Economic Prospects of Cross-Border Electricity Trade Between Nepal and India

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Abstract

This study focuses on exploring the economic opportunities and potential challenges of cross-border electricity trade between Nepal and India. The main focus is on the transmission infrastructure, economic prospects, regulatory frameworks, and challenges involved. The study was conducted through secondary data analysis and descriptive research methods, to explore the strategic importance of electricity trade for Nepal, considering its abundant hydropower potential and geographical advantages. The existing transmission lines, infrastructure, and the role of private sector involvement in facilitating trade were examined. Moreover, the study discussed the seasonal demand variations between the two countries and the regulatory hurdles that need to be addressed for successful trade implementation. The finding highlights the potential economic benefits of electricity trade and emphasizes the need for clear guidelines, infrastructure development, and effective cooperation to overcome challenges and maximize trade's positive impacts on economic growth and trade balance between India and Nepal.

Keywords: hydropower, economic growth, energy security, cross-border electricity, Nepal and India.

Introduction

Cross-border electricity trading between Nepal and India creates enormous economic prospects by exploiting Nepal's hydroelectric capability to meet regional energy demands. This trade can boost economic growth, improve regional energy security, and help achieve sustainable development goals. The economic possibilities for cross-border electricity trading between Nepal and India are bright, with major opportunities for economic growth and regional energy security. Nepal's transition to an energy surplus country, facilitated by projects such as the Upper Tamakoshi hydropower project, has prepared the path for formalised power trading agreements with India, demonstrating the economic potential of the surplus and the bilateral trade agreement (Gaudel, 2018).

The construction of high-voltage transmission lines, such as the 400 KV Gorakhpur-Butwal line, is crucial for facilitating this trade. The power system in Nepal operates within a regulated electricity market, where the government-owned utility holds a franchised monopoly over the transmission and distribution of electricity. The government also maintains a significant presence within the generation sector. However, there is a growing interest in encouraging private participation in the generation side of the hydropower project.

The majority of Nepal's electricity is generated by hydropower plans which are supplemented by cross-border power imports from India to meet the country's growing energy demands. Nepal has the opportunity to increase its generation capacity, earn export revenue, improve the power sector performance, and increase its electricity supply (Shrestha et al., 2021).

Nepal has a high potential for water resources, with a feasible hydropower generation capacity of 45,610 MW. The government's policy has focused on providing incentives to local institutions and organizations for small hydropower generation (1 MW to 25 MW) and promoting the development of medium hydropower (25 to 100 MW) for national drive sectors (Bhatt, 2017)

Nepal has an immense supply of hydroelectric power resources due to its proximity to the world's biggest mountains and the vast amount of water that flows through them, making it one of the world's wealthiest countries in this regard. The Nepalese government estimates that the country has a hydropower potential of about 42 gigawatts. However, Nepal has only used approximately 2.5 percent of its entire hydropower capacity for power generation (USAID's URJA Nepal Programme, 2021). Electricity consumption on both sides of the Nepal-India border is increasing, emphasizing the importance of infrastructure planning and development (Hurlbut, 2019). Nepal and India's power grids are currently connected by different transmission lines that traverse the border. There are plans to enhance and integrate by constructing new 400-kilovolt (KV) transmission lines. Previous research has looked into the possible impacts of individual cross-border initiatives (Asian Development Bank [ADB], 2015) and joint strategic foresight (Timilsian et al., 2015) between India and Nepal.

The Ministry of Energy, Water Resources and Irrigation (2017) examined three distinct scenarios related to economic growth. These scenarios include business as usual, with a 4.5 % growth rate, reference with 7.2 %, and high growth with 9.2 %. A range of policy measures have been taken into account, including the shift of 100% of cooking and 75% of water heating to electricity in urban areas by 2020, the introduction of metro systems in cities by 2025, and other initiatives under the 7.2% and 9.2% growth rate scenarios. The playing period lasts 25 years, from 2015 to 2040, offering electricity demand projections during this timeframe.

The cross-border exchange of electricity between Nepal and India has the potential to bring about many economic benefits. By increasing power exports, this trade can help to address trade imbalances, while simultaneously boosting economic growth in both countries. Moreover, the revenue generated from this trade can be reinvested into social infrastructure, further contributing to the overall development of the region (Lama, 2020).

India and Nepal have cooperated in the hydropower sector since the late 1950s. India has assisted Nepal in building several hydropower Projects, starting with the Koshi and Gandak projects. The exchange of power between the two countries began in 1971, and as of 2018, there were around 12 radial points for power exchange (Dhungel, 2018) Regional electricity cooperation in South Asia, especially between Bhutan, Bangladesh, India, and Nepal has been under debate, with discussions going beyond bilateral electricity trade to regional. The multiparty power importer countries, and Nepal and Bhutan as suppliers, while India is likely to play a dual role (Haque et al., 2020).

India possesses an installed generation capacity of 331 gigawatts (GW), with coal and renewable energy sources constituting 193 GW (58%) and 63 GW (19%) respectively, while the peak demand is recorded at 164 GW (Central Electricity Authority, 2017a.). The Indian government has established ambitious targets for renewable energy, to reach 175 GW by 2022, including 100 GW from solar and 60 GW from wind sources. India foresees a 5.9% annual growth in its electricity demand over the next decade, expecting peak demand to reach 230 GW by 2022. Moreover, the Ministry of Power in India, in the year 2016, issued revised directives regarding CBET, which facilitate the exchange of electricity on the Indian Power Exchanges under specific criteria (Central Electricity Authority, 2017b).

Nepal has started exporting electricity to India at full capacity, at an average price of Rs. 11.38 per unit. This has resulted in an average daily export of Rs. 100 to Rs. 250 million of electricity to India. India has also signed agreements to develop two mega hydropower projects with private/ public power developers from India's upper Karnili and Arun III (Ministry of Foreign Affairs Nepal, 2018).

According to the NEA annual report (2021), Nepal has achieved tremendous progress towards sustainable energy generation, with a total installed capacity of 1953 MW in 2021. To generate electricity, the country has primarily relied on renewable energy sources like as hydroelectricity and solar power. Nepal has produced 1900 MW of electricity from hydropower and the remainder by solar energy, establishing itself as a leader in sustainable energy generation. Despite rising electricity demand, Nepal builds new hydropower facilities every year, demonstrating the country's commitment to supplying its residents with reliable and clean energy. Furthermore, Nepal is researching cross-border energy markets to export surplus power to India and other nations, which will aid the country's economy to become greener.

The trade of electricity with India presents an inspiring opportunity that can significantly assist in balancing payment. This trade fosters a mutually beneficial relationship, between the two countries, strengthening their economic and social ties. The exchange of electricity bolsters energy security and enhances the sustainability of the power sector. Additionally, it has the potential to create employment opportunities and promote the growth of various industries; overall, the electricity trade with India is a promising prospect that can have a positive impact on both nations (Sanjel et al., 2022).

Argawal (2022) discusses the existing scenario and opportunities for India in cross-border electricity trade, Indian as a net exporter of electricity, has established cross-border transmission interconnection with Bhutan, Nepal, Bangladesh, and Myanmar, facilitating bilateral exchanges under government negotiations. Mcbennett et al. (2019). Nepal can potentially increase its annual exports to India by accelerating the development of domestic hydropower to 4,500 Megawatts. However, a significant partition of this increase may not be profitable to export due to the current market inefficiencies of both countries.

Cross-border electricity trade (CBET) is a promising solution to address energy shortages, stimulate economic development, and foster regional collaboration. Nepal and India have emerged as prominent players in the energy trade due to Nepal's significant hydropower potential and India's increasing energy demand. This study aims to investigate the economic opportunities and potential challenges of CBET between Nepal and India.

Hydropower Resources in Nepal

According to the Ministry of Energy, Water Resources and Irrigation (2017), Nepal has about 2.2% of the world's water resources. The theoretical and commercial potentials of hydropower in Nepal are estimated to be around 83,000 MW and 42,133 MW, respectively (Table 1).

Table 1

Hydropower Resources in Nepal

River	Number of project sites	Technical potential capacity in MW	Economic potential capacity in MW
Sapta Koshi	22350	11400	10860
Sapta Gandaki	20650	6660	5270
Karnali and Mahakali	36180	26570	25125
Southern river	4110	980	878
Total	83290	45610	42133

Cross-Border Transmission Lines

The cross-border transmission line between Nepal and India that facilitates the import and export of electricity trade between the two countries. It's designed to supports various voltage levels, including 400/220/132/66 and 33 KV, to ensure efficient and reliable power transmission (NEA, 2021).

Gandak-Ramnager and Muzaffarpur Transmission Lines

The Gandak-Ramnager transmission line holds historical significance as the first 132 KV cross-border transmission line was constructed in 1979. It is primarily utilized for exporting power generated by the Gandak powerhouse to India under the Gandak treaty. The transmission line traverses from the Bardghat substation to the Indian substation at Muzaffarpurvia, passing through Gandak, Ramnagar Bettiah, and Motihari, with a generation capacity of 15 MW. The Indian part of this line lies in located in the state of Bihar. The geographical location of the interconnection is significant as it is situated in the middle of the country, close to the lead center at Kathmandu and most of Nepal's generation facilities, making it suitable for both import and export (Dhungel, 2018).

Kushaha -Kataiya 132 KV Second Circuit Transmission Line

The Kushaha-Kataiya 132 KV second circuit transmission line constitutes an essential infrastructure project that seeks to enhance the cross-border transmission line between Nepal and India. It involves upgrading the existing Kushaha switching station to a full phase substation with a 132/11KV, 22.5 MVA power transformation, and the relevant 132 KV line bays that will connect transmission lines from Rupani, Duhabi, and Kataiya substations. The aim is to address the challenges that have hitherto hindered efficient power transmission between the two countries and to enhance the reliability, capacity, and efficiency of the power transmission network (NEA, 2020).

Dhalkebar-Muzaffarpur Transmission Line

The Dhalkebar-Muzaffarpur transmission line is a project established between Nepal and India, spanning 140 km. Its primary purpose is to facilitate power trade between the two countries. The Power Transmission Company Nepal Limited (PTCNL) and the Nepal

Electricity Authority (NEA) initiated the project. The transmission line has a capacity of transmitting up to 1,000 megawatts of electricity, supporting both the export and import of power. Plans include constructing another 400-220 KV substation at Dhalkebar to strengthen the transmission system further and promote the Nepal-India power trade (NEA, 2021). Nepal experienced a Compound Annual Growth Rate (CAGR) of 7% in its peak power demand, which rose from 885 Megawatt (MW) to 1,508 MW before declining to 1,320 MW in FY19. Subsequently, in FY20, it rose again to 1407.94 MW. To satisfy the growing domestic demand, Nepal's domestic installed capacity also increased at a CAGR of 6% from FY 2010 to FY 2020. However, despite the continual expansion of domestic generation capacity, more is needed to satisfy the ever-increasing demand. As a result, Nepal is facing a demand-supply gap, which it partially manages by importing power from India. In FY 2020, Nepal imported power ranging between 300 to 500 MW. Despite being a net importer of electricity, Nepal exports its power to India during the wet season when hydro generation is more significant due to increased water supply. Nepal's peak generation period aligns well with the peak demand season of India and other South Asian countries. In September and October 2020, Nepal's peak exports reached 29.57 GW. Nepal also exports power during its off-peak hours in wet and dry seasons. The 15-minute time-zone difference with India and the disparities in the geographical and social characteristics of the two countries result in a time-slab advantage and different peak references from India (NEA, 2020).

Butwal-Gorakhpur Transmission Line

The Butwal-Gorakhpur transmission line is a significant cross-border project between Nepal and India. This transmission line will have a capacity to transport power as much as 3,500 MW. The transmission line is around 135 KM long, with around 20 KM falling on the Nepal side and remaining on the Indian side. NEA and Power Grid Corporation of India Limited are jointly working on the project.

India's Guidelines for Import/Export (Cross-Border) of Electricity 2018

India's Guidelines for Import/Export (Cross-Border) of Electricity 2018 contain clauses that make it difficult for Nepal to export electricity to India. Clause 4.6 states that the designated authority will approve only after the concurrence of the Government of India. Clause 6.1 presents obstacles to exporting electricity produced in Nepal to India it states that the Government of India reserves the right to import/export electricity for reasons of larger policy interests (Ministry of Power, 2018).

Material and Method

To achieve the objective of the study, study secondary data was collected from various variety of reliable sources, including government websites and journals. The research was conducted using a descriptive research design analysis approach to investigate the economic opportunities and potential challenges of cross-board electricity trade.

Analysis

Cross-Border Electricity Trade has Economic Prospects

South Asia has diversified energy resources spread across different countries, with India being the leading in the region. The region has adequate fossil fuel reserves and high renewable energy potential to generate electricity (Agrawal, 2022). The South Asia Cross-

Border Electricity Trade and Cooperation study focuses on regulatory and governing evolution for increasing trade between countries and addresses economic value and technical considerations. It employs a detailed power system model to capture the system operations of the South Asia grids (McBennett et al., 2019). Cross-border trade in electricity enables countries to gain access to a more diversified portfolio of plants, producing over a wider geographic area, which can help in dealing with intermittency problems associated with renewable energy sources (Bahar & Sauvage, 2013).

Opportunities for Cross-Border Electricity Trade

Nepal's topography and rivers make it ideal for hydropower, but its seasonal fluctuations cause too much water. During the monsoon season, Nepal's hydropower generation is high while the demand is low. India's electricity generation from coal is affected during the wet season, and demand surges in the summer. Cross-border electricity trade seems like a perfect opportunity to balance the seasonal differences between the two countries.

Strategic and Financial Importance

Nepal, with its abundant hydropower potential and strategic geopolitical location, has significant opportunities for cross-border electricity trade, particularly with India. The trade holds both strategic and financial importance for Nepal, contributing to energy security, climate change management, economic growth, and balance of payment.

Infrastructure Development

The development of cross-border transmission lines is a key objective for facilitating electricity trade. Currently, there are around 12 active redial points along the "Nepa-Inda" border for power exchange.

Potential in Hydropower

Nepal's significant potential for hydroelectric can play an important role in meeting the surging electricity demand of India. By leveraging this opportunity, both nations can strengthen their partnership and foster sustainable development in the region.

Regulatory Framework and Agreements

The agreement on electricity power trade, cross-border transmission interconnection, and grid connectivity between Nepal and India, issued in 2014 testified to the mutual trust and cooperation between the two countries in the development of electricity. This agreement provides a regulatory framework for the secure and reliable operation of the national grids interconnected through cross-border transmission interconnections.

Private Sector Involvement

The involvement of the private sector is another significant opportunity for cross-border electricity trade. India firms have expressed interest in purchasing up to 2,200 MH of electricity from Nepal. The involvement of the private sector is another significant opportunity for cross-border electricity trade. Indian firms have expressed interest in purchasing electricity from Nepal.

Seasonal Demand and Supply

Nepal's highest electricity consumption occurs in the winter months (December to February), while India's peak demand is from June to September (Nepal's monsoon season).

This difference in demand patterns creates an opportunity for Nepal to export surplus electricity to India during its monsoon season (Dahal, 2021).

Market Access and Competitive Pricing

The introduction of cross-border electricity trade (CBET) regulation in 2019 and CBET rules in 2021 by the central electricity authority, India, has facilitated efficient and transparent electricity trade through energy exchange platforms. This has allowed Nepal to meet its dry season demand and sell surplus electricity through competition in the day-ahead market, leading to the discovery of competitive prices and optimal power procurement.

Challenges for Cross-Border Electricity Trade

Regulatory Challenges

The power system in Nepal has been regulated by the electricity market, with the Government-owned utility having a franchised monopoly over the transmission and distribution of electricity. This could pose regulatory and policy challenges to expanding cross-border electricity trade. For instance, India's guideline for cross-border electricity in 2018 contains some clauses that present significant hurdles to the export of electricity from Nepal (Ministry of Power, 2018).

Infrastructure Limitations

For trading of electricity, Nepal must have one designated authority, but currently, there is none. Only one cross-border transmission line has been ready between both countries and it's not enough for trading more than a thousand MH. The technical part is also challenging. Grid synchronization is a precondition but is an essential phase (NEA, 2021).

Production Cost

The production cost of electricity per MW in Nepal is comparatively higher than that of India, primarily because of costly customs duty and transportation charges

Conclusion and Implication

Nepal with its abundance of hydropower potential and strategic geographical location has significant economic prospects through cross-border electricity trade. Trading electricity with India holds both strategic and financial importance for Nepal. However, this trade presents both opportunities and challenges. While Nepal has the opportunity to trade electricity with India, it also faces challenges such as the need to formulate clear guidelines and economic strategies. The strategy must prioritize fulfilling domestic requirements over exporting. Therefore, successful implementation of cross-border electricity trade would require addressing these challenges and maximizing the trade's economic benefits. By doing so, Nepal can unlock the full potential of its hydropower potential and geographical advantages, which will help drive economic growth and development.

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