

**ASSESSING THE IMPACT OF ENERGY INSECURITY ON INDUSTRIAL DEVELOPMENT IN SOUTH ASIA: A COMPARATIVE STUDY OF INDIA, BANGLADESH AND NEPAL**

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**ABSTRACT**

*This article delves into the intricate relationship between energy security, industrial development, and environmental sustainability in South Asia, focusing on India, Bangladesh, and Nepal. It scrutinizes the challenges posed by heavy reliance on fossil fuels and industrial activities, particularly in terms of air pollution and its repercussions. By analyzing the regulatory frameworks and policy initiatives in these countries, the essay evaluates their efficacy in promoting clean energy adaptation and sustainable development. Moreover, it explores Nepal's hydropower potential and its implications for regional energy cooperation, highlighting opportunities for cross-border electricity trade. The study employs a political economy theoretical lens to understand the complex interplay of political, economic, and social forces shaping the energy landscape in South Asia. The findings underscore the importance of transitioning towards renewable energy sources and fostering regional cooperation to address energy insecurity and environmental challenges while promoting sustainable development. Furthermore, the essay emphasizes the role of organizations like BIMSTEC in facilitating clean energy adaptation and bolstering energy security in the region. Overall, it argues that harnessing clean energy solutions, particularly through the hydroelectric potential in Nepal, offers a pathway towards achieving energy security, fostering economic growth, and ensuring environmental resilience in South Asia.*

**Key Words:** *Adaptation, clean energy, climate change mitigation, cross-border electricity trade, energy insecurity, environmental degradation, grid interconnection*



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## INTRODUCTION

Energy insecurity is intertwined with economic stability, geopolitical dynamics and societal well-being, with implications for both developed and developing countries. Energy insecurity, characterized by fluctuations in energy markets and prices due to crises such as the Russian-Ukrainian conflict and hyperinflation, has led to macroeconomic and fiscal instability. The volatility affects both energy-exporting and energy-importing countries, impacting their economic performance and fiscal planning. For energy-importing nations, rising energy costs contribute to inflation and increase operating expenses for businesses, leading to concerns about economic stability. Geopolitical events, such as conflicts and tensions between major energy-producing nations, have a significant impact on energy security. Energy-exporting countries may use energy deliveries as leverage to pursue political objectives, further complicating global energy dynamics. The vulnerability of energy infrastructure to sabotage or attacks during conflicts, as seen in the Ukraine war with attacks on pipelines and power plants, underscores the geopolitical risks associated with energy security. Energy insecurity affects not only economic stability but also societal well-being. Developing countries, in particular, face challenges in adapting imported energy technologies to meet local demand, exacerbating their dependence on foreign expertise. Civil wars, domestic uprisings, and international conflicts can disrupt energy supplies, leading to power outages, shortages, and increased costs for consumers. Moreover, the ripple effects of energy insecurity, such as rising commodity and food prices, contribute to inflation and strain household budgets, posing risks to social stability (Biswas, 2023)

This complexity is clearly visible in the relationship between energy insecurity and industrial development in South Asia. This article seeks to analyze this with a specific focus on India, Bangladesh and Nepal. The primary aim of the essay is to evaluate how energy insecurity, particularly the reliance on fossil fuels, impacts industrial growth and sustainability in these countries. Through a comparative study, the essay seeks to analyze the unique challenges and opportunities faced by each country and explore potential solutions to address energy insecurity while promoting industrial development and environmental sustainability (Government of Bangladesh, 2023)

## INDUSTRIAL STATE OF GROWTH IN SOUTH ASIA

According to the World Bank, the industrial growth in South Asia, encompassing countries like India, Bangladesh and Nepal, has been remarkable in recent years. India, with its robust economic growth rates and increasing industrial production, stands out as a leader in industrial development. India's industrial sector is mainly driven by strong domestic demand and favorable business sentiment. Similarly, Bangladesh has experienced steady growth in its industrial sector, supported by government initiatives aimed at promoting various industries and ensuring food security. Nepal has also shown signs of improvement, with sectors like services and industry contributing to economic growth. As these countries continue to prioritize industrialization and

infrastructure development, the South Asian industrial landscape is poised for further expansion and transformation(World Bank, 2024).

India's industrial development has seen remarkable progress, as evidenced by robust economic growth rates, increasing industrial production, and a conducive business environment attracting foreign direct investment (FDI).S&P Global Market Intelligence published a report titled “India's Manufacturing Output Surges While Inflation Pressures Ease” in which it states that in India, economic momentum has remained strong, with industrial production rising by 10.3% year-over-year (y/y) in August 2023 and GDP growth reaching 7.8% y/y in the April-June quarter of 2023.Private consumption and gross domestic fixed capital formation have shown positive growth trends, with significant increases in the April-June quarter of 2023.Output in key segments of the service sector, such as financial, real estate, and professional services, witnessed rapid growth rates in the April-June quarter of 2023.India's industrial production surged by 10.3% y/y in August 2023, with manufacturing output, electricity output and capital goods production showing significant growth rates.The manufacturing sector's strong expansion is evidenced by the S&P Global India Manufacturing Purchasing Managers' Index (PMI), which registered 57.5 in September 2023.The services sector also experienced substantial growth, with the S&P Global India Services PMI Business Activity Index reaching 61.0 in September 2023. India's Consumer Price Index (CPI) inflation pressures have moderated, with the headline CPI inflation rate falling to 5.0% y/y in September 2023 (Biswas, 2023).

India's industrial development is driven by a combination of factors, including strong domestic demand, robust investment activities, and favorable business sentiment. The country's transition towards becoming a global manufacturing hub is evident from the rapid expansion of industrial production and the manufacturing sector's resilience, as indicated by PMI data.The surge in FDI inflows underscores India's attractiveness as an investment destination, particularly in technology-related sectors and infrastructure. This influx of foreign capital not only supports industrial growth but also contributes to India's external resilience and Foreign Exchange (FX) reserves.India's industrial development trajectory remains positive, supported by conducive macroeconomic conditions and ongoing reforms to enhance ease of doing business and attract investments (Biswas, 2023).

Similarly, the industrial sector in Bangladesh has experienced steady growth over the last few decades, with the cumulative contribution to GDP consistently increasing. The Bangladesh Economic Review 2023, attributes this growth to government initiatives aimed at promoting various industrial sectors, including manufacturing, fuel, agriculture, forestry, mineral extraction, tourism, construction, and ICT-based industries. These initiatives focus on expanding labor-intensive and export-oriented industries, ensuring food security through fertilizer production, and generating skilled manpower and employment opportunities. The National Industrial Policy 2022 underscores the importance of embracing technological advances for productivity enhancement, utilizing domestic resources efficiently, and creating an investment-friendly environment to achieve desired growth in the industrial sector(Government of Bangladesh, 2023).

According to the Bangladesh Bureau of Statistics (BBS), the contribution of the broad industry sector to GDP increased from 36.92 percent in FY 2021-22 to 37.56 percent in FY 2022-23. Among the industry sectors, manufacturing holds the highest contribution to GDP, accounting for 24.95 percent in FY 2022-23. The manufacturing sector has shown consistent growth, as evidenced by the volume and growth performance data from FY 2015-16 to FY 2022-23. The Quantum Index of Production for medium to large-scale manufacturing industries also reflects a significant increase from 213.22 in FY 2013-14 to 500.28 in FY 2022-23, based on the FY 2005-06 base price (Government of Bangladesh, 2023).

These highlight positive trends in the industrial sector, with notable contributions from manufacturing and other key industries. The government's strategic interventions, as outlined in policies like the National Industrial Policy 2022 and initiatives to support SMEs, have played a pivotal role in driving this growth. By prioritizing infrastructure development, creating an investment-friendly environment, and facilitating access to finance, the government aims to sustain and accelerate industrial growth. Overall, these measures align with Bangladesh's goal of achieving middle-income status through industrial development and economic growth (Government of Bangladesh, 2023).

“Nepal’s Development Update” published by the World Bank in 2024, shows that Nepal's economy has displayed signs of improvement in the first half of FY24, with a forecasted growth rate of 3.3 percent, a significant rebound from the low of 1.9 percent in FY23. This growth has been supported by various sectors, including services and industry, with notable contributions from accommodation and food services, financial activities, and higher hydroelectric production. However, challenges persist, particularly in private investment and fiscal deficit reduction (World Bank Group, 2024).

In the services sector, accommodation and food services have experienced growth, driven by a rise in tourist arrivals. Financial and insurance activities have also expanded, while there has been a contraction in wholesale and retail trade. The industrial sector has been supported by increased hydroelectric production. Agriculture saw an increase in paddy production due to improved seed availability and favorable weather conditions. Moreover, remittance inflows have increased, contributing to private consumption growth and strengthening the external position reduction (World Bank Group, 2024).

Given this background on industrial state of growth in south Asia, this paper delves into systematic review of literature on the impact of energy insecurity on industrial development in south Asia in the context of India, Bangladesh and Nepal. the paper is provides an overview of impact of energy security challenges on industrial development in south asia, while focusing on environmental challenges and regulatory frameworks and policy initiatives for clean energy adaptation in india, bangladesh, and nepal. the paper also provide a crical review before drawing a conclusion.

## IMPACT OF ENERGY SECURITY CHALLENGES ON INDUSTRIAL DEVELOPMENT IN SOUTH ASIA

Bangladesh, India, and Sri Lanka are heavily reliant on coal for their energy needs, posing significant challenges to their energy security and industrial productivity.

Table 1: Key Coal Matrix for Bangladesh, India and Sri Lanka

Country	Coal reliance (% of Total Primary Energy Supply in 2019)	% of electricity generation (2019)	% of final industrial energy demand (2019)	Import growth rate 2009 to 2019	% of coal in Total Primary Energy Supply that is imported (2019)	Does the country produce coal?
Bangladesh	5%	1%	33%	775%	88%	Yes
India	45%	72%	39%	131%	32%	Yes
Sri Lanka (Nepal)	12%	33%	2%	2288%	108%	No

Bangladesh, with its two existing coal-fired power plants, planned to build 18 new plants in 2020 but cancelled 10 by early 2021 due to activist pressure and rising coal prices. The synchronization of the Payra power plant in 2020 added 1,320 MW of capacity, yet the country only utilized 43% of its power plants' capacity in the 2018–19 fiscal year, a situation exacerbated by decreased demand due to COVID-19.

India, as the second-largest coal producer with the fifth-largest coal reserves globally, operates 233 GW of coal power capacity. Coal accounted for 45% of India's primary energy supply and 72% of its electricity generated in 2020. The power sector consumes 78% of the coal, with industries like steel, cement, and fertilizer using 19%.

Sri Lanka's sole coal-fired power plant in Puttalam has three 300 MW units. Despite planning more coal plants to avoid capacity shortages, Sri Lanka announced in 2021 it would not build any new coal-fired power plants, aiming for net-zero emissions by 2050 and sourcing 70% of energy from renewables by 2030 (South Asia Group for Energy, 2022).

All eight South Asian countries are liquid fuel deficient and heavily reliant on importing crude oil and refined petroleum products. This dependency makes the region, home to one-fourth of the global population, vulnerable to fluctuations in global oil supply and prices, which could significantly impact their economies and development activities. To mitigate these risks, it is essential to review South Asia's oil imports and explore potential energy collaboration opportunities among these nations.

India's oil and gas sector is among its six core industries, contributing about 15% to the country's GDP. Petroleum and natural gas exports account for 17% of India's total US\$480 billion export revenue. Currently, India imports 82% of its oil needs and aims to reduce this to 67% by 2022 through local exploration, renewable energy, and indigenous ethanol. As of March 31, 2017,



India's estimated crude oil reserves were 604 million tons. India, the world's 3rd largest crude oil importer after China and the USA, imported 220 million tons in 2017-18, while domestic production was 36 million tons. The total petroleum product import was 256 million tons, with 67 million tons exported to neighboring countries. The total import bill for petroleum products in 2017-18 was US\$80 billion. Additionally, India is the world's 2nd largest LPG importer, imported 30 million tons in 2022. India's share of global oil production was around 0.92% in 2016-18, with domestic production of 243.55 million tons of petroleum products in 2016-17, including diesel (42.08%) and petroleum (15.02%) (Firoz et al, 2019).

India's heavy reliance on fossil fuels, particularly coal and oil, poses a significant bottleneck for industrial development, impeding the country's transition towards sustainable energy and hindering its competitiveness in the global market. The critical dependence on fossil fuels undermines energy security, increases operational costs, and constrains the scalability of renewable energy (RE) solutions, thereby limiting industrial growth potential.

India's energy security strategy has historically prioritized fossil fuels, with coal accounting for a significant portion of electricity generation and CO<sub>2</sub> emissions. Despite ambitious targets for renewable energy expansion, coal is projected to remain the primary source of electricity generation, with coal capacity expected to increase modestly by 2032. Additionally, India's heavy reliance on imported crude oil, representing 88% of its consumption, poses a security risk due to price volatility and supply disruptions, as evidenced by global events like the Russian invasion of Ukraine (Tongia, 2023).

The entrenched reliance on fossil fuels as a major bottleneck for industrial development in India is clearly visible. Despite efforts to increase renewable energy capacity, the dominance of coal in electricity generation persists, hindering progress towards a sustainable energy future. The limited diversification of energy sources leaves India vulnerable to supply disruptions, price fluctuations, and geopolitical risks associated with fossil fuel imports. Moreover, the challenges associated with scaling up renewable energy, such as variability, lack of viable storage options, and investment implications, further complicate India's energy transition. While renewable energy presents opportunities for improving energy security and reducing emissions, the current infrastructure and regulatory landscape pose barriers to its widespread adoption, particularly in addressing the variability of solar and wind power. The complex interplay between energy demand, affordability, reliability, and sustainability underscores the multifaceted nature of the energy trilemma facing India. While clean energy technologies offer potential solutions, their deployment is hindered by structural and institutional challenges, including regulatory barriers, land limitations, and technological feasibility issues.

Bangladesh is energy deficient, with the state-owned Bangladesh Petroleum Corporation (BPC) overseeing import, storage, marketing, and distribution of petroleum products. The country's sole oil refinery, Eastern Refinery Limited, along with three fuel distribution companies, meets the nation's fuel needs. Annual fuel demand has grown from 2.0 mtpa to 7.5 mtpa over the past two

decades. In 2017, BPC imported 5.5 million tons of fuel, including 1.5 million tons of crude oil, while private sector companies imported 2 million tons of refined fuel. Current petrol demand is around 700,000 to 750,000 tons. Eastern Refinery's capacity is being expanded from 1.5 million tons to 4 mtpa by 2021. To address transportation inefficiencies and frequent interruptions, BPC is constructing a fuel pipeline network across the country, including the Sitalganj-HSIA pipeline for jet fuel, the Chittagong-Dhaka pipeline for petroleum products, and the India-Bangladesh Friendship pipeline for diesel. Rising fuel demand in Bangladesh is driven by transport (50%), irrigation (30%), and power generation (20%), with the latter's demand increasing from 1% in 2008 to 20% in 2018. Crude oil imports have remained constant at around 1.2 million tons per annum since 2002 due to the capacity limit of Eastern Refinery (Firoz et al, 2019).

Bangladesh's persistent energy shortage, characterized by a widening gap between supply and demand, constitutes a significant bottleneck for industrial development. Despite government efforts to expand the power and energy sector through increased investment and policy initiatives, the country continues to grapple with energy insecurity, hindering its ability to meet growing industrial demands and sustain economic growth. In a study titled "Energy crisis in Bangladesh: Challenges, Progress, And Prospects for Alternative Energy Resources" Islam, Al-Amin and Sarkar argue that Bangladesh has experienced a chronic energy deficit, with energy imports ranging from 12% to 22% of total energy consumption between 1990 and 2018. The increasing reliance on energy imports, reaching 20.5% in 2018, reflects the country's failure to achieve energy self-sufficiency and security. Despite substantial budget allocations and infrastructure expansion in the power sector, including quadrupling the number of power plants and tripling maximum power generation capacity, Bangladesh struggles to meet growing energy demands. The country provides significant subsidies to the energy sector, with subsidies accounting for 33.6% of GDP in 2013. However, the reduction in energy subsidies over time has not alleviated the economic burden imposed by the ongoing energy crisis (Islam, Al-Amin & Sarkar, 2021).

This underscores the persistent challenges faced by Bangladesh in addressing its energy crisis, which poses a formidable bottleneck for industrial development. Despite substantial investments and policy initiatives, the country remains heavily dependent on energy imports, undermining its energy security and economic resilience. The lack of policy coherence, regulatory effectiveness, and governance efficiency exacerbates the energy crisis, leading to bureaucratic inefficiencies, weak monitoring, and corruption. The dominance of natural gas in the energy mix, coupled with delays in diversifying energy sources and integrating clean energy technologies, further perpetuates the country's vulnerability to supply disruptions and price fluctuations. The absence of collaboration between the public and private sectors, coupled with bureaucratic hurdles and weak monitoring mechanisms, hinders the timely completion of power projects and impedes the expansion of the energy sector. As a result, Bangladesh struggles to meet the energy demands of its industrial sector, limiting its capacity for sustainable economic growth and industrial development.

## **Impact on Environmental Challenges that Constrain Industrial Development in South Asia**

A report titled “5 Biggest Environmental Issues in India in 2024” (Illuminem, 2024) states that air pollution poses a significant challenge in India, primarily due to the country's heavy reliance on fossil fuels, especially in industries. This reliance contributes to high levels of particulate matter and other pollutants in the air, exacerbating health risks and environmental degradation. India is home to 63 of the 100 most polluted cities globally, with New Delhi ranking as the capital with the worst air quality in the world, according to the 2021 World Air Quality Report. PM<sub>2.5</sub> concentrations in nearly half of India's cities exceed the WHO air quality guideline level by more than 10 times, highlighting the severity of the issue. Vehicular emissions, industrial waste, smoke from cooking, construction activities, crop burning, and power generation are major contributors to air pollution in India. The country's dependence on coal, oil, and gas for electrification makes it the world's third-largest polluter, emitting over 2.65 billion metric tons of carbon annually. The COVID-19 lockdown in 2020 led to a temporary improvement in air quality due to reduced human activities, but pollution levels quickly returned to pre-pandemic levels in 2021. Persistent exposure to PM<sub>2.5</sub> is linked to various health issues, including heart and lung disease, and contributes to millions of premature deaths annually. Measures like the Odd-Even Regulation and plans to ban coal use in industrial and domestic units in the National Capital Region demonstrate efforts to address air pollution. However, challenges persist, particularly in controlling emissions from thermal power plants, the largest consumers of coal (Igini, 2024).

This highlights the multifaceted nature of India's air pollution problem, with industrial emissions playing a significant role. The heavy reliance on fossil fuels for power generation and industrial processes releases pollutants into the air, contributing to high levels of particulate matter and other harmful substances. While temporary measures like traffic rationing and coal bans in certain sectors demonstrate governmental efforts to address air pollution, the challenge remains complex. The continued reliance on coal for power generation, particularly in thermal power plants, underscores the need for comprehensive strategies to transition to cleaner energy sources. Addressing India's air pollution crisis requires a concerted effort to reduce emissions from industries, improve public transportation infrastructure, promote renewable energy adoption, and enforce stringent environmental regulations. Only through such holistic approaches can India mitigate the health risks and environmental damage caused by air pollution and pave the way for a sustainable future.

Likewise, air pollution presents a significant challenge in Bangladesh, driven primarily by the heavy reliance on fossil fuels in industrial activities. This reliance contributes to greenhouse gas emissions, exacerbating global warming and posing severe environmental and economic risks to the country (Hossain, 2023). The country emits a substantial amount of CO<sub>2</sub> into the atmosphere, contributing to global GHG emissions. In 2018 alone, Bangladesh emitted 82,760 kt of CO<sub>2</sub>. Sectoral analysis reveals that agriculture is the highest contributor to GHG emissions in



Bangladesh, accounting for 39% of total emissions, followed by the energy sector and land-use change. The energy sector in Bangladesh heavily relies on fossil fuels for electricity generation and industrial processes, contributing significantly to CO<sub>2</sub> emissions. The World Economic Forum's Global Energy Transition Index ranks Bangladesh poorly in terms of clean fuel production and energy sustainability, highlighting the need for improvement in environmental practices (Hossain, 2023).

The above mentioned article underscores the pressing issue of air pollution in Bangladesh, exacerbated by the country's heavy dependence on fossil fuels, particularly in the energy and industrial sectors. This reliance not only contributes to local air pollution but also significantly impacts global climate change, exacerbating the vulnerability of Bangladesh to extreme weather events and rising sea levels. Bangladesh's poor ranking in global indices related to clean fuel production and energy sustainability underscores the urgent need for policy interventions and investments in renewable energy sources and sustainable practices. Transitioning away from fossil fuels towards cleaner alternatives is essential not only for reducing air pollution but also for ensuring long-term environmental sustainability and resilience in the face of climate change.

The effects of air pollution in Nepal, primarily from over reliance on fossil fuels, are severe and far-reaching, impacting public health, life expectancy, and overall quality of life. According to a recent international report, Nepal ranks as the third most-polluted country globally, largely due to the high concentration of hazardous PM 2.5 particles in its atmosphere. These tiny particles, which are about 25 times smaller than the diameter of human hair, can penetrate deep into the lungs and bloodstream, leading to serious health issues such as asthma, cardiovascular diseases, and respiratory problems. The Air Quality Life Index-2024 (AQLI) report reveals that the average life expectancy of Nepalis has decreased by 3.4 years due to air pollution. In the ten districts of Nepal that border the heavily polluted regions of North India, life expectancy has been reduced even further by 5.1 years. This significant reduction in life expectancy highlights the urgent need for effective air quality management (Subedi, 2024).

The shift to clean energy in South Asia's industrial sector can lead to healthier workers, lower operational costs, regulatory compliance, and improved reputation. By adopting clean energy solutions, industries can reduce the emission of harmful pollutants such as PM<sub>2.5</sub>, improving air quality and the overall health of workers. Healthier workers tend to have higher productivity levels, fewer sick days, and better output, leading to enhanced industrial performance. Clean Energy adaptation often leads to long-term cost savings by reducing the dependency on expensive and volatile fossil fuels. Clean energy sources are sustainable and less prone to price fluctuations, which can stabilize energy costs for industries, increasing their profitability and competitiveness. Adapting to clean energy can help industries stay ahead of regulatory changes, avoiding potential fines, shutdowns, or costly retrofitting of outdated equipment. This proactive approach can ensure uninterrupted production and compliance with future environmental standards. As global markets increasingly value sustainability, industries that adopt clean energy can enhance their reputation as environmentally responsible entities. This can open doors to

partnerships with international corporations that prioritize green practices, potentially increasing export opportunities and attracting foreign investments.

### **Regulatory Frameworks and Policy Initiatives for Clean Energy Adaptation in India, Bangladesh, and Nepal**

An IMF Working Paper titled *Climate Change in South Asia: Further Need for Mitigation and Adaptation* outlines the climate commitments of India, Bangladesh, and Nepal under the Paris Agreement. These countries have set ambitious goals to mitigate climate change through various regulatory frameworks and policy initiatives aimed at transitioning to clean energy.

#### **India's Commitment**

India, as a signatory to the Paris Agreement, has committed to significant mitigation efforts. The country's regulatory framework focuses on transitioning towards renewable energy sources and reducing emissions intensity (Agarwal et al., 2021). Despite its relatively low emissions per capita, India's large share of global greenhouse gas emissions makes its mitigation strategy crucial for global climate goals. The country's Nationally Determined Contributions (NDCs) include commitments to reduce emissions intensity by 33-35% by 2030, compared to 2005 levels, and increase the share of non-fossil energy in total power generation to 40%. Investments in renewable energy, particularly in solar and wind, indicate that India is on track to achieve these targets under current policies.

India's progress in renewable energy deployment offers the potential for the country to become a global leader in climate action. However, challenges remain, particularly in phasing out coal-fired power plants, which continue to be a significant source of emissions. By prioritizing renewable energy expansion and implementing measures to improve energy efficiency, India can accelerate its transition towards a low-carbon economy while addressing local air pollution and fostering job creation in the renewable energy sector.

#### **Bangladesh's Strategy**

Bangladesh, another Paris Agreement signatory, has outlined a dual approach with both unconditional and conditional targets, depending on international support (Department of Environment, Bangladesh, 2023). The country has pledged a 5% reduction in greenhouse gas emissions by 2030 in sectors such as power, transport, and industry, based on a business-as-usual scenario. Additionally, Bangladesh aspires to achieve net-zero emissions by 2030 with extensive international support (Agarwal et al., 2021). The focus on sectors like transport and industry highlights the country's commitment to scaling up climate action with the help of global partnerships.

Bangladesh's proactive approach to combating climate change recognizes the need for both domestic action and international collaboration. By leveraging global support, Bangladesh aims to accelerate its transition towards a sustainable and low-carbon development pathway, contributing to global climate goals while addressing developmental challenges.

### **Nepal's Mitigation Path**

Nepal's NDCs emphasize conditional commitments to reduce fossil fuel dependency by 50% by 2050, contingent on receiving bilateral or multilateral grant support (Climate Action Tracker, 2023). The reliance on hydropower positions Nepal well to leverage its renewable energy potential, making a transition to cleaner energy more feasible. However, achieving these targets will require substantial support from development partners to build the necessary infrastructure and reduce the use of fossil fuels.

Nepal's mitigation strategy, in contrast, underscores the importance of international support given its resource constraints. By prioritizing investments in renewable energy infrastructure and seeking assistance from development partners, Nepal aims to reduce its carbon footprint while promoting economic growth and energy security.

### **Regional Cooperation through BIMSTEC**

The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) plays a crucial role in promoting clean energy adaptation and enhancing energy security among its member states, including India, Bangladesh, and Nepal. BIMSTEC aims to harness the region's energy potential while promoting sustainability and self-reliance. The forthcoming establishment of the BIMSTEC Energy Centre in India is a significant step towards enhancing regional energy cooperation (The Financial Times, 2023). This center will serve as the secretariat for BIMSTEC's energy initiatives, fostering resilience and sustainability.

During a recent conference on *Enhancing Energy Cooperation in the BIMSTEC Region*, organized in collaboration with the South Asian Regional Initiative for Energy Integration (SARI/EI), stakeholders discussed the harmonization of operational, legal, and regulatory frameworks for regional electricity grids. The signing of a Memorandum of Understanding (MoU) for establishing the BIMSTEC Grid Interconnection during the Fourth BIMSTEC Summit in Kathmandu underscores the commitment to regional energy integration. Examples of cross-border power trade between BIMSTEC member states include India-Bangladesh and India-Nepal collaborations. These intergovernmental arrangements contribute to energy security and resource optimization (Amir, 2023).

BIMSTEC serves as a vital platform for promoting clean energy adaptation and regional energy cooperation. By establishing the BIMSTEC Energy Centre and facilitating conferences on energy cooperation, the organization demonstrates its commitment to addressing common energy

challenges collectively. The signing of agreements such as the MoU for Grid Interconnection highlights the concrete steps taken towards integrating regional electricity grids and promoting cross-border electricity trade. This interconnectedness enhances energy security and resilience by leveraging shared energy resources effectively.

Collaborations in the hydropower sector between India, Bangladesh, and Nepal exemplify the potential for mutually beneficial partnerships in renewable energy development. By tapping into the region's hydropower potential and promoting cross-border power trade, BIMSTEC member states can achieve sustainable energy goals while fostering economic growth and development. Through continued collaboration and collective action, BIMSTEC member states can unlock the full potential of clean energy resources and ensure a resilient and prosperous energy future for the region.

### **CRITICAL REVIEW**

Clean energy adaptation, particularly through the development of renewable energy sources like hydropower, can significantly improve industrial productivity in South Asia. The region's reliance on fossil fuels, such as coal and natural gas, has long been associated with environmental degradation and fluctuating energy costs, which in turn impact industrial efficiency. Transitioning to clean energy can mitigate these issues and create a more stable and sustainable energy supply, which is crucial for industrial growth.

Countries like India, Bangladesh, and Nepal have recognized the need for a shift towards clean energy and have implemented regulatory frameworks and policy initiatives to support this transition. For example, India, under its Nationally Determined Contributions (NDCs), has committed to reducing emissions intensity and increasing the share of non-fossil energy in power generation. This commitment has led to substantial investments in renewable energy, particularly in solar and wind, which are essential for reducing energy costs and ensuring a steady supply of power to industries. As industries gain access to more reliable and affordable clean energy, their operational efficiency and productivity can improve significantly.

Bangladesh's efforts to mitigate climate change through its NDCs include commitments to reduce greenhouse gas emissions in key sectors like power and industry. By focusing on cleaner energy sources and improving energy efficiency, Bangladesh can enhance industrial productivity by reducing energy costs and minimizing the environmental impact of industrial activities. The country's ambition to achieve net-zero emissions by 2030, with international support, further underscores the potential for clean energy to drive industrial growth while adhering to global environmental standards.

Nepal, with its abundant hydropower potential, presents a unique case where clean energy adaptation can directly influence industrial productivity. As the country continues to develop its hydropower capacity, it can offer a reliable and renewable energy source to domestic industries,

reducing their dependency on imported fossil fuels and stabilizing energy costs. The availability of affordable and sustainable energy is critical for industries that are energy-intensive, such as manufacturing and processing, enabling them to increase output and competitiveness.

The role of regional cooperation, particularly through initiatives like the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), is crucial in enhancing clean energy adaptation and improving industrial productivity in South Asia. BIMSTEC's efforts to harmonize regulatory frameworks and facilitate cross-border electricity trade among member states, including India, Bangladesh, and Nepal, can lead to a more integrated and resilient energy market. This integration allows for the optimization of energy resources, reducing energy costs and ensuring a stable supply of clean energy across the region.

## CONCLUSION

The industrial growth in South Asia, particularly in India, Bangladesh, and Nepal, demonstrates remarkable potential for continued development, yet is confronted by critical challenges, primarily concerning energy security and environmental sustainability. The region's heavy reliance on fossil fuels not only hinders the transition to sustainable energy but also exacerbates environmental degradation, including air pollution and greenhouse gas emissions. However, the concerted efforts by these countries to adopt clean energy solutions, supported by progressive regulatory frameworks and regional cooperation, signal a promising shift towards sustainable industrial development. The hydropower potential in Nepal stands out as a transformative opportunity, not only for meeting its domestic energy needs but also for fostering cross-border electricity trade, contributing to regional energy security and helping achieve global climate goals. In addressing these challenges and capitalizing on renewable energy sources, South Asia is well-positioned to experience industrial growth that is both economically vibrant and environmentally responsible. As such, the study provided the following recommendations.

To accelerate the adoption of renewable energy, particularly hydroelectricity, India, Bangladesh, and Nepal must implement robust and forward-looking strategies. First, these nations should develop and enforce comprehensive renewable energy plans, with ambitious yet achievable targets that diversify their energy mix based on sector-specific demand and potential. Establishing mandatory connection and purchase policies would guarantee a stable market for renewable energy, thereby attracting large-scale investments in clean energy infrastructure. Additionally, the creation of dedicated renewable energy development funds, financed through mechanisms like surcharges on grid companies, would bolster localized manufacturing, rural renewable energy programs, and research and development initiatives. International cooperation should be actively pursued to access cutting-edge technologies and expertise, enabling these countries to benefit from global advancements in renewable energy. Moreover, significant public investment in research and development will be essential for reducing the costs of renewable energy generation and enhancing efficiency. Finally, coordinating renewable energy manufacturing policies at the national and local levels will ensure sustainable growth, avoiding



short-term measures that might undermine long-term energy security and industrial expansion. By embracing these recommendations, India, Bangladesh, and Nepal can successfully lead the charge in integrating renewable energy into their industrial frameworks, advancing economic growth, environmental sustainability, and regional energy resilience.

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