud-based analytics. It also includes integrations with other plant management systems like SCADA, allowing for comprehensive monitoring of all critical assets and facilitating data-driven decision-making at a larger scale.
- **Payback Period:** 4–5 years
  - The payback period for advanced CM systems is slightly longer, ranging from 4 to 5 years, but the value proposition remains compelling. The key benefit of advanced systems is their ability to forecast potential failures with greater accuracy, allowing for more precise

maintenance planning and minimizing catastrophic failures. As the system matures, predictive algorithms improve, which further enhances operational optimization, reducing maintenance costs and downtime. Additionally, advanced CM systems enable hydropower plants to run at their maximum potential, improving generation efficiency and reducing overall operating costs.

5.2 Value Proposition

The value proposition of condition monitoring (CM) adoption is multifaceted, offering significant benefits across multiple stakeholders, including utilities, the national grid, and the broader economy. By enhancing the reliability and efficiency of hydropower plants, CM systems contribute to cost savings, operational optimization, and sustainable growth in the energy sector. The following outlines the key advantages for each stakeholder:

For Utilities:

- **Achieve a 20–30% Reduction in Operations and Maintenance (O&M) Costs:**
  - Condition monitoring plays a crucial role in reducing operations and maintenance (O&M) costs by shifting the maintenance strategy from reactive to proactive. By continuously monitoring the condition of critical assets such as turbines, generators, and auxiliary systems, CM systems enable utilities to detect faults early and schedule maintenance activities only when necessary. This results in fewer emergency repairs, lower labor costs, and a reduction in the need for expensive replacement parts.
  - Additionally, CM helps optimize the lifecycle of equipment, delaying costly replacements and improving plant efficiency. By enabling smarter maintenance schedules, utilities can avoid costly downtime, minimize the impact of unplanned outages, and extend the operational life of their assets. The combination of reduced downtime, less frequent repairs, and optimized resource allocation can lead to a 20–30% reduction in O&M costs over time.

For the Grid:

- **Enhance System Reliability and Reduce SAIDI (System Average Interruption Duration Index):**
  - System reliability is crucial for any national or regional power grid. CM systems not only enhance the health of individual assets but also provide a comprehensive view of plant performance, enabling operators to identify potential risks that could disrupt power supply. By detecting issues before they lead to catastrophic failures, CM minimizes forced outages, ensuring that hydropower plants maintain a steady output to the grid.
  - One key metric for grid reliability is the System Average Interruption Duration Index (SAIDI), which measures the average duration of power outages. With CM systems in place, utilities can significantly reduce SAIDI by preventing unscheduled outages, minimizing the duration of planned maintenance, and ensuring that plants are operating at optimal capacity. Enhanced reliability from CM adoption leads to a more stable

and predictable power supply, which is especially vital as Nepal expands its energy exports to neighboring countries like India and China.

For the National Economy:

- **Boost Revenue Through Increased Energy Exports, Particularly to India and China:**
  - As Nepal continues to expand its hydropower generation capacity, energy exports—especially to neighboring countries—become an increasingly important source of revenue. By improving the efficiency and reliability of hydropower plants, CM systems enable plants to operate at peak capacity and maximize power generation. This increased output can directly contribute to the nation's ability to meet growing domestic demand and enhance its export capacity.
  - In particular, Nepal has established ambitious goals for energy export to countries like India and China, which are rapidly increasing their demand for renewable energy sources. By improving the operational efficiency of hydropower plants, CM systems can play a pivotal role in boosting Nepal's exportable surplus. This, in turn, generates increased revenue for the country, contributing to economic growth, infrastructure development, and the creation of new jobs in the energy sector. Additionally, a reliable, well-maintained hydropower sector can position Nepal as a key regional player in the renewable energy market.

6 Conclusion and Recommendations

6.1 Key Findings

This paper underscores the critical role of condition monitoring (CM) in improving the reliability and sustainability of Nepal's hydropower sector. With hydropower being the backbone of the country's energy infrastructure, ensuring the efficient operation of its plants is crucial for both domestic power generation and energy exports. After evaluating the potential benefits and challenges, several key findings have emerged from this analysis:

1. **CM Significantly Improves Equipment Performance and Lifespan:**
   - One of the most compelling reasons to adopt CM in Nepal's hydropower plants is its proven ability to enhance equipment performance and extend the lifespan of critical assets. Through real-time monitoring and predictive maintenance, CM systems can detect faults early, allowing for timely interventions before equipment failure occurs. This approach not only prevents catastrophic breakdowns but also optimizes the overall operational efficiency of plants, leading to better power generation and reduced downtime.
   - Additionally, CM helps extend the lifespan of turbines, generators, and other vital components, which are often subjected to harsh environmental conditions. By identifying wear and tear patterns and addressing them proactively, CM reduces the need for expensive replacements and lowers the long-term capital expenditure required for

maintaining and upgrading the fleet of hydropower plants.

2. **A Combination of Regulatory, Technical, and Financial Measures is Needed for Effective Implementation:**

   - The successful implementation of CM in Nepal's hydropower sector requires a holistic approach involving a combination of regulatory, technical, and financial measures. On the regulatory side, it is important for the Nepal Electricity Authority (NEA) and other stakeholders to establish clear standards and mandates that ensure CM is adopted across the sector. Regulatory frameworks should define the minimum requirements for CM in hydropower plants, with periodic audits to ensure compliance.

   - From a technical standpoint, the deployment of CM systems must be supported by the installation of suitable sensors, data infrastructure, and analytics tools. The technical expertise required to install, operate, and maintain these systems must be developed through focused capacity-building initiatives, such as certification programs and technician exchange schemes.

   - Financially, it is critical to introduce incentives and financing options to alleviate the initial costs associated with CM adoption. This could include offering tax credits, low-interest loans, and other financial mechanisms to make CM systems more affordable, especially for smaller and medium-sized hydropower plants.

3. **Economic Analysis Supports CM as a Cost-Effective Strategy, Especially for Larger Facilities:**

   - The economic analysis of CM adoption reveals that it is a cost-effective strategy, particularly for larger hydropower facilities. By reducing operations and maintenance (O&M) costs and preventing costly unscheduled downtimes, CM offers a strong return on investment (ROI). The payback periods for basic and advanced CM systems are relatively short, ranging from 2 to 5 years, and the long-term savings far outweigh the initial investment.

   - Moreover, the value proposition of CM extends beyond individual plants. The improved reliability of plants with CM systems contributes to greater grid stability, reduces the risk of power interruptions, and enhances Nepal's ability to meet domestic demand and export electricity to neighboring countries. This results in substantial economic benefits for the country, especially as hydropower becomes an increasingly important source of revenue through energy exports.

Actionable Recommendations:

- **Immediate Steps:** Establish national CM standards, develop training programs for technicians, and initiate pilot projects to showcase the benefits of CM.

- **Medium-term Actions:** Roll out CM across 50% of Nepal's hydropower capacity, ensuring that both financial and technical support are available for the adoption process.

- **Long-term Vision:** Achieve full sector-wide integration of CM, including legacy plants, by 2030, with ongoing improvements in technology and policy.

The sustainable development of Nepal's hydropower sector hinges on the adoption of modern maintenance approaches like CM. As Nepal expands its hydropower generation capacity and looks to increase energy exports, CM will be a key enabler of reliable, efficient, and cost-effective power production, ultimately strengthening the country's energy infrastructure and economic prospects.

6.2 Actionable Steps

To actualize the benefits of Condition Monitoring (CM) in Nepal's hydropower sector, the following key steps are recommended:

1. **Immediate Formulation of CM Standards by the Nepal Electricity Regulatory Com- mission (NERC):**

   - **Action Plan:** The Nepal Electricity Regulatory Commission (NERC) should take the lead in formulating clear CM standards for the country's hydropower plants. These standards would outline the minimum requirements for CM implementation, covering aspects like sensor installation, data collection protocols, and periodic condition assessments.

   - **Rationale:** With well-defined regulatory standards, hydropower operators will be provided with a structured framework for CM adoption. This would ensure uniformity across the sector and increase compliance with CM best practices. Standards will also help align government initiatives, international funding, and local incentives to promote CM across plants of all sizes. Furthermore, regulatory mandates can act as a strong foundation for the success of CM in Nepal's hydropower sector, fostering an environment where technology is leveraged to optimize plant performance.

2. **Establishment of a National CM Training Center in Collaboration with CTEVT:**

   - **Action Plan:** Collaborating with the Council for Technical Education and Vocational Training (CTEVT), Nepal should establish a national CM training center aimed at building the technical capacity required for the widespread adoption of CM. This training center could offer certification programs that equip engineers, technicians, and operators with the necessary skills to install, maintain, and analyze CM systems.

   - **Rationale:** The technical expertise required for the proper implementation of CM systems is essential for long-term sustainability. By establishing a dedicated training infrastructure, Nepal can build a skilled workforce capable of handling the complexity of CM technologies. These programs will ensure that the future workforce is adequately trained to monitor, troubleshoot, and maintain condition monitoring equipment. Moreover, technician exchange programs, in collaboration with the Nepal Electricity Authority

(NEA), can provide hands-on experience in CM system operations and foster knowledge exchange.

3. **Execution of Pilot CM Projects Using Climate Finance and Donor Support:**

   - **Action Plan:** Pilot projects should be launched in collaboration with international climate finance initiatives and donor agencies to demonstrate the benefits of CM in the hydropower sector. These projects should target a diverse set of hydropower plants across the country, including small, medium, and large-scale facilities, and should focus on demonstrating the practicality of CM systems in Nepal's unique environmental and operational context.
   - **Rationale:** Pilot projects will act as real-world case studies for the effectiveness of CM, showing both the technical feasibility and the economic advantages of such systems. They will also serve as models for future CM implementation and help in identifying potential challenges, such as financing gaps, technology adaptation issues, and regulatory hurdles. By tapping into climate finance and donor funding, Nepal can alleviate the upfront costs associated with the adoption of CM and encourage private sector participation in energy sector improvements. Successful pilot projects can build momentum for broader adoption and attract investment into the sector.

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रसुवा जिल्ला स्थित साञ्जेन जलविद्युत केन्द्र

Hydropower to Hydrogen: Unlocking Nepal's Energy Transition

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***Abstract**: By the utmost utilization of it abundant hydroelectricity, Nepal holds the capability to be a global hub of green hydrogen. By driving policies, building essential infrastructure and facilitating with its surplus electricity, Nepal is undoubtedly a key asset for unlocking the Nepal's energy transition. Collaborative approach of government, NEA's central role and active participation of private sector will be instrumental for shaping fortunes of Nepal in Green Hydrogen Energy and realizing the Nepal's vision of Energy Independence and de-carbonization goal.*

Background

As per the data given by the International Energy Agency, the decade since 2013 has seen that the proportion of non-renewal source of energy in the energy mix of the world, has shown a gradual decline to 80 % in 2023 from 82% in 2013. Also till 2035 the growth rate in the demand of clean energy is expected to overcome the rate at which the demand total energy mix rises globally [1]. In the year 2024, the contribution of renewal energy to the global energy consumption sits around 14.6% and this marks a humble improvement from previous year as it was at 13% in 2023 [2].

In the meantime, clean hydrogen is enjoying its Political and Business momentum as the severity of discussion going on, policies that are being drafted and the rapid expanding nature of investments around the world seems to lay the strong foundation for the future. The earliest demonstration of hydrogen fuel dates back around 1800s whereby the water electrolysis and the fuel cell have captured the imagination of engineers. In the 18th and 19th century hydrogen used to fuel the combustion engines, balloons and air ships along with lifting the human race to the moon in 1960s [3]. There seems to be an opportunity for Nepal to become an early mover in developing hydrogen fuel as one of the leading asset of nation's economy mainly due to its hydroelectricity production and recurring energy surplus during the wet season [4].

Introduction

Known for being a lightest, Hydrogen is also the most abundant element in the universe. The utilization of this as a source of energy do not leave any carbon footprint instead, water vapour is the byproduct of combustion of hydrogen fuel. The applicability in electricity generation,

industrial usage along with feedstock for synthetic fuels, hydrogen provides enhanced scope of application [5].

The process of splitting water into two hydrogen and oxygen is known as Electrolysis. This splitting action is conducted in an electrolyzer containing two electrodes namely anode and cathode which are separated by an electrolyte.

After the application of electric field;

- The oxidization of water at anode produces oxygen gas along with hydrogen ions
- Hydrogen ions migrate to the cathode, where they go through the reduction process to produce the hydrogen gas.

The key reaction involved in this process is given as

$2H_2O$ (l) + Electricity (237.2kJ mol^{-1}) + Heat (48.6 kJ mol^{-1}) $\longrightarrow$ $O_2(g)+2H_2(g)$

Assuming that the above reaction is taking place at room temperature 1.23V theoretical thermodynamic cell is required for the electrochemical water splitting technique to split water into hydrogen and oxygen. However, experimental setup requires 1.48V of cell voltage for efficient splitting of water and the additional voltage is required to overcome the kinetic ohmic resistance of the electrolyte and the cell component of the electrolyzer. [6]

This whole proceeding requires highly purified water and sufficient amount of electricity. The efficiency of the chemical reaction sighting the amount of hydrogen fuel generated by the reactor ranges in-between sixty percent to eighty percent, and this depends upon the type of electrolyzer used. Proton Exchange Membrane (PEM) and Alkaline Electrolyzers are the common types of electrolyzers employed in green hydrogen system. [7]

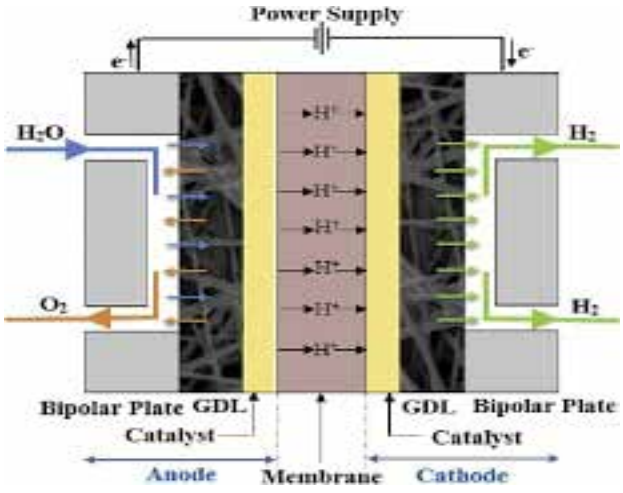

Figure 1: PEM Water Electrolysis Method [9]

Proton Exchange Membrane (PEM)

Water is electrochemically separated into hydrogen and oxygen at the appropriate electrodes in PEM water electrolysis, with hydrogen at the cathode and oxygen at the anode. Pumping water into the anode, where it splits into Oxygen (O_2), proton (H^+), and electrons (e^-), results in PEM water electrolysis. Then after, these protons are transported to the cathode side via a proton conducting membrane. The external power circuit, which supplies the reactions driving force (cell voltage), allows the electron to leave the anode. After the completion of transportation of protons from anode, the recombination of protons and electrons occurs at cathode yielding the creation of Hydrogen at gaseous state. [8]

Alkaline Water Electrolysis

At the cathode of the alkaline water electrolysis process, two molecules of alkaline solution (KOH/NaOH) go through the reduction process to get one Hydrogen molecule (H_2) and one Hydroxyl ion (OH^-). The Hydroxyl ion (OH^-) is then moved to anode through the porous diaphragm under the influence of electric field between the anode and cathode, where they are discharged to one molecule of water (H_2O) and ½ molecule of Oxygen (O_2). The generated H_2 is then removed from cathode surface to recombine in a gaseous state. According to the mechanism depicted in Figure 2, the O_2

recombined at electrode surface and escaped as Hydrogen. Lower temperatures, such as 30 to 80^{0}C, are used for alkaline electrolysis and the electrolyte is an aqueous solution of KOH or NaOH and the electrolyte concentration is approximately about 20% to 30%. [10, 11]

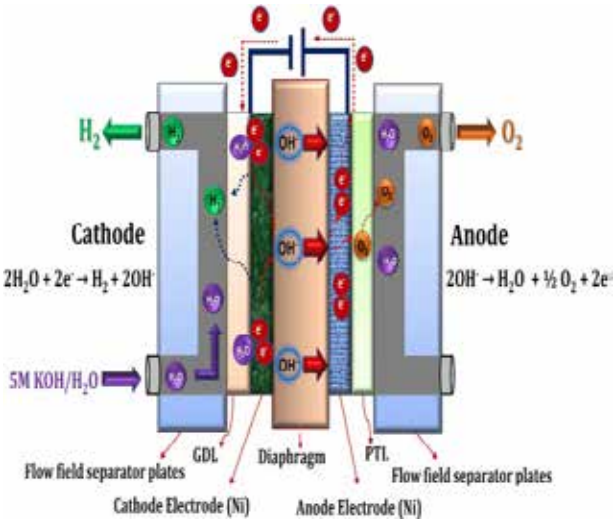

Figure 2: Alkaline Water Electrolysis Method [12]

Other than mentioned two methods Steam Methane Reforming (SMR), Coal Gasification, SMR or Gasification with Carbon capture, Biomass Gasification and other are some other processes with which Hydrogen Fuel can be generated.

Types of Hydrogen

There are several types of hydrogen that have been classified by their production method and source of energy used. They can be listed as:

- **Grey Hydrogen:** Produced from fossil fuels, emitting CO_2
- **Blue Hydrogen:** Produced from Fossil fuels but uses carbon capture technology to reduce carbon emission.
- **Green Hydrogen:** Produced by using renewal source of energy such as Hydroelectricity, Solar Energy, and Wind Energy to split water into Hydrogen and Oxygen through the electrolysis process.

Among all green Hydrogen is gaining global attention due to its environmental benefits and potential to store renewal energy for use during peak demand or dry season. [13]

Nepal's Hydropower Advantage

With the capacity of around 83000MW of hydroelectricity generation and among which about 42000 MW could be harnessed sighting the feasibility in terms of economic and technical aspects, Nepal is recognized as the most profound place for the production of green hydrogen [14]. According to reports, Nepal will have at least 10,000 megawatts of hydropower by 2030, with a demand of approximately 7,000 megawatts. The total capacity is expected to be 39,000 megawatts by 2040[15]. It is anticipated that the cost of producing green hydrogen will be below 1 USD per kg by 2050 which approximately sits around 3.01 USD per Kg at 2024 [16].

Application scope of Green Hydrogen

Consisting wide variety of utilization area green hydrogen's scope of application could be illustrated by following picture.

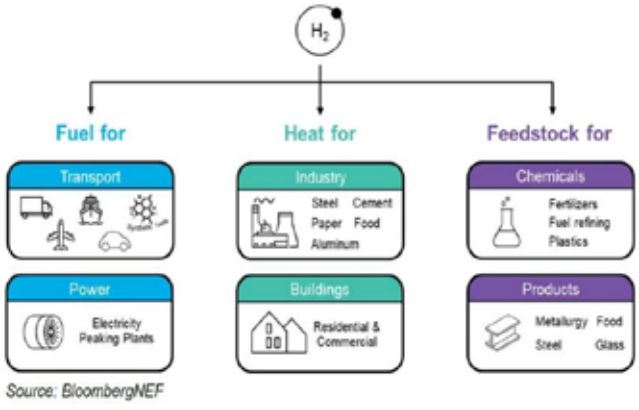

Figure 3: Usage of Green Hydrogen [17]

Development in Nepal

In the fiscal year 2082/83 Nepal has aimed to conduct feasibility study of green hydrogen production in association with universities and private sector. Along with this National and foreign investor will be encouraged to invest in Nepal in the field of Green Hydrogen production. Also there is a provision to provide tax exemption for the green hydrogen producing industries [18]. Along with this some of the major development steps in regard to the green hydrogen could be listed as follow:

❖ **Policy Level awareness:**

- Green Hydrogen Policy, 2080

❖ **Research and Development**

- Possibility of Hydrogen Energy in Nepal, 2065: A research report prepared by the integrated team of Tribhuvan University, Nepal and Western Michigan University, USA.
- A study conducted by Asian Development Bank regarding Hydrogen generation using hydroelectricity in Nepal, 2077.
- Possibility of production and usage of Green Hydrogen in Nepal, 2078, a research reported submitted to Cabinet by Water and Energy Commission.
- A team of experts of Ministry of Energy, Water Resources and Irrigation studied on use of Green Hydrogen for the production of chemical fertilizer in Nepal. [19]

❖ **Structural Development**

- Green Hydrogen Lab, Kathmandu University, established at 2020 this laboratory has been instrumental for the research aspirants to study the vibrant dimensions of Green Hydrogen
- HFP Nepal: a collaborative project between Kathmandu University and Nepal Oil Corporation. This project aims to identify the feasibility scenario for technology transfer and adaptation for the production of green hydrogen as a commercial fuel from hydropower plants.
- Nepal Hydrogen Initiative: a project for carbon neutrality and energy independent Nepal running under Kathmandu University.

❖ **Programmatic Initiations**

- 16th Periodic plan (2024/25-2028/29) has included green hydrogen as a possible source of alternative energy in the provision of Major Programs and Transformative strategies.
- Unveiling of green hydrogen fueled car numbered Ba 1 Jha 111 by the Prime Minister of Nepal in 2024.
- Commencement of Green Hydrogen refueling station at Kathmandu University.
- Nepal Has engaged in some informal conversation with International agencies likes UNDP and ADB in regard to the technical assistance for the possible pilot projects for the development of Hydrogen in Nepal.
- Green Hydrogen and Green Ammonia Plant Project under Investment Board Nepal at an estimated cost of 1100 million USD to be commenced under Public Private Partnership Model.

Where does Nepal Electricity Authority stands in the Picture

Nepal Electricity Authority being a supreme leader of the electricity generation, transmission and distribution, is expected to play as a frontier for the development of overall aspects of Green Hydrogen in Nepal. Some of the major initiations taken by the authority could be listed as follow:

- Conduction of feasibility study by creating an alliance with Global Green Growth and Kathmandu University for Green Hydrogen targeting for the commencement of Green Hydrogen Plant in Nepal.
- Looking for the regional cooperation for the development of Green Hydrogen as a way forward strategy for the years to come.
- Sighting Green Hydrogen technologies contributing to the domestic economy with better utilization of Hydropower electricity, NEA has signed a MOU with School of Engineering, Kathmandu University.
- Business Promotion Division has opted for the studying, executing, monitoring and evaluating hydrogen development as one of its major focal point. [20]

Challenges and Aspects to be considered

- Meet the need of extensive infrastructure development
- Acquiring significant financial investment
- Development of efficient and cost effective electrolysis technology that best fits modality of Green Hydrogen Production Mechanism opted by Nepal
- As the policy formulated till date in Nepal are in its preliminary state, there seems to make legal enhancement to nurture the Green Hydrogen development in Nepal
- Establishment of Comprehensive Regulatory Framework so that the whole proceeding of the Green Hydrogen research and development, investment, planning, production, storage, usage (Selling and Buying) is carried out under the specific regulatory umbrella of the state.
- As there is a significant drawback of seasonal hydropower fluctuation, role of Nepal Electricity authority to stabilize the power supply to the Green Hydrogen Industry seems to vital.

Way Forward

The process turning Green Hydrogen's theoretical sculpture to practical realization is a long term process. The achievement of being one of hub in Green Hydrogen producer nation along with the enhancement of the country's economy below mentioned approaches seems to instrumental for the Nepal's fate:

❖ **Infrastructure Development**

- Creation of specialized wing for Green Hydrogen under Ministry of Energy, Water Resources and Irrigation which will act as a top level representative of the government of Nepal.
- Restructuring Alternative Energy Enhancement Centre so that Green Hydrogen Gets top level priority as an alternative source of energy to reduce carbon footprint.
- Establishment of a Regulatory body under Federal Government which will ensure that the strategy of government and ground realization do not have gaps and holes.

❖ **Resource allocation**

- Strategic financial interventions by the government by laying foundation for Green Hydrogen Transition via Budget, period plan and strategies.
- Fund allocation from all three levels of governments sighting the practicality of the circumstances in the respective work scope.
- Direct Financial Incentives for Electrolyzer manufacturers and Green Hydrogen Producers

❖ **Research and Development**

- Investment in research and development by the Federal and state level governments
- Promotion of research activities through the research aspirants of top universities of Nepal under the supervision of subject experts
- Activating scientific research wings of Nepal likes of NAST, NAARC, National Innovation Centre, Nepal Physical Society and other research agencies of Nepal.

❖ **Regulations and standards**

- Formulation of acts from Legislation and specific regulations from the relevant ministry to complete the legal pathways for Green Hydrogen Transition
- Setup Safety regulations for Producers (both electrolyzer as well as Green Hydrogen), Transporters and Users so that everything runs under the controlled and safe environment.
- Formulation of specific legal provision for importing electrolyzer, equipment and other necessary stuffs.

❖ **Investment Invitation**

- Utilization of Public Private Partnership modality to ensure the sufficiency of capital for the purpose.
- Improvement in Doing Business Environment Index and call for global Investors via Foreign Direct Investment and Create a capital market for Green Hydrogen Development so that foreign investor may have the luxury to invest in the portfolio market.
- Promotion of Non-Resident Nepali Community to invest in Green Hydrogen pilot projects of Nepal.

❖ **Demand Creation**

- Exploration of National and Global market through Consulate General in International Stations, global economic forums and relevant global stakeholders.
- Development of chemical fertilizer industry so that green hydrogen could be utilized for the production Ammonium based fertilizers.
- Transformation of domestic transportation industry from fossil fuel to Green hydrogen with special incentives provided by the government.

Participation of Nepal Electricity Authority

Primarily sitting at the central composition of the country's power sector, Nepal Electricity Authority have to play a pivotal role in the multidimensional development of Green Hydrogen in Nepal. Here are the best fitting responsibilities and contributions that NEA is expected to act upon:

- Provide enhanced facilitation to the Green Hydrogen industry through the utilization of surplus hydroelectricity, economically viable and appropriate PPA framework implementation
- Grid integration, optimization of dispatch strategy to electrolyzer manufacturer and assurance of adequate and stable power supply to Green Hydrogen power plant
- Develop infrastructure such as transmission lines, designated power plants, specialized distribution wing
- Collaboration with Government of Nepal, research institutions, and corporate sector to enhance the efficiency of infrastructure development
- Run research & development, capacity building and knowledge sharing programs so the best brains could

be developed inside NEA which will ultimately foster the Green Hydrogen as a possible source of revenue for the organization.

Conclusion

To recapitulate, Nepal's journey from Hydropower to Hydrogen is in nascent stage. Careful planning, adequate investment and collaborative integration of Government of Nepal, all the state level governments, corporate sector, private sector, and global players of the industry is expected to provide synergetic effective for the Green Hydrogen to be staged as a strategic tool for energy security, sustainability and a subject of regional and international trade.

Standing at the cusp of green hydrogen revolution, Nepal seems to be at the energy transition phase with its remarkable energy potential and recurring energy surplus. In the meantime, Nepal Electricity Authority is undeniably instrumental player in this endeavor which is designated to assist in multidimensional approach from providing surplus hydropower at the economically viable charges to developing vital infrastructure along with nurturing research and development. Acting as a central stakeholder in the power industry, NEA holds the capability to transform Nepal into a leader in the production and utilization of Green Hydrogen ultimately fostering the national economy and green revolution.

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माथिल्लो मुस्ताङ्ग क्षेत्रको विद्युतीकरण

Nepal's Transition from Load Shedding to Energy Export

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Introduction: A Nation Reborn in Light

Nepal's energy landscape has undergone a metamorphosis that defies conventional development timelines. A country once crippled by 18-hour daily blackouts (once upon a time), now commands regional attention as an electricity exporter, earning Rs 15 billion from cross-border sales in FY 2023/24. This radical pivot from load-shedding pariah to clean energy innovator reflects strategic infrastructure bets, diplomatic ingenuity, and visionary leadership. Yet beneath the triumph lies a complex tapestry: climate vulnerabilities, policy instability, and the audacious dream of harnessing 28,500 MW by 2035. As Nepal balances domestic security against export ambitions, its journey illuminates a path for energy-poor nations worldwide.

The Darkness Era of Nepal's Electricity Sector (2008–2016): A Critical Overview

Between 2008 and 2016, Nepal experienced daily power cuts ranging from 8 to 18 hours, especially during the dry season (winter). The Darkness Era (2008–2016) was a period of major crisis in Nepal's power sector. It was caused by poor planning, seasonal hydropower dependency, and lack of investment. However, the end of the era began with reforms in NEA, improved imports from India, and better grid management.

Turnaround in Electricity Generation: Engineering Revolution & Government Policies (2016–2024)

From Power Crisis to Power Surplus

Before 2015, Nepal faced severe load shedding, weak generation capacity (~850 MW), and dependency on imports. After 2016, with focused government policy and new action plan Nepal revolutionized electricity generation by:

- Accelerating hydropower development
- Bringing in engineering innovations
- Reforming electricity policies
- Promoting investment & exports

Between 2016 and 2024, Nepal proved that:

When politics supports policy and execution, even a power-starved nation can become an emerging energy exporter.

Nepal's transformation in generation wasn't accidental it was the result of bold political decisions, timely engineering action, and strong policy direction.

Now, with surplus generation in the wet season and growing export channels, Nepal stands ready to become a regional green energy hub in South Asia.

Helped Remove Load Shedding

1. **Increased Generation Capacity**
    - Before 2016: ~850 MW (insufficient to meet demand)
    - After 2021: >2,800 MW (surplus during wet season)
    - Projects like Upper Tamakoshi (456 MW) and several IPP-based RoR projects helped close the supply-demand gap
2. **Private Sector (IPP) Involvement**
    - Over 60% of new capacity added after 2016 came from Independent Power Producers
    - NEA signed PPAs with dozens of IPPs, accelerating project execution
3. **Transmission Expansion**
    - NEA 220 kV and 400 kV lines are completed (Dhalkebar–Hetauda–Inaruwa corridor)
    - Allowed reliable evacuation of generated power to load centers
4. **Dry Season Management**
    - Though hydro is seasonal, import through Dhalkebar–Muzaffarpur line helped manage dry season shortages
    - This bought time for Nepal to complete large hydropower projects
5. **System Planning and Policy Reform**
    - Government declared energy emergency in 2016
    - Accelerated licensing, construction, and grid development
    - NEA improved load management and reduced technical losses
6. **99-action plan for the national electrical development decade (2015/2016)**
    1. **Legal & Policy Reforms**
        - Implement "take-or-pay" Power Purchase Agreements (PPA) for new projects
        - PPAs to be denominated in US dollars for 10-year duration to hedge currency risk
        - Introduce VAT subsidy of NPR 50 lakh per MW for projects commissioned by 2025/26 fiscal year
        - Extend deadlines (RCOD) by up to one year for earthquake-affected projects
        - Allow conversion of resettlement cost into equity to engage local communities as stakeholders
    2. **Administrative & Institutional Measures**
        - Establish single-window systems and streamline approval procedures
        - Form multiple coordination committees to oversee PPAs, transmission line planning, laws, and project management
        - Invite the private sector participation in building transmission lines via a build-and-transfer model
        - Strengthen the Nepal Electricity Authority's institutional capacity and legal clarity
    3. **Structural/Technical Interventions**
        - Ramp up hydropower development—run-of-river, reservoir-based, and large projects

- Promote solar and wind, targeting renewable share up to 10% of generation capacity
- Import short-term electricity from India to ease shortages during implementation phase
- Prioritize completion of major projects such as Kulekhani I & II, Budhigandaki, Naumure, and Nalsinghgarh

4. Incentives & Project Facilitation

- Provide security deployment at project sites (developer funded) when necessary
- Offer extended commercial operation deadlines for disaster-impacted projects
- Equity-based community participation to reduce conflict and increase local benefit-sharing
- Tax relief and structured incentive packages to encourage private and foreign investment

Market Innovation: Nepal–India Electricity Exchange (Since 2021)

Harnessing Surplus through Competitive Power Trade

Starting in 2021, Nepal entered a new energy market phase by participating in India's competitive electricity exchange system (IEX). This marked a major shift in how electricity was traded from rigid government-to-government imports to a dynamic, market-based export model.

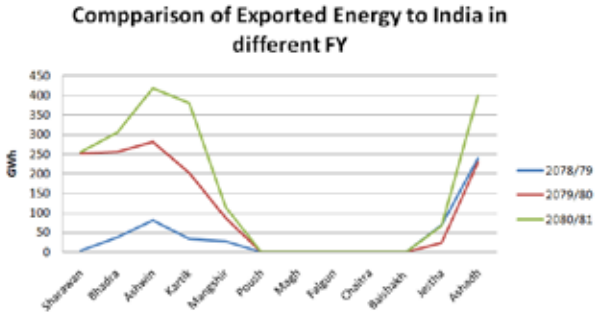
Core Concept: Use surplus electricity during wet seasons to generate revenue via export through energy markets, and manage imports smartly during dry seasons through bilateral and open access agreements.

Political & Strategic Decisions Supporting This Innovation

- 2021: India allows Nepal to participate in IEX after trust-building and grid synchronization.
- Gov & NEA: Regular submission of project-wise export requests to Indian Central Electricity Authority (CEA)
- Cross-border trade policy: Evolved to support non-Government PPAs and third-party trade.
- Bangladesh Export Agreement (via India): First regional trilateral energy trade pilot launched.

From 2021 onward, Nepal's engagement in the Indian Energy Exchange (IEX) marked a historic market innovation:

It transformed Nepal from a passive power importer into an active energy trader, leveraging surplus to generate revenue and integrating into South Asia's emerging power market. This shift, backed by policy reform, regional cooperation, and infrastructure like the Dhalkebar–Muzaffarpur line, positions Nepal as a regional energy player with long-term growth potential. Nepal's hydropower development played a direct and essential role in ending load shedding. By expanding generation capacity through NEA and IPPs, supported by strong policy and transmission infrastructure, Nepal not only met its domestic demand but also became a power exporter.



Comparison of exported Energy to India in different FY

FY	Shrawan	Bhadra	Ashwin	kartik	Mangshir	Poush	Falgun	Chaitra	Baishakh	Jestha	Ashadh
2080/81	256	305	418	380	114	0	0	0	0	68	401
2079/80	252	256	281	202	88	0	0	0	0	24	230
2078/79	3	38	81	33	28	0	0	0	0	70	240

Nepal–India Electricity Exchange Overview with Seasonal Insights

The graph illustrates Nepal's monthly electricity export to India over three fiscal years (2078/79, 2079/80, 2080/81):

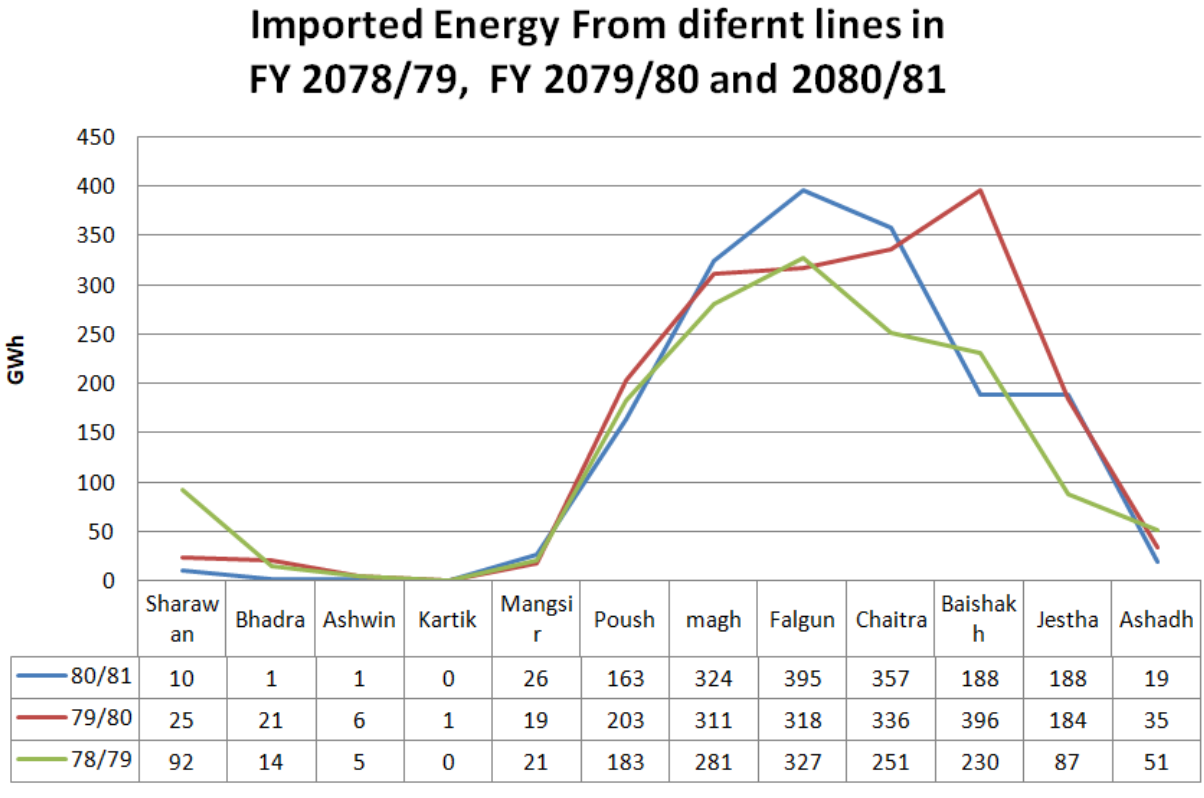
- High Export Months (Shrawan to Kartik): Exports peak in the monsoon season, especially in Ashwin and Kartik, when generation is at its highest due to abundant water flow in rivers feeding Nepal's run-of-river hydropower plants.
- Export drops sharply from Mangsir onward, almost to zero from Poush to Baishakh, across all three fiscal years.
- Export rises again in Jestha and Ashadh, when pre-monsoon rainfall begins to increase river flow.

Poush to Baishakh: Low Generation, Zero Export

This period corresponds to Nepal's dry season (winter to early spring). Here's what happens:

Low Hydropower Generation:

- The run-of-river hydropower plants face significantly reduced river flow, leading to sharp declines in energy generation.
- As seen in earlier monthly generation data (image you provided earlier), generation during Poush to Chaitra in 2080/81 dropped to around 24,570 MWh to 25,030 MWh — the lowest of the year.



	Sharawan	Bhadra	Ashwin	Kartik	Mangsir	Poush	magh	Falgun	Chaitra	Baishakh	Jestha	Ashadh
80/81	10	1	1	0	26	163	324	395	357	188	188	19
79/80	25	21	6	1	19	203	311	318	336	396	184	35
78/79	92	14	5	0	21	183	281	327	251	230	87	51

No Export to India:

- Due to low domestic generation and rising internal demand (especially in cold months), Nepal stops exporting to India during this time.
- Instead, as shown in the load curve chart, Nepal imports electricity from India during peak demand hours, especially in the evening (e.g., Jestha 16, 2081 system peak load of 2408 MW at 19:30).

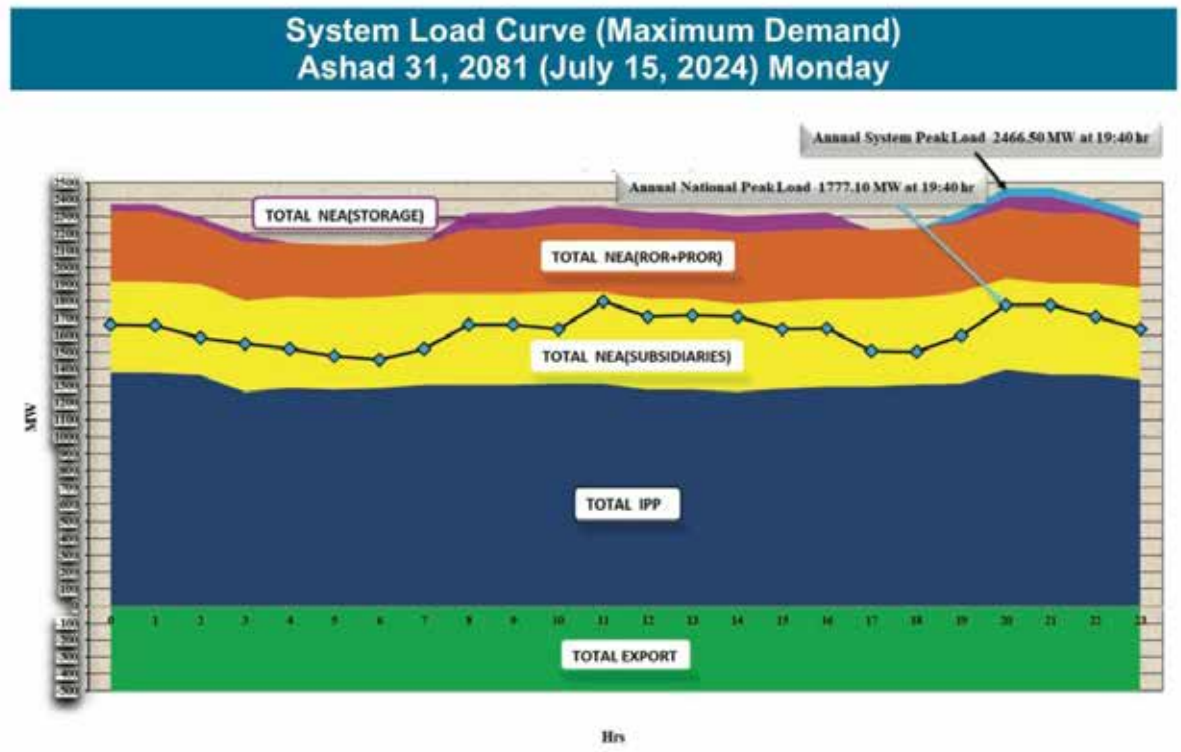
From Poush to Baishakh, the graph shows that Nepal's electricity export to India drops to nearly zero in all three fiscal years (2078/79, 2079/80, 2080/81).

- There is very minimal or no export recorded, indicating Nepal is not in a surplus generation condition.

Nepal, during Poush, Magh, Falgun, Chaitra, and up to early Jestha, becomes a net importer of electricity, especially during:

- Morning and evening peak demand periods
- Cold winter months, when electricity demand increases due to heating needs
- Times of low water flow, reducing hydropower generation

This conclusion is supporte d by the system load curve of Jestha 16, 2081 (May 29, 2024), which clearly shows:



Based on the Annual System Peak Load Curve of Jestha 16, 2081 (May 29, 2024) from the Nepal Electricity Authority (NEA), we can draw the following conclusion about Nepal's electricity import and export patterns with India throughout the day:

Conclusion on Nepal–India Power Import and Export (Jestha 16, 2081)

The system load curve clearly reflects Nepal's dynamic role as both an importer and exporter of electricity depending on the time of day:

1. During Off-Peak Hours (Night to Early Morning & Afternoon):
    - Nepal exports electricity to India, as seen in the green shaded area labeled "TOTAL EXPORT".
    - This reflects surplus generation from domestic sources, especially from Independent Power Producers (IPPs) and NEA's run-of-river plants, when internal demand is low.
    - Export generally happens from around midnight to 6 AM, and again in the early afternoon (around 1–4 PM).
2. During Peak Hours (Evening):
    - Nepal's domestic demand rises sharply, peaking at 2408.62 MW at 19:30.
    - To meet this surge in demand, Nepal relies on electricity import from India, seen in the red shaded "TOTAL IMPORT" portion.
    - This indicates that Nepal currently lacks adequate dispatch able power, such as from storage hydro or flexible thermal units, to meet evening peaks without support from India.
3. Internal Power Mix:
    - The base of the curve is covered largely by Independent Power Producers (IPPs) and NEA run-of-river/pro-rated (ROR+PROR) generation.
    - Storage-based generation contributes more prominently during peak demand hours but is still insufficient alone.

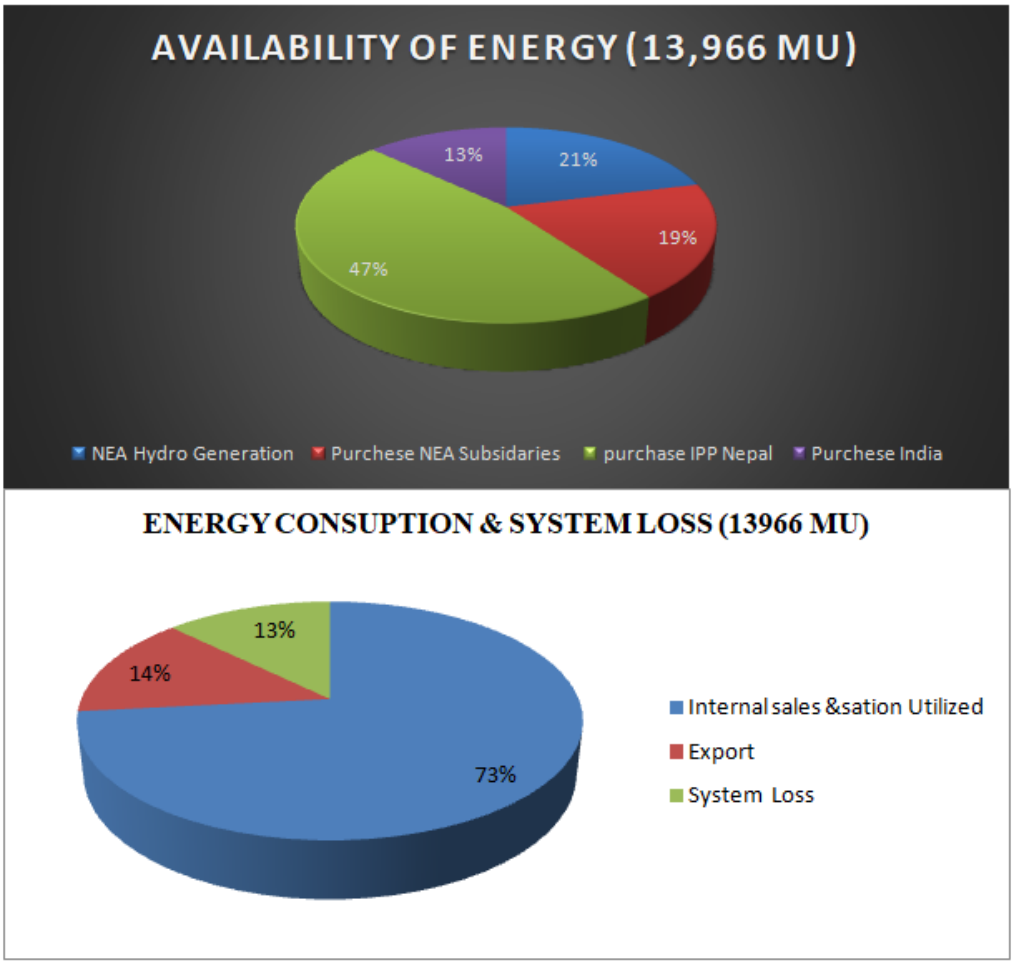


Chart Represent: statics and schematics data (MU= Million Units)

Param-eter	Monsoon (Jun-Sep)	Dry Season (Dec-Apr)
Generation	3,300 MW	1,000 MW
Demand	2, 300 MW	2,300 MW
Balance	1,200 MW surplus	>50% deficit

What Happens If This Line Gets Disconnected or Cut from Dhalkebar- Muzaffarpur

1. during Dry Season (Nov–Apr)

Nepal imports up to 600 MW from India via Dhalkebar to meet demand.

Impact:

- Severe power shortage across Nepal.
- Load-shedding may be reintroduced temporarily in industrial areas or cities.
- NEA may ration power supply (especially to large consumers and industries).
- Domestic generation (mostly run-of-river) won't be enough to meet peak load.
- Emergency diesel generation (expensive) may be considered.
- Imports via other smaller 132 kV lines (like Kataiya–Kushaha, Raxaul–Parwanipur) may help, but their capacity is limited (below 100 MW).

2. during Monsoon (May–Oct)

Nepal exports electricity to India using the same line.

Impact:

- Loss of a major export route → revenue loss for NEA and IPPs.
- Potential grid overloading inside Nepal if export is blocked (surplus energy stays unused).
- IPPs may be asked to reduce generation ("spilling water" = economic loss).
- NEA may try to divert export via Tanakpur, Mahendranagar (132 kV lines), but these can't handle bulk exports.
- Internal consumption may be boosted temporarily (e.g. cheap tariffs to industrial zones).

For all time self dependent

Nepal has made remarkable progress in hydropower generation, enabling seasonal electricity exports to India and Bangladesh during the monsoon. However, the country still faces significant challenges in the dry season due to reduced river flow and over-dependence on run-of-river projects.

To achieve full-year energy self-reliance, Nepal must now diversify its generation mix. Integrating solar power, establishing battery storage systems, and investing in pumped storage and reservoir hydropower are essential next steps. These technologies will help balance seasonal fluctuations, reduce dry-season imports, and ensure stable electricity supply for national growth.

Only by combining hydropower with solar and energy storage, can Nepal become truly energy independent, resilient, and a green energy leader in South Asia.

To achieve self-dependence in electricity supply, the Government of Nepal needs to focus on the following key areas:

1. Maximize Hydropower Development

Nepal has an estimated hydropower potential of over 80,000 MW, but less than 10% of it has been developed so far. To achieve energy independence:

- Prioritize the development of strategic large, medium, and small hydropower projects.
- Streamline project approvals and reduce bureaucratic delays.
- Ensure timely completion of projects through better project management and accountability.
- Encourage public-private partnerships (PPP) and provide access to finance for developers.
- Integrate climate-resilient infrastructure planning, especially for projects vulnerable to glacial lake outbursts or flooding.

2. Diversify Renewable Energy Sources

Hydropower alone cannot ensure reliable supply, especially during the dry season (winter months), when river flows are low. To balance the energy mix:

- Invest in solar energy—ideal for Nepal's high-altitude, sunny regions.
- Promote wind energy projects in suitable areas like Mustang and Palpa.
- Support biomass and biogas technologies in rural and agricultural areas.
- Implement hybrid systems (e.g., solar + battery + micro-hydro) for off-grid or remote regions

3. Improve Transmission and Distribution Infrastructure

A major bottleneck in Nepal's power sector is the weak and outdated transmission network. To solve this:

- Expand the national transmission grid and ensure connectivity to all provinces.
- Upgrade existing lines to reduce transmission and distribution losses (currently around 15–20%).
- Build cross-border transmission lines to enhance power trade with India and China.
- Invest in smart grid technologies to improve real-time monitoring and load management.

4. Encourage Private Sector and Foreign Investment

Private developers have played a crucial role in energy production. To enhance this further:

- Simplify and streamline the licensing and approval process.
- Ensure predictable and stable regulatory frameworks for return on investment.
- Provide tax incentives, subsidies, or risk-sharing mechanisms.
- Establish a one-window policy for energy investors to reduce delays.
- Strengthen public-private partnership (PPP) models for large-scale infrastructure.

5. Promote Energy Efficiency and Conservation

To reduce energy demand and maximize the use of available electricity:

- Launch nationwide campaigns for energy-saving practices in households, industries, and public buildings.
- Mandate energy-efficient appliances and equipment, including labeling and standards.
- Provide incentives for industries to adopt energy-efficient technologies.
- Promote demand-side management (DSM) strategies through utility companies.

6. Enhance Regional Energy Trade and Storage Solutions

Nepal can benefit from power export during surplus seasons and import during shortages:

- Expand bilateral and multilateral energy trade agreements, especially with India and Bangladesh.
- Join regional power markets like the South Asia Regional Energy Cooperation (SAREC).
- Invest in energy storage solutions such as:
- Pumped storage hydropower (to store excess power during low demand).
- Battery storage systems for grid stability and rural electrification.
- Develop a seasonal storage strategy to tackle the dry season's low generation.

7. Strengthen Policy, Institutional Capacity, and Governance

A strong legal and institutional framework is vital for sustained energy sector growth:

- Update and align national energy policies and strategies with long-term goals (e.g., SDG 7 and net-zero goals).
- Ensure effective coordination among entities like NEA, AEPC, DoED, and ERC.
- Strengthen regulatory bodies to ensure fair pricing, transparency, and quality standards.
- Encourage decentralization of energy governance to empower local governments and communities.

Conclusion

Nepal has successfully transitioned from an era of prolonged load shedding (2008–2016) to becoming a seasonal electricity exporter by 2024. With major hydropower projects completed and regional trade through the Indian Energy Exchange (IEX) and bilateral agreements, Nepal now exports hundreds of megawatts of surplus power during the wet season.

However, due to the seasonal nature of run-of-river hydropower, Nepal still depends on electricity imports from India during the dry season. This shows that while Nepal has achieved significant progress, it is not yet fully energy self-reliant year-round.

To ensure full energy independence, Nepal must now focus on developing reservoir-based hydropower, solar power, and energy storage systems to bridge the seasonal gap and stabilize supply.

The country has not only become self-sufficient in power production to a certain extent but it has also turned from an energy importing country to an energy exporting country conclusion.

To become self-reliant in electricity, Nepal must leverage its natural resources wisely, diversify its energy mix, invest in infrastructure and technology, and create a supportive environment for investment and innovation. A balanced approach combining hydropower dominance with renewable diversification, smart grid systems, regional cooperation, and energy efficiency will ensure not only energy independence but also economic growth, sustainability, and improved quality of life for all.

Reference:

This article data collection from NEA A year in review - Fiscal Year 2023-2024 Annual Report

Architects as a Strategic Pillar for an Energy-Sustainable Nation

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Nepal's rapid urbanisation, with millions of homes constructed and damaged over the past decade, has placed unprecedented demands on its energy resources. The nation is moving forward with ambitious targets to achieve negative carbon emissions by 2050 and net zero by 2045. In this context, engineering branches, predominantly architectural engineering, could provide a robust framework to surpass global expectations. Now, the question remains, how?

The Building Energy Efficiency in Nepal (BEEN) report suggests that in FY 2078/79, the building sector, primarily residential buildings, accounted for 60.59% of the total energy consumption in Nepal. Interestingly, designing impactful residential areas is a fundamental yet crucial part of architectural practice. Additionally, by integrating climate-responsive design, low-embodied-energy materials, and controlled energy consumption systems, architects can transform models into buildings and bring the dreams of an energy-efficient Nepal into reality.

NEA's FY 2023/24 report stated that the total domestic electricity consumption was 10,243 GWh, while the total available energy in the system was 13,966 GWh. It is almost 73% of the total available energy. Residential consumption has the largest share of domestic consumption. That being the case, a well-designed infrastructure can lower energy consumption by almost 30% compared to a conventional structure. Nepal's urban population is expected to exceed 50% by 2035, with the construction of millions of new buildings. This trend increases the demand on the national grid, especially during harsh seasons, for cooling in summer and heating in winter. Research on constructing energy-efficient buildings has discovered that more than 40% of the energy is used for heating and cooling in new residential structures. Furthermore, with sufficient architectural brilliance, redesigning Nepal shall no longer remain just on paper.

In Architectural Engineering, designing structures is not just about making them visually pleasing; it is also about how the building breathes and how efficiently it consumes energy. Architects design structures staying within the basics of engineering. Although most designs are tailored to meet clients' requirements, governmental schemes can significantly influence the choice of energy-efficient designs. Furthermore, with a proper understanding of local climate, practical constraints, and energy-related challenges, a system of legal code could be introduced before the construction design.

In the context of Nepal, we have Traditional Buildings and Modern Residential Houses as existing structures, with a minor percentage of high-rise buildings currently under construction. The concept of passive housing, environmentally and energy-friendly buildings is not new in Nepal, yet it is not widely practised. While 40% of energy is consumed in heating and cooling houses in our country, the introduction of the Passive Housing concept into the system allows buildings to achieve an average energy saving of 75%.

Passive houses reduce energy consumption by almost 90% during the summer season for cooling and a similar amount during the winter season for heating. Introducing solar heating and natural ventilation makes heating and cooling simpler, reducing a significant chunk of electricity consumption throughout the year.

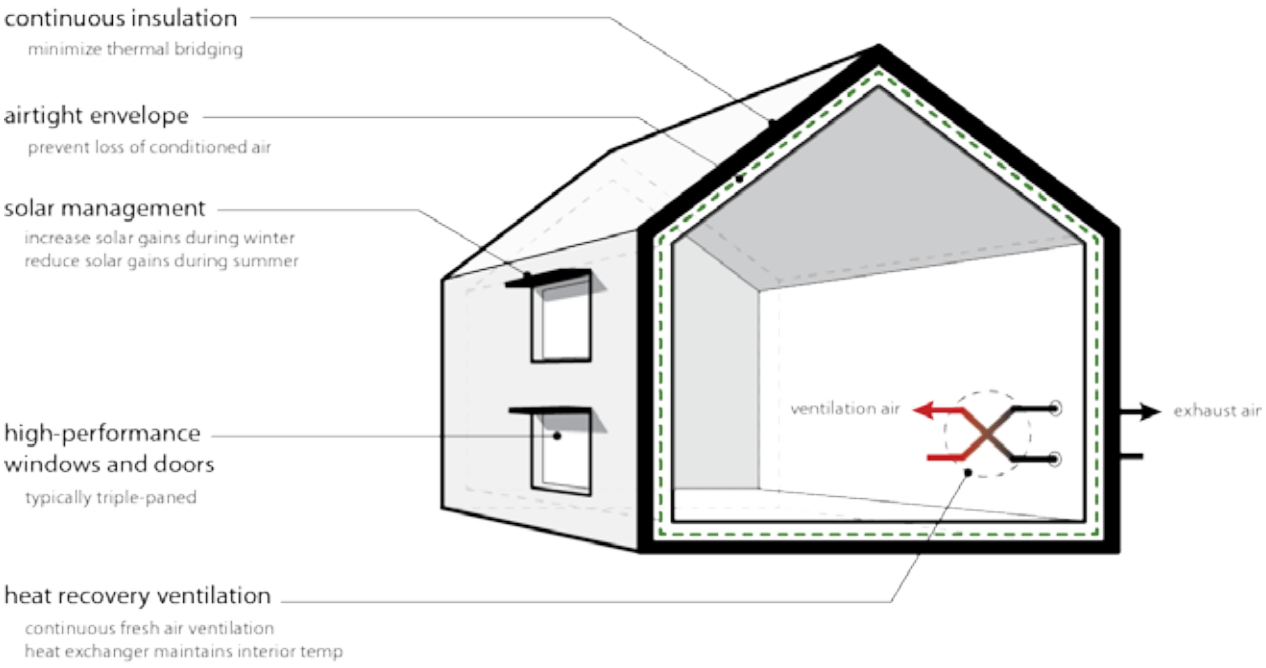

Fig: Illustration of key passive housing features.

The underlying fundamental of these residential houses is the orientation and direction of the structure. Nepal is divided into three geographical regions and five climatic zones influenced by its varying terrains and altitudinal features. Climate-responsive building orientation involves positioning a building to align with the sun's light path and prevailing wind direction, thereby maximising airy features. The heat and wind that enter the structure determine whether or not it is energy efficient in a broader context. If the building's walls, windows, ventilation, openings, and other considerable passive design components are properly organised, then the requirement for an artificial cooling system is minimised.

For climate-responsive orientation, natural ventilation and cross-airflow designs are more preferable. Strategic zoning and design allow air to move and buildings to accept maximum daylight with controlled glare. It further reduces the dependence on artificial lighting during the day, which is common in traditional houses.

Architectural designs are not always uniform and often vary significantly, depending on the region of construction. This factor dictates the distinction of construction materials. After

orientation, the concept of thermal mass must be utilised efficiently in designs to achieve an optimal energy outcome. Essentially, thermal mass refers to a material's ability to absorb, store, and release heat as needed, and it should be incorporated variably based on diverse geographical regions. Materials like concrete, brick, stone, and adobe are widely accepted and effective in controlling thermal mass.

Thermal mass control constitutes another fundamental concept of insulation. It is yet another fundamental requirement in a passive housing system. It allows the building to remain cool, maximising heat loss during summer and minimising heat loss in the winter. Materials such as EPS, glass wool, cotton, and cellulose are primarily used for insulation in buildings.

Furthermore, comparing Traditional (Old) and Modern Houses with the Passive House System, the understanding of the fundamentals of redefining Nepal as an energy-efficient nation is further clarified. For an architect in the modern world, imagining a nation with optimised electricity consumption is all about introducing passive housing to the general public. Educating undergraduates on this particular trend, running campaigns and notably considering this idea of housing in national law makes it more reachable.

Besides architectural designs integrated with Passive Housing Concepts, investing in green infrastructures would be crucial for building an energy-efficient Nepal. The integration of this concept during the construction of modern houses enables nature-friendly solutions to the country's energy crisis. The fundamental principle behind green infrastructure in optimising energy consumption is the introduction of sustainable design principles, as previously implemented in China.

The Chinese initiative to include the "Green building Action Plan" (2020) within the major timeline has enabled them to grow rapidly in green technology, minimising energy consumption to a greater extent. Allowing such plans to flourish helps Nepal achieve its dream of becoming an energy-efficient nation.

In closing, while Nepal is in the early stages of development, there is an undeniable contribution of architectural engineers, particularly in preparing the framework for the future. The dream of millions of Nepalese for an energy-sustainable nation, despite rapid urbanisation and climatic challenges, has brought accountability and answerability to the engineers. With proper planning and execution of passive strategies, as well as the introduction of green infrastructure, Nepal's excess energy consumption is expected to reach zero within a couple of decades. This is not just about reducing energy bills; it is about redefining a nation's identity, and we, as architects, have to plan the path to sustainability.

Electrifying Nepal's Transportation Sector: Legal Infrastructure for EV Charging Networks

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Abstract

Nepal, with major hydropower potential, faces critical challenges in the paradigm shift from fossil fuel-based transportation to a cleaner alternative. Electric vehicles have gained popularity, indicative of rising environmental concern and the economic burden posed by fuel imports. However, the legal and policy framework on EV infrastructure development, mainly on charging networks, is still in its infancy. The paper covers energy and transport blocks in Nepal, the rise of EVs itself, and other national legal instruments in their promotion of clean mobility, such as the National Transport Policy, Electricity Act, and Environment Protection Act. It then describes the roles of the key players such as Nepal Electricity Authority (NEA), the Alternative Energy Promotion Centre (AEPC), and the Department of Transport Management (DoTM). The study also makes an analysis of licensing, safety standards, tariff regulations, investment incentives, and the impact of urban planning regulations. Legal loopholes, inadequate infrastructure, and perception building are some of the constraints in harnessing the EV potential of the country, and reforms must tackle these.

Keywords: Electric Vehicles (EVs), Charging Infrastructure, Legal Framework, Hydropower Energy, Sustainable Transport

1. Background on Nepal's Energy and Transport Landscape

Nepal is a beautiful, small, and sublime country in South Asia, endowed by nature with rivers and mountains. Behind the idyllic beauty, the country faces major challenges in energy and transportation sector. Transport sector in Nepal is largely dependent upon imported petroleum products. According to the Department of Customs[1], Nepal spends billions of rupees every year to import fossil fuels like diesel and petrol. These fuels not only offer an expensive pathway but also pollute the environment. In other words, Nepal has enormous potential for clean energy. There are scads of rivers and streams flowing all over the country that can be utilized to generate hydroelectricity. Hydropower is clean and renewable energy. Shrestha & Shrestha (2019)[2], in an article published in the Journal of Renewable Energy, have estimated that Nepal can economically generate a little more than 40,000 MW of hydroelectric

1 Department of Customs. (2023). *Annual Trade Statistics*. Government of Nepal.

2 Shrestha, R., & Shrestha, P. (2019). Hydropower Development in Nepal: Status, Challenges, and Future Directions. *Journal of Renewable Energy*, 8(2), 15–22.

power. However, tragically, only a small fraction of this hydropower potential is being harnessed at present. The total power generation capacity is still insufficient to meet all demands of the country, especially during peak hours.

Roads are often congested and poorly maintained in Nepal concerning transportation. Most vehicles in Nepal are diesel and petrol-powered. Number of vehicles is growing every year, which in tandem grows pollution. As per the Ministry of Physical Infrastructure and Transport[3], Kathmandu is facing tremendous traffic issues and growing air pollution situations brought about by fossil-fuel-powered vehicles. This goes on to be a great threat to human health and environment. Electric vehicles appear to be the new horizon toward these problems. They are cleaner in the sense they do not produce harmful smoke or gases. Also, they may harness electricity generation from Nepal's own hydropower, so the country can save some foreign exchange that is otherwise spent on buying fuels from outside. According to Thapa & Joshi (2021)[4] in Nepalese Journal of Environmental Policy, the promotion of electric vehicles to reduce air pollution; make the cities of Nepal cleaner and a healthier place. The government of Nepal has started promotion of electric mobility. National Action Plan for Electric Mobility 2020[5] envisions that 25% of all vehicles will be electric by 2025. The government also provides tax benefits and other incentives to EV buyers. Yet, challenges like the lack of charging stations, poor infrastructure, and unclear laws exist.

2. Rise of Electric Vehicles (EVs) in Nepal

Electric vehicles or EVs are gaining a lot of popularity in Nepal as an alternative to petrol and diesel. On the contrary, these vehicles are clean, silence, and friendly towards the environment. In the last few years, many have started to look towards electric vehicles in Nepal because of high fuel prices and worsening air pollution.

When EVs were first set up in Nepal, their growth was slow at first. The "Safa Tempo" was one of the earliest electric vehicles in Nepal: these are mini three-wheelers that functioned as public transport in Kathmandu. According to Shrestha & Bajracharya (2018)[6] in the Journal of Sustainable Transportation, Safa Tempos have been running since the 1990s and worked toward pollution reduction in the city.

In recent years, electric cars, scooters, and buses have begun to be purchased increasingly more by various people. Electric vehicles are presently being sold in Nepal by BYD, Tata, and Hyundai. The number of electric vehicles sold rose more than 200% in the year 2022[7] as compared to previous years, said the Nepal Electricity Authority (NEA), indicating a growing interest of the people toward clean transportation.

3 Ministry of Physical Infrastructure and Transport. (2020). *Annual Transport Report 2020*. Government of Nepal.

4 Thapa, R., & Joshi, M. (2021). Promoting Electric Vehicles in Nepal: Environmental and Economic Benefits. *Nepalese Journal of Environmental Policy*, 5(1), 33–40.

5 Government of Nepal. (2020). *National Action Plan for Electric Mobility*. Ministry of Energy, Water Resources, and Irrigation.

6 Shrestha, S., & Bajracharya, C. (2018). Role of Safa Tempos in Promoting Electric Public Transport in Kathmandu. *Journal of Sustainable Transportation*, 4(1), 12–18.

7 Nepal Electricity Authority. (2022). *EV Charging Infrastructure Report*. Government of Nepal.

A change is also being supported by the government. In line with that assumption, this government has reduced customs duty and road tax on electric vehicles. According to Dhungana (2021)[8] in Nepal Policy Review, government policies as well as an increase in public awareness have really influenced the growth of EVs in Nepal.

There are still some challenges here, however, as the EV sector is growing. The greatest challenge: the shortage of charging stations. Buyers may hold back to buy EVs if they feel there would be a challenge in charging them. With increased investment and better-regulated policies, however, the future for EVs in Nepal is certainly bright.

3. Legal and Policy Framework for EV Infrastructure in Nepal

a. National Transport Policy and EV Promotion

Electric vehicles (EVs) are to be promoted by the government under its national transport policies. These are norms and objectives that state how a transportation system ought to grow in the country. Due to increasing pollution and rise in fuel prices, the government has now been interested in exiting the petrol and diesel vehicle-laden environment in favor of electric vehicles.

A first attempt at improving transportation was made under the National Transport Policy, 2001. However, in the years afterward, it was updated with an eye on clean and green mobility. To promote Electric Vehicles, the Electric Mobility Promotion Plan (2020–2030)[9] was brought in. According to Basnet & Koirala (2020) in the Journal of Clean Energy Development, the plan has principals such as 25% of vehicles running on electricity by 2025.

There are tax incentives and concessions on import duties for the purchase of electric vehicles in this policy. This makes the model relatively cheaper and more affordable for the common man. The government also intends to increase the number of charging stations all over the country.

3.2 Electricity Act and Renewable Energy Policies

Several laws have been implemented for managing electricity and encouraging clean energy in Nepal. One famous law is the Electricity Act of 1992[10]. This law governs electricity development, generation, and distribution. It allows private companies to generate electricity in the country, mostly from hydropower. Since Nepal has many rivers, the possibilities to generate clean energy are very high. The Renewable Energy Policy, 2006[11], also supports the use of clean sources such as water, wind, and solar power. These policies become vital for electric vehicles (EVs) as EVs run on electricity. When electric energy is

8 Dhungana, R. (2021). Electric Mobility in Nepal: Policies and Progress. *Nepal Policy Review*, 3(2), 45–50.

9 Government of Nepal. (2020). *Electric Mobility Promotion Plan (2020–2030)*. Ministry of Energy, Water Resources, and Irrigation.

10 Government of Nepal. (1992). *Electricity Act*. Ministry of Water Resources.

11 Government of Nepal. (2006). *Renewable Energy Policy*. Alternative Energy Promotion Centre (AEPC).

harnessed from clean sources, it helps to further reduce pollution. According to Adhikari & Tiwari (2020)[12] published in the Journal of Energy Policy and Management, these laws ease the starting of new energy projects and help in linking the charging stations of electric vehicles to the national grid. An article in The Himalayan Times (2021)[13] mentioned that the government of Nepal is updating the archaic electricity laws to meet the demand of new energy systems, including EVs.

3.3 Environment Protection and Urban Planning Laws

To make cities clean and safe, Nepal has established laws dealing with environment protection and urban planning. These laws are connected to electric vehicles (EVs) as well since such vehicles reduce air pollution and require proper infrastructure, such as charging stations and the resilient distribution of network. One of the most important ones is the Environment Protection Act, 2019[14]. This law deals with pollution prevention and conservation of natural resources. It states that projects such as EV charging stations are required to conduct an Environmental Impact Assessment (EIA), if they are of large size, in order to make sure that these projects do not cause harm to nature. According to Gautam & Acharya (2021)[15] in the Journal of Environmental Law and Policy, this law stands for the promotion of green technology and hence for promoting the EVs. Also, the country has urban planning laws such as the Town Development Act, 1988[16], the Laws governing the development of urban areas. These enable the government to reserve land for public use, which includes EV charging stations. A report from The Kathmandu Post (2022)[17] mentioned that local governments are now planning to incorporate green transport and charging points into city layouts.

4. Regulatory Landscape for EV Charging Stations

a. Licensing and Permits

Businesses need licenses and permits to legally build and run electric vehicle charging stations in Nepal. Such legal authorizations help ensure the stations are genuinely safe and laid down per government rules. The process usually involves applying for permits from local government offices and the Nepal Electricity Authority (NEA). According to Khadka & Sharma (2021)[18], published in the Journal of Energy Regulation, one must obtain a license to connect charging installations to the national power grid. Further,

12 Adhikari, B., & Tiwari, R. (2020). Electricity Law and Energy Access in Nepal. *Journal of Energy Policy and Management*, 4(1), 30–36.

13 *The Himalayan Times*. (2021, March 10). Government to Review Electricity Laws to Support EV Sector.

14 Government of Nepal. (2019). *Environment Protection Act*. Ministry of Forests and Environment.

15 Gautam, R., & Acharya, S. (2021). Role of Environmental Laws in Promoting Sustainable Transport. *Journal of Environmental Law and Policy*, 5(2), 19–25.

16 Government of Nepal. (1988). *Town Development Act*. Ministry of Urban Development.

17 *The Kathmandu Post*. (2022, April 14). Local Governments Eye EV-Friendly Urban Plans.

18 Khadka, R., & Sharma, L. (2021). Licensing Challenges for EV Infrastructure in Nepal. *Journal of Energy Regulation*, 3(1), 12–17.

local government authorities impose permits concerning use of land, construction safety amongst others. Hence charging stations without licenses cannot legally operate. The Kathmandu Post (2022)[19] suggests lax, unclear permit processes have discouraged many investors from taking up ventures in EV charging. The government therefore is engaged in streamlining licensing regulations to invite more investments. Having artisanal, rapid licensing certainly brings development to the EV charging network of Nepal, supporting the broader aspiration of cleaner transportation in the sisterland.

4.3 Standards and Safety Regulations

Standards and safety regulations ensure that safety is maintained at EV charging stations in Nepal for the user and environment. These are guidelines for the design, installation, and operation of the charging stations. Such regulations basically prevent mishaps such as electric shocks or fires. The Nepal Bureau of Standards and Metrology (NBSM)[20] works to formulate the standards for electrical machinery, including EV chargers. If one follows the standards, the chargers will work properly and be in long use, according to Sharma & Gurung (2022)[21] in the Journal of Electrical Safety. The Kathmandu Post, 2023[22]: Safety rules particular to EV charging stations would soon be formulated by the government for the protection of consumers and infrastructures.

5. Institutional and Governance Mechanisms

a. Roles of NEA, DoTM, and AEPC

Several government institutes assist in creating an EV infrastructure in Nepal. The Nepal Electricity Authority (NEA), which maintains the power supply system across all of Nepal, has its attention on establishing the power connection from charging stations. The NEA also intends to put up a charging network.[23]

The Department of Transport Management (DoTM) has vehicle registration and driving licenses under its control. It therefore seeks to promote the use of EVs by streamlining processes for vehicle registration and giving incentives to EV owners, according to Shrestha & Paudel (2021)[24] in the Journal of Transport Policy.

The promotion of renewable energy programs including EV infrastructure is one concern of AEPC. AEPC promotes the research, training, and investment in clean energy so that Nepalese transportation may become greener.[25]

19 *The Kathmandu Post*. (2022, June 5). Licensing Hurdles Slow Down EV Charging Station Growth.

20 Nepal Bureau of Standards and Metrology. (2021). *Electrical Equipment Standards*. Government of Nepal.

21 Sharma, P., & Gurung, R. (2022). Electrical Safety Standards for EV Infrastructure in Nepal. *Journal of Electrical Safety*, 7(1), 20–25.

22 *The Kathmandu Post*. (2023, May 10). New Safety Rules for EV Charging Stations Expected Soon.

23 Nepal Electricity Authority. (2022). *Annual Report*. Government of Nepal.

24 Shrestha, K., & Paudel, S. (2021). Institutional Roles in Promoting Electric Vehicles in Nepal. *Journal of Transport Policy*, 5(2), 28–33.

25 Alternative Energy Promotion Centre. (2021). *Renewable Energy Programs*. Ministry of Energy.

The Kathmandu Post (2022)[26] reports these agencies coordinate towards establishing the EV ecosystem in a sustainable way in Nepal.

6. Tariff Structure and Incentives

EV Charging Station Tariff

Voltage Level	Consumer Category	Demand charge (NPR/Kva/month)	Energy charge (NPR/kWh)
High Voltage (≥66 kV)	Public Transportation (charging station)	230	Peak : 7.00 Off-Peak : 3.70 Normal : 5.50
Medium Voltage (11 kV / 33 kV)	Public Transportation (Charging Station)	230	Peak : 7.15 OffPeak : 4.20 Normal : 5.60
Medium Voltage (11 kV / 33 kV)	Other Transportation	230	Peak : 9.65 OffPeak : 4.20 Normal : 8.50
Low Voltage (230/400 V)	Public Transportation (Charging Station)	200	Peak : 7.25 OffPeak : 4.30 Normal : 5.75
Low Voltage (230/400 V)	Other Transportation	220	Peak : 9.75 OffPeak : 4.30 Normal : 8.60

Time Slot	NEA Public Charging Rate (NPR/kWh)
Off – Peak (10 PM – 5 AM)	6.00
Daytime (5 AM – 5 PM)	9.00
Peak (5 PM – 10 PM)	11.00

7. Investment, Financing, and Incentive Mechanisms

a. FDI and Domestic Investment Opportunities

When companies from other nations invest in Nepal to start or enlarge industries, FDI comes into existence. This contributed to employment generation in Nepal, the transfer of new technology, and economic improvement (Adhikari, 2018)[27]. Domestic investment takes place when Nepalese themselves or local companies invest their money in local businesses or projects. FDI and domestic private investment are equally important for the development of Nepal because both are needed for laying infrastructure, factories, and services (Thapa & Gurung, 2020)[28]. The government provides several facilities such as duty-free import of capital goods, tax holidays, exemption from income tax, and so on to investors (The Rising Nepal, 2021)[29]. Nepal has prime investment potential in tourism, hydropower, and

26 *The Kathmandu Post*. (2022, August 15). Government Agencies Join Hands for EV Growth.

27 Adhikari, K. (2018). *Foreign Investment in Nepal*. Kathmandu: Nepal Economic Publishers.

28 Thapa, S., & Gurung, P. (2020). "Investment Opportunities in Nepal." *Nepal Economic Journal*, 10(3), 50-60.

29 *The Rising Nepal*. (2021). "Incentives to Boost Investment." July 5, 2021.

agriculture (Shrestha, 2019)[30]. Other than this, political instability hinders the pace of investment at times (Joshi, 2017)[31]. All in all, promotion of FDI and domestic investments is the way for economic development in Nepal.

8. Challenges in Fragmentation and Ambiguity in Laws

Nepal's legal system faces major challenges due to fragmented and ambiguous laws. Fragmentation means legal provisions are spread across various documents and institutions, making them difficult to access and interpret (Sharma, 2017)[32]. Ambiguity arises from unclear or vague language in the laws, often leading to confusion, disputes, and inconsistent application (Adhikari, 2019)[33]. These issues affect citizens, businesses, and officials alike, particularly in sectors like land ownership and foreign investment, where overlapping or conflicting regulations cause delays and legal hurdles (Thapa, 2020)[34]. According to *The Kathmandu Post* (2021)[35], such legal confusion undermines development efforts and erodes public confidence in the justice system. Experts recommend revising and simplifying the legal framework to promote transparency and coherence (Bhattarai, 2018)[36]. Additionally, public awareness and market readiness are essential for economic growth. Many people in Nepal lack adequate knowledge of their rights and new opportunities due to limited access to information (Kafle, 2019)[37]. Market challenges such as inadequate infrastructure and a shortage of skilled labor further hinder progress (Ghimire & Basnet, 2020)[38]. Education and media can play a vital role in improving awareness, enabling informed participation in the economy (*The Rising Nepal*, 2022)[39]. Training and awareness programs are thus crucial to prepare Nepal for future development (Sharma, 2018)[40].

9. Conclusion

Nepal is at a crossroads for sustainable transport, with EVs being an efficient, greenway of cutting down the import of fossil fuel and tackling urban air pollution in cities like Kathmandu. Though the country is endowed with a huge potential for hydropower generation, it has, of late, started using this clean energy for transportation. Other government initiatives for encouraging the use of EVs include the National Action Plan for Electric Mobility and tax incentives. However, the lack of an established legal framework for charging infrastructure

30 Shrestha, R. (2019). *Economic Development and Investment*. Kathmandu: Himalaya Books.
31 Joshi, M. (2017). "Challenges to Investment Growth." *Nepal Business Review*, 5(1), 14-20.
32 Sharma, R. (2017). *Legal Challenges in Nepal*. Kathmandu: Nepal Law Publications.
33 Adhikari, S. (2019). "Ambiguity in Nepalese Laws." *Nepal Law Journal*, 5(1), 12–19.
34 Thapa, M. (2020). "Conflicts in Land and Investment Laws." *Nepal Legal Review*, 8(2), 30–37.
35 *The Kathmandu Post*. (2021). "Legal Ambiguity Hurts Development." June 15, 2021.
36 Bhattarai, P. (2018). "Improving Nepal's Legal System." *Nepal Economic Journal*, 11(3), 22–28.
37 Kafle, D. (2019). *Public Awareness in Nepal*. Kathmandu: Social Science Press.
38 Ghimire, R., & Basnet, S. (2020). "Market Readiness in Nepal." *Nepal Business Review*, 9(1), 45–52.
39 *The Rising Nepal*. (2022). "Education Key to Economic Growth." March 10, 2022.
40 Sharma, P. (2018). "Importance of Awareness and Training." *Nepal Development Journal*, 7(3), 18–25.

serves as a big impediment to the nation. Fragmented laws and varying procedures for licensing along with poor coordination among concerned regulatory agencies are slowing the progress on and the promotion of an EV sector. Legal reforms need to be carried out in totality to unleash Nepal's renewable energy potential. Legislations, including the Electricity Act, Environment Protection Act, and urban planning regulations, need harmonization along with the stipulation of specific standards for infrastructural requirements for EVs. Awareness-building and market readiness through education and incentives are equally important. In order to streamline and effectively implement policies, key institutions such as the NEA, DoTM, and AEPC need to work in close collaboration. Having a set of transparent and conducive regulations in place could fast track investments from both within Nepal and abroad. With proper legal and institutional backing, Nepal can build a sustainable network for EV charging that secures energy, promotes economic growth, and safeguards the environment, making it a green-mobility hub in South Asia.

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Securing NEA's Digital Infrastructure with Cybersecurity

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Nepal's power sector is being rapidly modernized. In recent years, NEA has started to implement advanced technologies like smart grids, smart metering and also substation automation. One major change includes expanding renewable integration. These must-needed innovations such as mobile apps and online billing help increase productivity, reliability, and customer service. They do however also introduce cyber risks. Digital systems and internet connected devices now monitor and control generation, transmission, and distribution. NEA's own reports note that it has "digitized infrastructure and services" and introduced online portals so customers can pay bills, report issues and access outage information. While this "Digital transformation has empowered NEA" to enhance the customer experience, it also makes the grid a high value target. In this modern energy era, cyber security is very crucial for every industry ranging from small to big. Even a single breach could disrupt power supply and put public safety at risk ultimately weakening public trust. That's why strong cyber defenses are very essential for Nepal to unlock the full potential of a smart and efficient energy system.

The Digitalization of NEA

NEA's digital transformation spans every level of the grid. At the customer interface, NEA has rolled out online services including web portals and mobile apps and a centralized call center (hotline "1150"), allowing millions of Nepalese to pay bills electronically, report outages and get support. Internally, NEA is modernizing its operations. It is automating its distribution and transmission systems, building new high-voltage substations, and upgrading its SCADA and load dispatch centers. The introduction of Advanced Metering Infrastructure (AMI) is underway, and will replace millions of electromechanical meters with smart meters that will support real-time data. These meters allow two-way communication between homes and utility, enabling load management and much faster fault detection. Other wonderful digital initiatives include implementing an enterprise resource planning (ERP), geographic information system (GIS) and customer relationship management (CRM) system. These changes give NEA powerful new capabilities. Also these real-time monitoring and control make the grid more efficient and reliable. Now faults can be isolated quickly, and the electricity flows can be optimized. Smart meters also help reduce the losses and manage peak demand. Digitized processes improve responsiveness and transparency (e.g. automating billing and complaints). NEA can even export surplus power on short notice thanks to enhanced data sharing. In short, Nepal's grid is becoming smarter and greener, but with digital integration everywhere, it's certain that the attack surface is also growing. So cyber security must also evolve side by side.

Cyber Threat Landscape in Energy Infrastructure

The global energy sector has become a prime target for cyber adversaries. Unlike other assets, the power grid touches every part of society, homes, hospitals, industry and national security. Disrupting electricity can quickly paralyze a region. Moreover, modern grids rely on Operational Technology (OT) specialized control systems (SCADA, PLCs, RTUs, etc.) which are often built by third-party vendors and designed for reliability more than security. Hackers, criminal syndicates and even nation-states see huge leverage in attacking this infrastructure.

In recent years, there have been serious warnings about cyber attacks on the energy systems, which has been called a warning signal for all. In December 2015, Ukraine had experienced a coordinated cyber attack where hackers caused blackouts for over 225000 customers taking control of breakers at three regional utilities. The attack happened when these attackers used malicious software to wipe important control systems and disrupted communication devices to disable substations. A year later, Ukraine faced another attack where attackers used a malware called "Crash Override". This new malware could send harmful commands to grid devices, rapidly opening and closing breakers, causing disruption. These incidents highlight how vulnerable poorly secured control systems are which also justifies how cyber-attacks on energy systems are rising globally. In 2021, the Colonial Pipeline in the US was hacked, causing major fuel shortages. Even though it was not a part of the power grid, it showcased how vulnerable energy infrastructure could really be. In Europe alone, cyber-attacks on energy firms doubled from 2020 to 2022, which in many cases included ransom ware. In 2022 alone, there were around 1,100 reported attacks on utilities worldwide. Most of the energy companies have faced breaches, and many of them fear that one successful attack could shut down operations. In practice, even one compromised meter, substation controller, or communication link can lead to a big problem. Attackers might start with a phishing email to an engineer, then move through the network to control servers, and then cause damage by misoperating breakers or generators. Supply-chain vulnerabilities, like unpatched software or hacked IoT devices, double the existing risk. As Nepal's grid becomes more connected, including cross-border links with India, a breach could spread beyond NEA's network. The energy sector is seen as a "soft target" by cybercriminals. For example, a blackout in Kathmandu during the monsoon season could harm the hospitals, disrupt communications, many industries will suffer loss, and cause public panic. It could also affect foreign exchange earnings from power exports and the investors might also lose faith in it. Therefore, Nepal's modernizing grid is critical national infrastructure and a high-value target for cyber-attacks.

Key Cyber security Risks Faced by NEA

NEA has paved a way for smart energy which has also bought several vulnerabilities:

1) SCADA/Control Systems: Many of NEA's control centers and substations run legacy ICS and SCADA platforms (e.g. Siemens and ABB systems). These technologies were often not designed with modern cyber threats in the mind. The common risks includes weak or hard-coded credentials, outdated operating systems, and unencrypted protocols. If the attackers gain access to these systems, they could inject malicious commands to circuit breakers, transformers or generators, causing blackouts or equipment damage (as seen in Ukraine)

2) Smart Meters and AMI: NEA's smart metering initiative greatly improves data visibility, but also expands the attack surface. Millions of smart meters and their wireless networks could be hacked or spoofed. Attackers might manipulate meter readings or even remotely disconnect customers. If meter data is sent to a central MDMS (Meter Data Management System), compromising that system could provide attackers with a wealth of network topology and usage data.

3) Substation Automation and IoT: New substations and distribution feeders are being equipped with Internet-connected relays, sensors and automation controllers. These type of IoT devices are often bought from various vendors and there is a high chance of them containing various vulnerabilities or insufficient authentication. If hackers get a way to penetrate a substation LAN, they could reconfigure protection settings or send false telemetry, undermining grid stability.

4) Interconnected Grid/Supply Chain: Nepal's grid is increasingly interconnected domestically and with India. A breach in one region or linked network could propagate. For instance, malware planted in equipment procured abroad could slip into NEA's network which is a classic supply-chain risk. Any third-party vendor or contractor having network access (for example, to update software on NEA systems) is a potential entry point if not thoroughly vetted.

5) Remote Access and OT-IT Convergence: NEA's digitization means more and more of remote connectivity, For example engineers can work from remote offices or smartphones accessing network dashboards. This convergence of IT and OT networks can blur security boundaries. Poorly segmented networks or weak VPN configurations might give a chance for an attacker in the business network to reach operational systems. Phishing or credential theft on the IT side could translate into OT compromise.

6) Human Factor: All the technology is ultimately managed by people. Social engineering attacks (phishing emails posing as colleagues or utility alerts) could trick even staff into revealing passwords or clicking malicious links. A single compromised account could bypass many technical safeguards.

NEA's Current Cybersecurity Measures

Recognizing these several risks, NEA has started improving its cyber security to protect its digital infrastructure. As per the official reports, they are taking bold steps. Firstly, they are strengthening their infrastructure by using firewalls, intrusion detection systems, web application firewalls (WAF), and tools to block DDoS (Denial of Service) attacks. Secondly, they use monitoring systems like SIEM (security information and event management) and NDR (Network Detection and Response) to watch for any strange activity in real time. Thirdly, In Syuchatar, NEA has built its own Data Center to safely host important services like billing and GIS. Also, for better network safety, they are using SD-WAN to divide and secure traffic across locations and are setting up secure access points and LANs that allow only trusted devices. Further, NEA has also updated its IT Policy in 2023 to follow Digital Nepal goals. This includes rules for audits, strong passwords, and using multi-factor login for important systems. Staff training is part of the plan too; emails, phishing, and reporting problems are covered in memos and training sessions. Overall, while the system is still developing, these steps like building a data center, using firewalls, and updating policies show NEA is really serious and its efforts are fabulous to keep the grid secure.

Global Best Practices and Recommendations

While NEA has made an admirable progress, the global energy sector still continues to set higher standards in cybersecurity. NEA can benefit a lot by adopting or aligning with the following international best practices:

1) International Standards: Many countries require adherence to cybersecurity frameworks. As for example, North American grid operators must follow NERC CIP (Critical Infrastructure Protection) standards, which cover everything which goes from network segmentation to incident reporting. Adopting elements of IEC 62443 (for industrial automation security) and IEC 62351 (security for power systems protocols) can strengthen NEA's programs.

NEA should also consider aligning its policies with such best-practice guidelines, which we can also call it as a protocol. For example, NEA could follow trusted frameworks like NIST's ICS security guide or IEC standards carrying out regular cybersecurity audits, run vulnerability scans, and manage the patches effectively. These steps will help identify the weaknesses early and keep systems up to date and attack free.

2) Real-Time Threat Monitoring: Advanced utilities have special teams called Security Operations Centers (SOCs) that watch their networks all the time using smart tools and AI to spot threats. AI helps find new kinds of attacks or unusual activity in connected devices. NEA has started using a tool called SIEM to do this, but they can improve this by adding machine learning to catch tactful attacks. Around the world, many utilities have dedicated SIEM teams working 24/7 to check for problems and send alerts quickly.

3) Cybersecurity Exercises: Regular drills and "war games" must be organized. In Europe, energy companies participate in annual exercises (e.g. EU Cyber Europe drills) simulating grid attacks. In the U.S., the Department of Homeland Security runs GridEx to test utility response. NEA (together with Nepal's National Energy Control Centre) should organize inter-departmental simulations: for example, a mock cyber-incident causing a substation loss, requiring coordinated response. These exercises build up muscle memory and expose gaps in incident plans. Emergency response teams, IT staff and executives should practise roles, communication protocols and the recovery steps.

4) Dedicated Cyber Workforce: Internationally there is a trend that utilities invest in specialized cybersecurity personnel. NEA could form a cybersecurity unit within its IT department which are staffed by experts trained in ICS security. Positions like ICS security analyst, forensic investigator and OT network engineer can be formed which would ultimately institutionalize cyber defense. Joint training with law enforcement and CERT agencies can also help. As global surveys note, there is a severe shortage of qualified cyber professionals. NEA may need to collaborate with universities or participate in international training programs to build expertise.

5) International Collaboration: Cyber threats do not consider borders, so cooperation is the key. NEA should join global information-sharing organizations (e.g. INL's ICS-CERT, CERT-EU forums, ASEAN Grid Security networks). Sharing threat intelligence – such as details of phishing campaigns or malware signatures – can alert NEA to new dangers. Moreover, NEA's experiences could benefit neighboring countries (e.g. Bhutan or India's grid authorities), building a regional defensive network. Tech partnerships with international agencies (ADB, World Bank energy cybersecurity projects) can also bring in expertise and funding. For instance, the ADB has funded NEA's smart grid projects.

6) Holistic Governance: Utilities globally are extending governance beyond tech to culture and processes. This includes third-party risk management (vetting suppliers and contractors for cybersecurity compliance) and formal incident-response plans (including legal counsel, PR, and coordination with police). NEA should ensure that every contract (for hardware and software services) includes the necessary security requirements and audit rights. It can also adopt the practice of "least privilege" that is giving contractors only the minimum network access needed and further requiring timely patch updates for vendor equipment.

7) Benchmarking and Metrics: Smart organizations use clear metrics like how fast they detect threats or how many critical patches get applied on time. These things help them stay on top of their cybersecurity game. NEA could build a simple dashboard to track these key performance indicators

(KPIs), making it easy to monitor progress . Lastly this will help keep both leadership and regulators in the loop.

Building a Culture of Cybersecurity

Technology alone is not enough at all. A security-conscious culture is a must at NEA. This means every employee, contractor and even customer must play a vital role:

1) Employee Awareness: NEA should make cybersecurity training for all. This includes staff from field technicians to top managers. They need regular briefings on the latest cyber threats like phishing tactics, social engineering and malwar. They should also be encouraged to use strong password and not plug in unknown USB drives. Simple steps like enforcing multi-factor authentication for VPNs or desktop logins will improve cyber hygience. Routine phishing drills like sending fake malicious emails to see who clicks can keep people vigilant. Encouraging a mindset of "assume breach" where users question unusual requests and report them reduces human risk.

2) Incident Reporting and Transparency: All employees and contractors should know how to report suspicious events (strange emails, unusual outages) immediately. NEA can establish an internal hotline or portal for reporting. Management must treat reports seriously and without blame. Transparency in dealing with incidents (e.g. after a phishing test or minor breach, sharing lessons learned) helps build trust and ensures mistakes are corrected.

3) Engaging Partners and Suppliers: Vendors and service providers should be part of the security culture. NEA can hold security workshops for partner companies and require them to follow NEA's security protocols (e.g. no use of personal devices on sensitive networks, encrypted communications). Contracts can include penalties for security lapses. Subcontractors working in substations or IT shops should sign non-disclosure and security agreements, and undergo background checks.

4) Consumer Education: While NEA's main duty is the grid, raising public awareness indirectly helps security. For example, NEA newsletters or social media could advise customers to protect their smart appliances or report unauthorized access to smart meters. If consumers are aware of cybersecurity, they may avoid actions (like installing unapproved wireless extenders near meter boxes) that could create vulnerabilities.

5) Leadership and Policy Alignment: Top leadership must actively support cybersecurity. When executives and board members make cybersecurity a priority in their strategies and budgets, it sends a clear message throughout the organization. NEA should align its cybersecurity objectives with national policies, such as Nepal's emerging National Cybersecurity Strategy. Recognizing and rewarding good security practices. For example, acknowledging employees who prevent phishing attacks also helps strengthen the security culture.

Conclusion

Nepal's energy transformation is moving forward rapidly. A reliable, smart power system is no longer just a vision, it is becoming a reality. However, its digital foundation must be well protected. NEA must be aware that strong cybersecurity is crucial in this new era. Securing NEA's digital infrastructure is more than an IT responsibility; it is a national priority. It is also crucial since the power grid supports the economy, healthcare and transportation. Looking ahead, NEA must maintain a proactive approach by continually improving defenses. As the threat landscape changes very rapidly investing in skilled people and technology will be best. It should also be working with international partners. By following global best practices and creating a strong culture of cybersecurity awareness, NEA can easily protect Nepal's electricity supply. This will ensure the vision of a smarter and greener energy. When these things are achieved the country's future will not be threatened by cyber risks and ultimately Nepal's power will remain safe and reliable, no matter what challenges arise.

नेपाल विद्युत प्राधिकरण

अनिवार्य अवकाश प्राप्त कर्मचारीहरूको विवरण

२०८१ माघ १ गते देखि २०८२ असार मसान्तसम्म

सि नं.	क.स.नं.	तह	पद	नाम थर	अवकास मिति	अवकासको किसिम	कार्यरत कार्यालय	कैफियत
१	१५४००२	६	सहायक ईन्जिनियर	नेत्रध्वज थापा	२०८१/१०/०१	अनिवार्य	काठमाण्डौं उपत्यका मध्य तथा उत्तर वितरण प्रणाली सुदृढीकरण आयोजना	
२	१४९९१६	३	मिटर रिडर	अशोक लुइटेल	२०८१/१०/०१	अनिवार्य	दुहवी ग्रिड महाशाखा	
३	१८३७१०	४	फोरमेन	गितादेवी बुढाथोकी	२०८१/१०/०३	अनिवार्य	काठमाडौ ग्रिड महाशाखा	
४	१९७७६२	७	प्रशासकीय अधिकृत	राजकुमार कडरिया	२०८१/१०/०४	अनिवार्य	तालिम व्यवस्थापन विभाग	
५	११७१८३	५	सुपरभाईजर	प्रदिप पौडेल	२०८१/१०/०४	अनिवार्य	अनारमनी वितरण केन्द्र	
६	१४१७४९	७	प्रशासकीय अधिकृत	अंग बहादुर खड्का	२०८१/१०/०७	अनिवार्य	जनशक्ति योजना तथा विकास शाखा	
७	१४४६१७	३	ईलेक्ट्रिसियन	रामशरण बाटा	२०८१/१०/११	अनिवार्य	भक्तपुर वितरण केन्द्र	
८	१८८०४६	१२	उप-कार्यकारी निर्देशक	मनोज सिलवाल	२०८१/१०/१२	अनिवार्य	वितरण तथा ग्राहक सेवा निर्देशनालय	
९	१३५८५७	१२	उप-कार्यकारी निर्देशक	रामजी भण्डारी	२०८१/१०/१२	अनिवार्य	इन्जिनियरिङ्ग सेवा निर्देशनालय	
१०	१६८९५०	१२	उप-कार्यकारी निर्देशक	लोकहरी लुईटेल	२०८१/१०/१२	अनिवार्य	अर्थ निर्देशनालय	
११	१४९८१४	६	सहायक लेखा अधिकृत	जुवेर अहमद खाँ	२०८१/१०/१३	अनिवार्य	तुलसीपुर वितरण केन्द्	
१२	१३९९८१	६	सहायक लेखा अधिकृत	रविनभक्त कायस्थ	२०८१/१०/१५	अनिवार्य	सिन्धुपाल्चोक वितरण केन्द्र	
१३	१२५४२७	२	कार्यालय सहयोगी	मुकुन्द प्रसाद भट्टराई	२०८१/१०/१५	अनिवार्य	हेटौंडा वितरण केन्द्र	
१४	१३७५४६	३	मिटर रिडर	गोविन्द प्रसाद पोखरेल	२०८१/१०/१५	अनिवार्य	कञ्चनपुर वितरण केन्द्र	
१५	१७५२८४	३	ईलेक्ट्रिसियन	मुक्त बहादुर गुरुङ्ग	२०८१/१०/१५	अनिवार्य	गोरखा वितरण केन्द्र	
१६	१२५३००	३	मिटर रिडर	यज्ञ बहादुर घिमिरे	२०८१/१०/१५	अनिवार्य	इटहरी वितरण केन्द्र	
१७	१६१७४९	७	लेखा अधिकृत	गंगादेवी तभ्या श्रेष्ठ	२०८१/१०/१७	अनिवार्य	लेखनाथ वितरण केन्द्र	
१८	१५९७९८	५	लेखापाल	विनोद खनाल	२०८१/१०/१९	अनिवार्य	बागमती प्रादेशिक कार्यालय, काठमाण्डौं	
१९	११८६२९	६	सहायक ईन्जिनियर	तुलसी प्रसाद भट्टराई	२०८१/१०/१९	अनिवार्य	उर्लावारी वितरण केन्द्र	
२०	११३७९९	३	मिटर रिडर	दुर्गा बहादुर अधिकारी	२०८१/१०/२०	अनिवार्य	लमजुङ वितरण केन्द्र	
२१	१४७९५८	३	ईलेक्ट्रिसियन	खेमराज पौडेल	२०८१/१०/२६	अनिवार्य	धुलावारी वितरण केन्द्र	
२२	१९८९६८	३	मिटर रिडर	सतिस कुमार पौडेल	२०८१/११/०१	अनिवार्य	विराटनगर वितरण केन्द्र	
२३	११४४९४	५	सुपरभाईजर	चम्पक थापा	२०८१/११/०४	अनिवार्य	काभ्रे वितरण केन्द्र	
२४	१७८७७७	२	हेल्पर	पेमा छिरिङ्ग लामा	२०८१/११/१२	अनिवार्य	दोलखा वितरण केन्द्र	
२५	१९१५८७	७	ईन्जिनियर	उपेन्द्र सिंह	२०८१/११/१३	अनिवार्य	भौगर्भिक परीक्षण विभाग	
२६	१३८२४२	५	सि.हे.इ.अ.	बालमुकुन्द भण्डारी	२०८१/११/१५	अनिवार्य	चिलिमे त्रिशुली दृढ्ण के.भी. प्रसारण लाइन आयोजना	
२७	१७०७५०	५	सि.हे.इ.अ.	ईश्वर कुमार भण्डारी	२०८१/११/१५	अनिवार्य	बालाजु वितरण केन्द्र	

२८	१६०७४१	७	प्रशासकीय अधिकृत	देवराज प्रसाई	२०८१/११/१५	अनिवार्य	काठमाण्डैं उपत्यका प्रसारण क्षमता सुदृढीकरण आयोजना	
२९	१७८३२६	७	प्रशासकीय अधिकृत	यादव राज घले	२०८१/११/१६	अनिवार्य	सोलु कोरिडोर ज्ञघद्द के.भी.प्र.ला.आयोजना	
३०	११७८७७	६	सहायक लेखा अधिकृत	राजेन्द्र थापा	२०८१/११/१७	अनिवार्य	इन्जिनियरिङ्ग सेवा निर्देशनालय	
३१	१२३७८६	६	सहायक प्रशासकीय अधिकृत	चन्द्रकला शर्मा	२०८१/११/१८	अनिवार्य	लेखा विभाग	
३२	१२१६६२	८	सहायक प्रवन्धक	ललित नारायण चौधरी	२०८१/११/१९	अनिवार्य	लहान वितरण केन्द्र	
३३	१४१०६६	३	ईलेक्ट्रिसियन	मान सिंह ल्वार	२०८१/११/२२	अनिवार्य	बाजुरा वितरण केन्द्र	
३४	१५७५९३	४	सि.मि.रि.	जहान सिंह बुढाथोकी	२०८१/११/२८	अनिवार्य	बानेश्वर वितरण केन्द्र	
३५	१४७४१७	२	कार्यालय सहयोगी	हरी प्रसाद पाण्डे	२०८१/१२/०३	अनिवार्य	कालिगण्डकी ए जलविद्युत केन्द्र	
३६	१२४४०५	२	हेल्पर (मेका.)	असी उल्लाह	२०८१/१२/०५	अनिवार्य	तौलिहवा वितरण केन्द्र	
३७	१८२३४५	९	उप(प्रबन्धक	जगत प्रसाद भट्टराई	२०८१/१२/०६	अनिवार्य	सर्भे महाशाखा	
३८	११४१२२	३	ईलेक्ट्रिसियन	बुद्धि बहादुर थिङ	२०८१/१२/०९	अनिवार्य	हेटौंडा वितरण केन्द्र	
३९	१८९४३९	७	प्रशासकीय अधिकृत	विष्णु कुमार थापामगर	२०८१/१२/१०	अनिवार्य	कीर्तिपुर वितरण केन्द्र	
४०	१९७६३८	४	फोरमेन	खिमलाल पौडेल	२०८१/१२/१०	अनिवार्य	गण्डकी प्रादेशिक कार्यालय, पोखरा	
४१	११४६४२	५	सुपरभाइजर	श्याम किशोर मण्डल	२०८१/१२/१०	अनिवार्य	भैरहवा वितरण केन्द्र	
४२	१८६७५९	६	सहायक प्राविधिक अधिकृत	रामकृष्ण गिरी	२०८१/१२/१२	अनिवार्य	रत्नपार्क वितरण केन्द्र	
४३	११९७५८	५	सुपरभाईजर	कल्याण बहादुर भुजेल	२०८१/१२/१४	अनिवार्य	दुध कोशी जलविद्युत कम्पनी लिमिटेड	
४४	१४४०४४	६	सहायक प्रशासकीय अधिकृत	खगेन्द्र प्रसाद न्यौपाने	२०८१/१२/१५	अनिवार्य	ठूला उत्पादन संचालन तथा संभार विभाग	
४५	१४९८१३	२	हेल्पर	धनविर गुरुङ्ग	२०८१/१२/१५	अनिवार्य	तनहुँ वितरण केन्द्र	
४६	१२९७८७	४	सहायक लेखापाल	इच्छँ श्रेष्ठ	२०८१/१२/१५	अनिवार्य	महाराजगंज वितरण केन्द्र	
४७	१९६९१५	४	फोरमेन	भरत बहादुर विश्वकर्मा	२०८१/१२/१९	अनिवार्य	नुवाकोट वितरण केन्द्र	
४८	१८९५८१	२	हेल्पर	रुपमाया भुजेल	२०८१/१२/२०	अनिवार्य	दुहवी ग्रिड महाशाखा	
४९	१७७१५५	६	सहायक प्राविधिक अधिकृत	जगत बहादुर गुरुङ्ग	२०८१/१२/२०	अनिवार्य	पोखरा ग्रिड महाशाखा	
५०	१७२६९७	६	सहायक लेखा अधिकृत	टोपराज जोशी	२०८१/१२/२०	अनिवार्य	सुदुर पश्चिम प्रादेशिक कार्यालय अत्तरिया	
५१	१९१५३५	८	सहायक प्रवन्धक	सुहेश श्रेष्ठ	२०८१/१२/२०	अनिवार्य	बागमती प्रादेशिक कार्यालय, काठमाण्डैं	
५२	१२३६६८	५	सुपभाईजर	हिराकाजी श्रेष्ठ	२०८१/१२/२२	अनिवार्य	ठिमी वितरण केन्द्र	
५३	१८४०९२	५	सुपभाईजर	भिख नारायण चौ धरी	२०८१/१२/२३	अनिवार्य	गण्डक जलविद्युत केन्द्र	
५४	१७५३४८	६	सहायक लेखा अधिकृत	जनार्दन घिमिरे	२०८१/१२/२४	अनिवार्य	केन्दीय भुक्तानी महाशाखा	
५५	१९२२०८	४	सहायक लेखापाल	जगदिश कुमार ओझा	२०८१/१२/२८	अनिवार्य	धनगढी वितरण केन्द्र	
५६	१२९२८०	२	कार्यालय सहयोगी	हेलवा थारु	२०८२/०१/०१	अनिवार्य	लुम्बिनी प्रादेशिक कार्यालय, बुटवल	
५७	१४०६८२	४	फोरमेन	नवि रसुल मिया हजाम	२०८२/०१/०१	अनिवार्य	सिमरा वितरण केन्द्र	
५८	१३३१४२	३	मिटर रिडर	राम सागर मण्डल	२०८२/०१/०१	अनिवार्य	मधेश प्रादेशिक कार्यालय, जनकपुर	
५९	१६६०५५	२	हेल्पर	चक्र बहादुर वाईवा	२०८२/०१/०१	अनिवार्य	भरतपुर वितरण केन्द्र	
६०	१६५७५४	२	हेल्पर	मान बहादुर थिङ्ग	२०८२/०१/०१	अनिवार्य	कंक्रिट पोल प्लाण्ट अमलेखगंज	
६१	१६६४५४	६	सहायक लेखा अधिकृत	लोक प्रसाद काफ्ले	२०८२/०१/०१	अनिवार्य	पोखरा वितरण केन्द्र	
६२	१४६५८२	५	व.स./सि.मि.री.	बुद्ध कुमार कार्की	२०८२/०१/०१	अनिवार्य	केन्दीय भण्डार हेटौंडा	
६३	१५५७८६	५	लेखापाल	खिलराज राई	२०८२/०१/०२	अनिवार्य	भौगर्भिक परीक्षँण विभाग	

६४	१५७३९६	१०	प्रबन्धक	बोधराज ढकाल	२०८२/०१/०२	अनिवार्य	वितरण प्रणाली सुदृढीकरण तथा विस्तार आयोजना	
६५	१३६९६५	५	सुपरभाईजर	गणेश बहादुर ऐर	२०८२/०१/०४	अनिवार्य	अत्तरिया ग्रिड महाशाखा	
६६	११५८८०	५	सुपरभाईजर	तुलसी राम भट्टराई	२०८२/०१/०४	अनिवार्य	अमुवा वितरण केन्द	
६७	१७३०२७	५	सुपरभाईजर	राम राज साह	२०८२/०१/०६	अनिवार्य	जनकपुर वितरण केन्द्र	
६८	१२४५५३	६	सहायक प्राविधिक अधिकृत	आइत सिंह तामाङ्ग	२०८२/०१/०७	अनिवार्य	माथिल्लो त्रिशुली घ "ए" जलविद्युत केन्द्र	
६९	१६५३६८	७	ईन्जिनियर	शंकर बहादुर लामा	२०८२/०१/०७	अनिवार्य	पाँचखाल वितरण केन्द्र	
७०	१८९३१९	५	लेखापाल/स्टोरकीपर	तौलन प्रसाद चौधरी	२०८२/०१/०७	अनिवार्य	तौलिहवा वितरण केन्द्र	
७१	११६३१७	६	सहायक ईन्जिनियर	मधु सुदन गौतम	२०८२/०१/०८	अनिवार्य	नयाँमिल वितरण केन्द्र	
७२	१९६४७९	३	मिटर रिडर	सानुकान्छा पाखिन	२०८२/०१/१०	अनिवार्य	कुलेखानी दोश्रो जलविद्युत केन्द्र	
७३	१३७६२४	६	सहायक लेखा अधिकृत	जनक बाबु बस्नेत	२०८२/०१/१०	अनिवार्य	रत्ननगर टाँडी वितरण केन्द्र	
७४	११६३१७	२	हेल्पर	ज्ञानीसरा न्यौपाने	२०८२/०१/१०	अनिवार्य	स्याङ्जा वितरण केन्द्र	
७५	१६४७८९	३	मिटर रिडर	हरि बहादुर बस्नेत	२०८२/०१/११	अनिवार्य	बानेश्वर वितरण केन्द्र	
७६	१३७०९६	६	सहायक ईन्जिनियर	प्रेम बहादुर भुजेल	२०८२/०१/१३	अनिवार्य	बर्दघाट वितरण केन्द्र	
७७	१४२४९७	७	ईन्जिनियर	ललित बहादुर चन्द	२०८२/०१/१५	अनिवार्य	धनगढी वितरण केन्द्र	
७८	११३५०७	५	सुपरभाईजर	नन्दन सिंह महरा	२०८२/०१/१६	अनिवार्य	बेलौरी वितरण केन्द्र	
७९	१९४९५१	३	मिटर रिडर	काशी रावत अहिर	२०८२/०१/१७	अनिवार्य	हेटौंडा वितरण केन्द्र	
८०	१२४२०४	६	सहायक ईन्जिनियर	राजेश सिंह शाह	२०८२/०१/१८	अनिवार्य	महाराजगंज वितरण केन्द्र	
८१	१७०९१६	६	सहायक प्रशासकीय अधिकृत	देश वन्धु श्रेष्ठ	२०८२/०१/२०	अनिवार्य	तनहुँ वितरण केन्द्र	
८२	१९९३५१	३	ईलेक्ट्रिसियन	रामचन्द्र पन्त	२०८२/०१/२०	अनिवार्य	लमजुङ वितरण केन्द्र	
८३	१२९५८३	४	सहायक लेखापाल /स.स्टोरकीपर	कविता गुरुङ वैद्य	२०८२/०१/२४	अनिवार्य	अवकाश कोष व्यवस्थापन महाशाखा	
८४	११९४८९	४	फोरमेन	शिव नारायण शाह	२०८२/०१/२५	अनिवार्य	गौरादह वितरण केन्द्र	
८५	१५०७६९	९	उप-प्रबन्धक	राम दुलार यादव	२०८२/०१/२५	अनिवार्य	योजना तथा प्राविधिक सेवा विभाग	
८६	१७२९९३	३	ईलेक्ट्रिसियन	प्रेम प्रसाद घतानी	२०८२/०१/२८	अनिवार्य	दमक वितरण केन्द्र	
८७	१५८८०६	२	हेल्पर	प्रदुमन पछिमा थारु	२०८२/०२/१०	अनिवार्य	परासी वितरण केन्द्र	
८८	१६५१२३	३	ईलेक्ट्रिसियन	शेर बहादुर मास्के	२०८२/०२/१०	अनिवार्य	बेलवारी वितरण केन्द्र	
८९	१४०५०२	६	सहायक कानून अधिकृत	राम प्रसाद कर्माचार्य	२०८२/०२/११	अनिवार्य	कानून विभाग	
९०	१५४२४९	८	सहायक प्रवन्धक	शिव प्रसाद नेपाल	२०८२/०२/१२	अनिवार्य	संस्थागत योजना तथा अनुगमन विभाग	
९१	१४८९६१	७	लेखा अधिकृत	कुलानन्द भट्ट	२०८२/०२/१५	अनिवार्य	सिंगटी लामोसाघु १३२ के.भी.प्र.ला.आयोजना	
९२	१८८१९३	६	सहायक प्रशासकीय अधिकृत	निर्मला श्रेष्ठ	२०८२/०२/१५	अनिवार्य	गुलरिया वितरण केन्द्र	
९३	१२७९५०	४	फोरमेन	मोहन प्रसाद श्रेष्ठ	२०८२/०२/१५	अनिवार्य	लालबन्दी वितरण केन्द्र	
९४	११८३८७	५	सुपरभाईजर	अच्युत खतिवडा	२०८२/०२/१९	अनिवार्य	सुन्दरीजल जलविद्युत केन्द्र	
९५	११२५३८	३	मिटर रिडर	हरण लाल थारु	२०८२/०२/१९	अनिवार्य	दुहवी वितरण केन्द्र	
९६	१५९२४७	३	ईलेक्ट्रिसियन	प्रेम खत्री	२०८२/०२/२५	अनिवार्य	रत्नपार्क वितरण केन्द्र	
९७	१५४९७७	३	ईलेक्ट्रिसियन	नागेश्वर ठाकुर	२०८२/०२/३०	अनिवार्य	जनकपुर वितरण केन्द्र	
९८	१४२३६७	२	कार्यालय सहयोगी	कुमार लिम्बु	२०८२/०३/०२	अनिवार्य	धनकुटा वितरण केन्द्र	
९९	१८७२४९	७	प्रशासकीय अधिकृत	शारदा प्रसाद भट्टराई	२०८२/०३/०४	अनिवार्य	ईन्जिनियरिङ्ग सेवा निर्देशनायल	
१००	१३३८१४	२	कार्यालय सहयोगी	दिलमाया पोडेनी	२०८२/०३/०५	अनिवार्य	ठिमि वितरण केन्द्र	
१०१	१७८१५१	२	हेल्पर	हरी बहादुर गिरी	२०८२/०३/०९	अनिवार्य	कुलेश्वर वितरण केन्द्र	

१०२	१९८७३८	५	लेखापाल/स्टोरकीपर	राजु महर्जन	२०८२/०३/१०	अनिवार्य	पुल्चोक वितरण केन्द्र	
१०३	१९०८९४	२	कार्यालय सहयोगी	कृष्ण विश्वकर्मा	२०८२/०३/१०	अनिवार्य	पोखरा ग्रिड महाशाखा	
१०४	१५७८०७	४	फोरमेन	शिव प्रसाद दुलाल	२०८२/०३/१०	अनिवार्य	बानेश्वर वितरण केन्द्र	
१०५	१९६१२०	२	हेल्पर	पेशल कुमार भट्टराई	२०८२/०३/१०	अनिवार्य	सिराहा वितरण केन्द्र	
१०६	१८९०५१	४	फोरमेन	अमृत बहादुर थिङ लामा	२०८२/०३/१०	अनिवार्य	कुलेखानी दोश्रो जलविद्युत केन्द्र	
१०७	१७९१५७	६	सहायक ईन्जिनियर	श्याम किशोर झा	२०८२/०३/११	अनिवार्य	गौर वितरण केन्द्र	
१०८	१५७७४३	६	सहायक कम्प्यूटर अधिकृत	नन्दराम पाठक	२०८२/०३/१२	अनिवार्य	अर्थ निर्देशनालय	
१०९	१७२१०९	४	फोरमेन	धन बहादुर लामा	२०८२/०३/१३	अनिवार्य	हेटौंडा वितरण केन्द्र	
११०	१२८३३६	५	लेखापाल/स्टोरकीपर	रामदेवी महर्जन	२०८२/०३/१४	अनिवार्य	लगनखेल वितरण केन्द्र	
१११	११४९३०	३	ईलेक्ट्रिसियन	सरस्वती पुडासैनी	२०८२/०३/१५	अनिवार्य	हेटौंडा ग्रिड महाशाखा	
११२	१४७८५९	६	सहायक लेखा अधिकृत	पुर्ण बहादुर अधिकारी	२०८२/०३/१८	अनिवार्य	हेटौंडा वितरण केन्द्र	
११३	१२५८५३	२	हेल्पर	ललित बहादुर भुजेल	२०८२/०३/१८	अनिवार्य	चनौली वितरण केन्द्र	
११४	११९३९६	५	सुपरभाईजर	केशव प्रसाद पराजुली	२०८२/०३/१९	अनिवार्य	सिन्धुपाल्चोक वितरण केन्द्र	
११५	१४१५९२	६	सहायक ईन्जिनियर	शिव के.सी.	२०८२/०३/१९	अनिवार्य	बुटवल ग्रिड महाशाखा	
११६	१६९३०६	३	ईलेक्ट्रिसियन	जंग बहादुर माझी	२०८२/०३/१९	अनिवार्य	डोटी वितरण केन्द्र	
११७	१३४२८३	४	फोरमेन	राधाकृष्ण श्रेष्ठ	२०८२/०३/२२	अनिवार्य	बानेश्वर वितरण केन्द्र	
११८	१३०५४४	७	लेखा अधिकृत	हरी प्रसाद रेग्मी	२०८२/०३/२४	अनिवार्य	आन्तरिक लेखा परिक्षण विभाग	
११९	१७९५२४	५	सुपरभाईजर	डम्बर राज पनेरु	२०८२/०३/२५	अनिवार्य	महेन्द्रनगर वितरण केन्द्र	
१२०	१३८९९३	२	हेल्पर	अपूर्व पौडेल	२०८२/०३/२५	अनिवार्य	काभ्रे वितरण केन्द्र	
१२१	११८६४१	३	ईलेक्ट्रिसियन	लाल किशोर सिंह	२०८२/०३/३१	अनिवार्य	मधेश प्रादेशिक कार्यालय, जनकपुर	

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राजीनामा स्वीकृत भएका कर्मचारीहरूको विवरण

२०८१ माघ १ गते देखि २०८२ असार मसान्तसम्म

सि नं	क.स.नं.	तह	पद	नाम थर	अवकास मिति	अवकासको किसिम	कार्यरत कार्यालय	कैफियत
१	१८२१७८	३	ईलेक्ट्रिसियन	भागिराम वली	२०८१/०५/०६	राजिनाम	घोराही वितरण केन्द्र	छूट
२	१६८६४५	५	मि.रि.सू.भा.	राजेश कुमार साह	२०८१/०६/०७	राजिनामा	यदूकुहा वितरण केन्द्र	छूट
३	धन १४०४७७	५	सूपरभाईजर	प्रयाग मेहर कायस्थ	२०८१/०८/०६	राजिनामा	आयोजना विकास विभाग	छूट
४	१६६६८८	७	वातावरणविद	प्रभा आले मगर	२०८१/०८/१८	राजिनामा	वातावरण तथा सामाजिक अध्ययन विभाग	छूट
५	१५७२१६	३	इलेक्ट्रिसियन	आरती अंगाई	२०८१/१०/१५	राजिनामा	पोखरा ग्रिड महाशाखा	
६	१६०५३५	५	मि.रि.सू.भा.	दिपक काफ्ले	२०८१/१०/२०	राजिनामा	उदयपूर वितरण केन्द्र	
७	१४७१५२	७	ईन्जिनियर	अनमोल वटाजु	२०८१/११/०१	राजिनामा	योजना तथा प्राविधिक सेवा विभाग	
८	१७२९२४	१	जू.हेल्पर	महेन्द्र कुमार घिमिरे	२०८१/११/०८	राजिनाम	भैरहवा वितरण केन्द्र	
९	१६३४३२	४	सहायक लेखापाल	पूष्पकमल उपाध्याय	२०८१/१२/०३	राजिनामा	धादिङ वितरण केन्द्र	
१०	११९४४३	७	ईन्जिनियर	दीपा उपाध्याय सुवेदी	२०८१/१२/०७	राजिनामा	आयोजना व्यवस्थापन निर्देशनालय	

नेपाल विद्युत प्राधिकरण

स्वेच्छिक अवकाश लिएका कर्मचारीहरूको विवरण

२०८१ माघ १ गते देखि २०८२ असार मसान्तसम्म

सि नं.	क.स.नं.	तह	पद	नाम थर	अवकास मिति	अवकासको किसिम	कार्यरत कार्यालय	कैफियत
१	१९७८०६	६	सहायक लेखा अधिकृत	चन्द्रदेव कपाडी	२०८१/०८/२५	स्वेच्छिक	थानकोट चापागाउ भक्तपूर १३२ के.भी. प्रसारण लाइन आयोजना	छूट
२	१९४०८०	६	सहायक प्रशासकीय अधिकृत	रीता राना मगर	२०८१/१०/०१	स्वेच्छिक	केन्द्रय कर्मचारी अभिलेख शाखा	
३	१९६३९९	४	सिनियर मिटर रिडर	शंकर प्रसाद खतिवडा	२०८१/१०/१५	स्वेच्छिक	कोहलपूर वितरण केन्द्र	
४	१२४५४९	४	फोरमेन	विष्णू भक्त श्रेष्ठ	२०८१/११/१९	स्वेच्छिक	काभ्रे वितरण केन्द्र	
५	१४२९४३	४	फोरमेन	मात्रिका प्रसाद संग्रौला	२०८२/०१/११	स्वेच्छिक	धूलावारी वितरण केन्द्र	
६	१८८७७५	५	सि.हे.इ.अ.	किरण तण्डूकार	२०८२/०१/१६	स्वेच्छिक	सामान्य प्रशासन महाशाखा	
७	११३०४६	५	सूपरभाईजर	सूशिल कूमार खत्री	२०८२/०२/०१	स्वेच्छिक	रत्नपार्क वितरण केन्द्र	
८	१७७३६२	४	फोरमेन	धर्मरा ज महर्जन	२०८२/०२/०१	स्वेच्छिक	मनाङ वितरण केन्द्र	
९	१५६०५४	३	ईलेक्ट्रिसियन	भिम बहादूर अस्लामी मगर	२०८२/०२/१३	स्वेच्छिक	कूलेखानी दोश्रो जलविद्युत केन्द्र	

नेपाल विद्युत प्राधिकरण

प्रशासन निर्देशनालय

जनसाधन विभाग

केन्द्रीय कर्मचारी प्रशासन शाखा

२०८२ असार महिनाको दरबन्दी विवरण

पद	सेवा	स्वीकृत दरबन्दी	मौजूदा कर्मचारी		
			स्थायी	म्यादी/करार	जम्मा
कार्यकारी निर्देशक		१	१	०	१
उप कार्यकारी निर्देशक	(प्राविधिक/प्रशासन)	५	८	०	८
अधिकृत स्तर (तह ६ देखि ११ सम्म)	प्राविधिक	१७५८	१२६१	०	१२६१
	प्रशासन	८८३	६८०	१	६८१
	जम्मा	२६४१	१५४१	१	१५४२
सहायक स्तर (तह १ देखि ५ सम्म)	प्राविधिक	६०१५	४२१३	१११	४३२४
	प्रशासन	२७६३	२२८५	५३	२३७८
	जम्मा	८७८२	६४५८	२०४	६७०२
	कूल जम्मा	११४३३	८४४८	२०५	८६५३

नेपाल विद्युत प्राधिकरणको ग्राहक महानुभावहरूमा अनुरोध

चुहावट नियन्त्रण महाशाखाको छड्के टोलीले कुनैपनि बेला तपाईंको मिटर निरीक्षण गर्न आउन सक्छ । तसर्थ,

- मिटरमा क्तयअप ग्लष्त छ भने आजै सम्बन्धित वितरण केन्द्रमा सम्पर्क गरी Stock Clear गरौं ।
- Meter Bypass गरी विद्युतको दुरुपयोग नगरौं ।
- Hooking गरी विद्युतको दुरुपयोग नगरौं ।
- स्वीकृत क्षमता भन्दा बढीको MCB/MCCB प्रयोग नगरौं ।
- मिटर बन्द भएको छ भने यथाशिघ्र सम्बन्धित वितरण केन्द्रमा सम्पर्क गरी नया मिटर बदली गरौं ।
- नेपाल विद्युत प्राधिकरणले मिटर/बाकस लगायत कुनैपनि ठाउँमा लगाएको सिल जथाभावी काट्ने काम नगरौं ।
- विद्युत सम्बन्धी कुनै समस्या आएको खण्डमा तुरुन्त सम्बन्धित वितरण केन्द्रमा सम्पर्क गरौं ।

नेपाल विद्युत प्राधिकरण
चुहावट नियन्त्रण महाशाखा

आर्थिक सहायता लिने कर्मचारीहरूको विवरण

(२०८१ माघ १ गतेदेखि २०८२ असार मसान्तसम्म)

सि.नं.	विवरण	आर्थिक सहायता लिने कर्मचारीहरूको विवरण	जम्मा रकम रु.
१	काजक्रिया सहायता	कार्यविधि, २०७९ अनूसार १३५ जना कर्मचारीको परिवार लाई २० हजार साथै ७ जना कर्मचारी स्वयंको मृत्यु भएकोले ३० हजारका दरले जम्मा १४२ जनालाई काजक्रिया सहायता उपलब्ध गराईएको ।	२९,१०,०००।००
२	कडा रोग सहायता	कार्यविधि, २०७९ अनूसार ४ जनाको कडा रोग सहायता उपलब्ध गराईएको ।	२,००,०००।००
३	दैवी प्रकोप सहायता	कार्यविधि, २०७९ अनूसार १ जनाको ४० हजारका दरले दैवी प्रकोप सहायता उपलब्ध गराईएको ।	४०,०००।००
		जम्मा	**३१,५०,०००।००**

विद्युत चोरी भएको देखेमा वा थाहा पाउनु भएमा नेपाल विद्युत प्राधिकरण सम्बन्धी कुनै गुनासो भएमा वा जानकारी आवश्यक भएमा नेपाल विद्युत प्राधिकरणको हट लाइन नं. ११५० मा सम्पर्क गर्नुहुन अनुरोध गरिन्छ ।

दुर्घटनामा परी घाइते तथा अंगभंग भएमा पेश गर्नुपर्ने कागजातहरू :

१. चालकको नाम, ठेगाना, सवारी इजाजत पत्र नवीकरण सहितको प्रतिलिपि
२. सम्बन्धित कार्यालयका प्रमुखबाट दिइएको कार्यदेश पत्र ।
३. दुर्घटना प्रतिवेदन (कार्यालयको तर्फबाट)
४. दुर्घटनाको प्रहरी प्रतिवेदन (स्थलगत मुचुल्का सहित)
५. दुर्घटना भएको साधनको नम्बर र किसिम (भाडा, सहकारी, संस्थान आदि)
६. सवारी साधन बीमा गर्दाको चालु बीमालेखको प्रतिलिपि ।
७. दुर्घटनाको किसिम (दुर्घटना आफ्नो कारणले वा तेस्रो पक्ष) ।
८. उपचार खर्चका सक्कल बिल तथा Prescription र शीर्षक वाइज खर्चको विवरणहरू ।

विद्युत प्राधिकरणको ४० औं वार्षिकोत्सवको अवसरमा आयोजित वृक्षारोपण कार्यक्रम

नेपाल विद्युत प्राधिकरण

जनसम्पर्क तथा गुनासो व्यवस्थापन शाखा

दरबारमार्ग, काठमाडौं
फोन : ०१-४१५३०२१, ४१५३०२२
आन्तरिक : २००२, २००३
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