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Energy Horizons whilst assessing South Asia's Renewable Future, Chinese Investment Collaboration, obstacles and Geopolitical Dynamics

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Abstract

The energy requirements in South Asia are rapidly increasing, presenting a growing challenge for satisfying these demands. This difficulty arises from the elevated expenses associated with traditional energy sources, the unsustainable patterns of energy consumption, and the substantial emanations they generate. Although South Asia boasts abundant potential for renewable energy (RE), particularly hydropower, it still needs to be utilized. This article explores the future of RE in South Asia, examining the role of Chinese investment and geopolitical dynamics. With escalating energy demands in the region, attention has turned to sustainable solutions amidst concerns about security and environmental impact. Chinese investment offers potential avenues for RE development in South Asia, yet it involves complex geopolitical considerations. The qualitative method is used to find the answer to the question. The provision of energy services must prioritize minimal environmental impact. Fossil fuel combustion has emerged as a significant impediment to sustainable progress in South Asia. Although RE has undergone substantial progress in recent years, there remains a need to draw upon the insights garnered from this progress for further application. This article proposes potential solutions to promote renewable energy (RE) sources in South Asia via various approaches.

***Keywords*:** South Asia, China, Energy, Geopolitics, Investments, BRI, Energy Trilemma

Introduction

South Asia has emerged as a rapidly growing global region, with its countries collectively maintaining an impressive average annual growth rate of approximately 7% in recent years(Global Economic Prospects: Heightened Tensions, Subdued Investment, 2019). Despite this consistent economic growth, these nations have largely remained constrained by energy limitations(Murshed, 2021). Consequently, the economic growth of these countries has not reached its full potential due to persistent energy limitations. The energy calamities in South Asian states can be attributed mainly to significant heterogeneity in their indigenous energy resources (Nandy, 2019). As a result, most of these countries have struggled to fulfill their energy demands solely through local energy sources. This unreliability in energy supply across the area is alleged to have hindered the progress way of South Asian realms (*In the Dark: How Much Do Power Sector Distortions Cost South Asia*, 2018).

Additionally, the lesser electrification ratio, particularly in rural areas, is a prevalent issue in these nations, prompting the energy crisis within South Asia. The energy crisis confronting South Asian nations is postulated to significantly hinder their progress towards attaining the Sustainable Development Goals (SDGs) set forth by the United Nations. Notably, the region's low electrification rates are frequently cited as a primary obstacle to attaining SDGs (UN ESCAP, 2018). In 2017, an estimated 1.62 billion individuals in South Asia (Murshed, 2021) lacked an approach to grid-connected electrical energy, representing over 24% of the universal population without such connectivity (Global Economic Prospects: Heightened Tensions, Subdued Investment, 2019). Hence, it is crucial for South Asian financial prudence to enhance their grid connectivity significantly. The persistently low electrification rates can largely be attributed to the heavy reliance of these nations on fossil fuels. This reliance on limited fossil fuel reserves, mainly to produce electricity, has undermined the energy supply's overall stability and future viability and created severe environmental hazards (Murshed, 2019).

Consequently, ensuring energy security has become a top priority for South Asian governments, as sustainable socioeconomic and environmental development is unlikely to be maintained without it. Among the various strategies for guaranteeing energy sustainability, the amalgamation of Renewable Energy (RE) sources into the national energy mix is considered supreme. Not only does increasing the use of RE supplies help to alleviate the energy problem, but it also helps to better environmental quality. Renewable Energy Transition (RET) reducing fossil fuel reliance is a challenging endeavor, particularly for underdeveloped economies that face technological backwardness. Additionally, inadequate energy infrastructure within these countries presents further obstacles to electricity generation using renewable resources (Murshed, 2018), and many South Asian countries contend with these limitations. As a result, the foremost South Asian economies have primarily relied on non-renewable energy sources. Therefore, in terms of attaining energy sustainability, it is of high importance for South Asian states to recognize the factors enabling them to undertake RET.

While these barriers to RET may be overwhelmed by technical spillovers, especially from Foreign Direct Investment inflows, such routes to aid the RET process are subject to temporal lags. As a result, it is critical to develop intermediate and rapid measures to increase the use of RE in South Asian economies. In this respect, intra-regional energy trading emerges as a promising way to improve the usage of RE levels throughout South Asia(Saklani et al., 2020). Smaller South Asian finances, such as those of Nepal and Bhutan, have long relied on RE sources to provide considerable national output. Furthermore, both nations have excess RE because of their small energy requirements. Larger South Asian economies, such as India, Bangladesh, and Pakistan, have relied significantly on domestic and imported non-renewable fossil fuels (Danish et al., 2017). As a result, all these possibilities make South Asia a key player in the global energy transition, a feasible hub for intra-regional power trade, and a place to attract Chinese investments. For instance, Bhutan and Nepal supply hydroelectric power to neighboring South Asian countries that rely on fossil fuels (Timilsina, 2021). This could significantly enhance the general usage of RE around the area, thereby contributing to energy sustainability in South Asia.

Nevertheless, despite the auspicious potential, intra-regional energy trade amongst South Asian nations has yet to make significant progress. A key factor contributing to this phenomenon is the historically low level of overall trade among South Asian states(Shah, 2020) and many geopolitical rivalries. Overcoming these rivalries is a significant challenge, but it's one that we must be determined to meet. In 2015, intra-regional trade in South Asia accounted for only 5 percent of the

entire universal trade in the region (Kaushik, 2015). The estimates suggest that intra-regional trade in this region is valued at just 23 billion US dollars(Kaushik, 2015) (Kaushik, pic. Trade), which is substantially below its potential. These disappointing drifts can be attributed to various reasons, including unsuitable tariff measures, high charges of intra-regional connectivity, and, notably, geopolitical rigidities amongst these nations that hinder trade engagement amongst neighbors (Kathuria, 2019). Moreover, the inefficacy of the South Asian Association for Regional Cooperation, (SAARC) agreement has additional impeded intra-regional trade across South Asia.

Creating an opportunity for Chinese investments, according to Miller, (2017) for the last fifteen years, China has emerged as one of the world's foremost investors. Chinese enterprises, commercial banks, and policy banks have significantly expanded their influence across various global regions, including South Asia. Implementing the plans, China aims to further this path through the Belt and Road Initiative (BRI), that seeks to stimulate trillions of dollars in investments focused on infrastructure and regional amalgamation throughout Asia and elsewhere. During these investments, China has positioned itself as a global leader in combatting and mitigating climatic changes, playing a pivotal role in the Sino–US climate agreement that contributed to establishing the Paris Agreement in 2015 ("E.U. Looks to China for Climate Leadership," 2017). Domestically, Sino has implemented substantial policies to curtail fossil fuel usage and has significantly advanced the adoption of RE technologies. Moreover, China has enhanced its capacity to supply these renewable technologies, mainly wind and solar, to other economies (Gallagher et al., 2019).

As mentioned, South Asia's pursuit of RE technologies offers crucial solutions and opportunities for China as it navigates through various forthcoming development challenges. However, these technologies also bring about ecological, socio-economic, and infrastructural changes. Among the most debated developments is the construction of several large hydroelectric dams, which have caused significant ecological disruption and the displacement (Randell, 2022) of millions of residents. Similarly, future large-scale tidal barrage projects could have similar adverse impacts. Furthermore, RE systems are inherently material-dependent and require industrial processes to produce the necessary installation equipment. Therefore, no RE technology can be considered entirely carbon neutral or completely "renewable" in an absolute sense, as most of the components on which it is based are finite. Emissions from the combustion of biomass and biofuels can also lead to ecological complications. In addition, some RE systems such as wind farms and solar parks necessitate extensive uninhabited areas, which present ecological, financial, and spatial constraints. Despite these challenges, the potential of RE to generate cleaner and safer energy than fossil fuels or nuclear power is crucial for decarbonizing economic activities, achieving sustainable development ensuring long-term energy security, and to combat the issue of change in climate. This is particularly significant for China and South Asian nations given their interconnected environmental challenges, energy, economics and their global implications. This article aims to quantify the opportunities for Chinese foreign investment in energy production from RE resources, such as through the BRI and other means. The article also offers policy recommendations that explore how China's strengths and capabilities can be leveraged to address these gaps, thereby maximizing the economic viability, developmental impact, and ecological sustainability of China's foreign investments. Furthermore, the Energy politics within the region, the energy trilemma and issues within the South Asian countries.

Energy Security

In South Asia, biomass remains the predominant energy source for the population, with oil, natural gas, coal, and electricity in usage. In South Asian countries, around 52.25 percent of people depend

on biomass (*Bioenergy in Asia*, n.d.), primarily derived from crops remainders, wood, and animal manure. This heavy dependence on biomass is incompetent and presents considerable health and environmental hazards. It is the fossil fuels that are predominant cause of viable energy in maximum South Asian countries. They are considered unsustainable and unpredictable due to high emissions and price volatility. Despite India and Pakistan possessing the region's main technically possible hydropower resources, energy production in these countries remains largely dependent on fossil fuels, with a growing trend towards increased fossil fuel-based electricity production (Tortajada & Saklani, 2018). The energy consumption by sector in the region is represented in

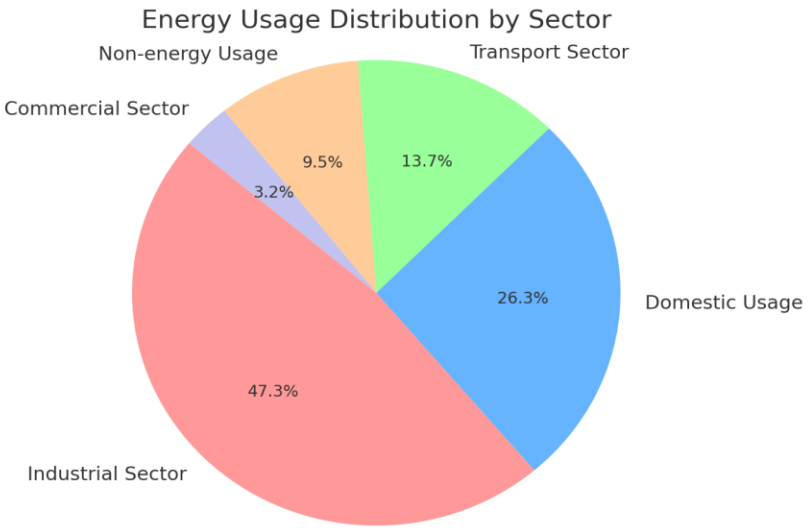

Figure 1 Authors self-presentation in Pie chart. The data source is, World Bank (2018). Available online at: https://data.worldbank.org/.

Given the industrial sector's high energy consumption, the urgency of addressing future energy demand is clear, as it will increase due to financial development, populace expansion, and climatic changes. It is worth noting that the South Asian region has huge renewable energy generation potential. This argument could be justified by its weather and its presence in the tropical region. Additionally, both wind and solar energy could be the best option alongside hydropower. In South Asia, the growth of industrial segments has contributed to fiscal development and improved livelihoods. However, this sector's greenhouse gases (GHGs) have exacerbated the region's climate change impacts. **Figure. 2** illustrates the per-capita energy usage in these republics (South Asian), which is minimal compared to developed nations such as Iceland, which has the maximum per-capita energy usage. This highlights a significant disparity, and energy requirements in the area are projected to rise sharply alongside fiscal progress. For example, since 2000, energy consumption in India has doubled, with 80 percent of its needs still being met by coal(*India Energy Outlook 2021*, 2021). Low per-capita energy usage coupled with a significant reliance on biomass and fossil fuels highlights the issues of energy insecurity and energy poverty in South Asia. The per-capita energy use is intricately connected to food and water security, as well as the broader, underscoring the urgency of the situation.

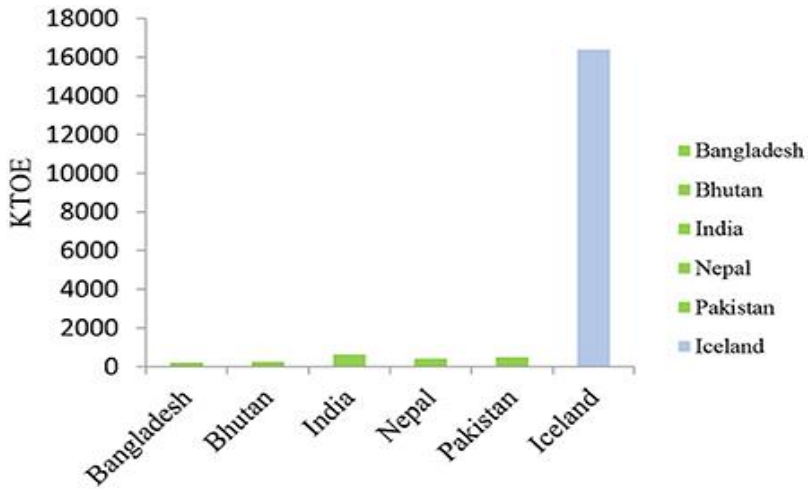

Figure 2 Per-capita Energy Consumption (PCEC) of South Asian nations compared to the nation with the world's largest PCEC. Kilotons of Oil Equivalent (KTOE). Source (Neupane et al., 2022a)

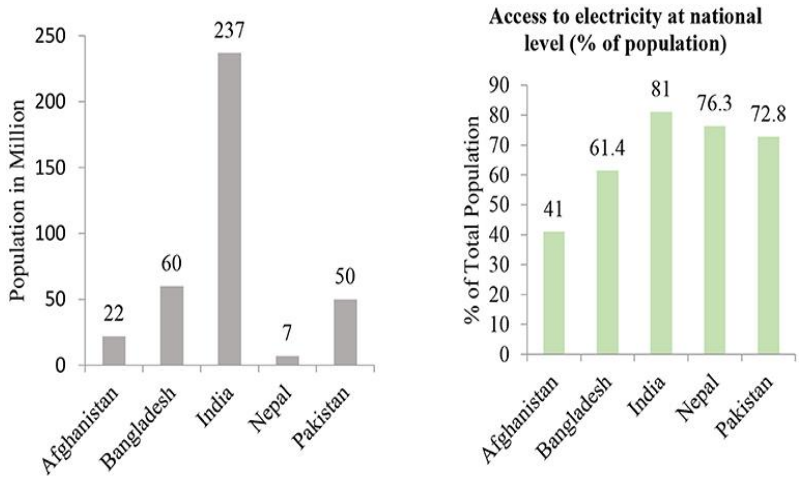

Figure 3 Population with electricity access. Source (Neupane et al., 2022a)

The electrical energy approach is another crucial aspect of energy security and needs urgent improvement in these states. **Figure. 3** portrays the percentage of the national population with access to electricity in South Asian countries. Over 376 million people in the six South Asian nations lack electricity access(Luitel, 2010). The region urgently needs better electricity grid connectivity, consistency, regularity, capability, and quality of energy supply. The situation is particularly dire in rural areas, which require urgent quality energy supplies for transport, improving agrarian production, and creating new income-generating opportunities. Prone to such an event, the projected electricity demand. **Table. 1** will exacerbate the situation. This urgency has led to the formation of Nonconventional Renewable Energy (NCRE), which is the form of electricity generation through wind power, small-scale hydropower, and utilizing solar energy (Wijayatunga & Fernando, 2013).

Table 1 Projected electricity demand. Source(Wijayatunga & Fernando, 2013)

Country	2010 GW/hr.	2020 GW/hr.	Compounded annual growth rate (%)
Afghanistan	1,132	3,877	13.10
Bangladesh	33,716	71,990	7.88
Bhutan	2,260	3,703	5.06
India	1,077,000	2,550,000	9.00
Maldives	1,923	2,447	2.44
Nepal	3,731	8,990	9.91
Pakistan	14,4711	261,523	6.10
Sri Lanka	10,327	22,040	7.88
total	1,274,800	2,924,570	8.66

Journeying through Energy Security and Climatic Changes Amidst Sino Financial Growth

Since becoming a net importer of crude oil in 1996, China has integrated energy supply risk mitigation into its national energy security policy, transitioning to a net distributor of coal for the first time, with oil import dependency at approximately 53% in 2009 (Wu et al., 2012). By 2013, oil and natural gas imports had risen to 58.9 percent and 27.6 percent, respectively. In 2024 there would be a further surge in LNG to 77 {mil mt} mm (Liang, 2024). meanwhile, China's crude oil imports slipped 6% in March 2024, and total crude oil imports in the first quarter stood at 137.4 million tons (Reuters, 2024). This necessitates China to urgently address energy security anxieties and adjust to the energy structure, encouraging China to intensify its investments in the energy sector. The supremacy of coal in the energy mix leads to significant GHG emissions and other pollutants, contributing to severe environmental issues. Additionally, the traditional usage of biomass for the purpose of cooking and the low standard of supply of electricity the zones that are rural and are distant, largely hinder efforts related to the poverty alleviation. Consequently, energy security will be a critical challenge for sustainable progress in China; along with this, energy insecurity has become a pressing concern in South Asian countries, too, due to the dependency on imported fossil fuels, increasing energy demands, and limited non-renewable resources (Rehman et al., 2023). Hence the development of RE could be a valuable solution to this problem.

As a developing state (Kanwit, 2023), China has enacted numerous strategies and set voluntary emission decrease targets to combat climatic changes. Since 2008, the National Development and Reform Commission (NDRC) has annually published a report on China's Policies and Actions for Addressing Climate Change. In November 2014, China showed its national plan for tackling climatic changes named "China National Plan for Tackling Climate Change (2014-2020)" (China's Policies and Actions for Addressing Climate Change, 2016). It included various strategies to tackle climatic concerns through 2020 (*China National Plan for Tackling Climate Change (2014-2020). | FAOLEX*, 2014). Following the Sino-US Joint Announcement on Climatic Changes, China aims to peak its carbon emanations and to increase the share of non-fossil fuels in primary energy consumption to around 20 percent by 2030 (*U.S.-China Joint Announcement on Climate Change*, 2024). China's Intended Nationally Determined Contributions, updated at the end of 2015, emphasize its dedication to combating climate change, highlighting the critical role of RE development in establishing a low-carbon energy system.

With substantial growth over the last thirty years, China's economy is approaching a new period known as the "New Normal" (Seek Sustained Development and Fulfill the Asia-Pacific Dream,

2014). This stage is essential not just as a historical achievement but also for determining the economy's future in three critical areas: medium-to-high-speed growth, ongoing fiscal transformation, and an invention-driven progress model, making Chinese investment influx into the energy sector, majorly the RE sector. The twelfth Five-Year Plan for National Strategic Emerging Industries Development has selected the RE sector as one of the significant emerging sectors (Lu, 2012). This suggests that energy from renewable sources will be a new driver of economic expansion in China.

Investments Amplified: Unveiling China's BRI, the green finance, obstacles and *is* the BRI on the brink of green shift?

Energy security concerns, a matter of strategic importance, are significantly influenced by the policy frameworks of involved states and their adoption of national energy security strategies. These frameworks, shaped by fiscal and geopolitical considerations, are crucial in the global energy landscape. Against the backdrop of increasing energy demands and declining forecasts for significant new energy discoveries within its borders, China's political leadership and administrative elite have been remarkably proactive in seeking new energy sources abroad since 1996/97 (Umbach, 2004). The Third forum of Belt and Road in 2023 unveiled that, from the inception of the BRI in 2013, Sino cumulative financing via mortgages have exceeded 687 billion US$ (*Building an Open, Inclusive and Interconnected World for Common Development--The Third Belt and Road Forum for International Cooperation*, 2023). Notably, BRI involvement, primarily in the shape of construction investments and contracts, has predominantly focused on infrastructure development within the transportation and energy areas. **Figure. 4**, the chart provides a visual representation of the $498 million that China's two major development finance institutions (DFIs) such as Export-Import Bank of China (CHEXIM) and China Development Bank (CDB) have committed across the globe to the sovereign borrowers. (Engel & Moses, 2023)

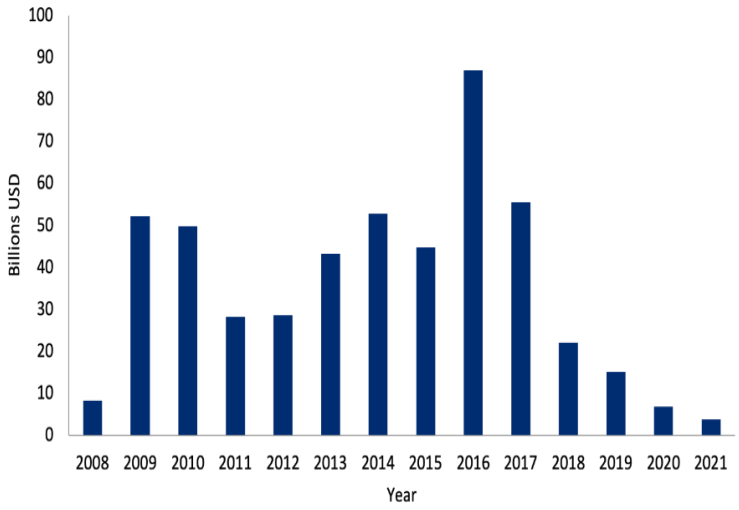

Figure 4 China's Overseas Development Finance, 2008-2021. Source (Engel & Moses, 2023)

During the start of the Sino pledge to cease funding for building new power stations fired by coal in BRI nations in 2021, Chinese foreign investments within the BRI have witnessed a notable shift towards renewable energy sources (Nedopil, 2023). Following the announcement of the Chinese

premier Xi in 2021, China will no longer build new coal-fired projects abroad(Springer, 2022). As an example, while a request was made from Bangladesh to replace five coal-powered power projects, the Chinese embassy in Bangladesh responded to the Bangladeshi Ministry of Finance that "the Chinese side shall no longer consider projects with high pollution and high energy consumption, such as coal mining and coal-fired power stations"(Shepherd, 2021). Although a message specific to Bangladesh, it marked the first official statement from the Chinese side related to the use of coal. Nonetheless, renewable energy investments of China, abroad remain considerably lower than those of its domestic ventures. From 2013 to 2023, the aggregate investment in the energy segment amounted to 12.3 billion US$, with only 990 million US$ allocated to Renewable energy sources, encompassing wind, solar and hydropower energy. In terms of total energy investments facilitated through the BRI spanning from 2010 to 2019, Renewable energy projects accounted for a mere 22%. In stark contrast, Renewable energy initiatives constituted a substantial 77% of China's domestic investments in the energy sector during the same period (Larsen & Oehler, 2023). A considerable lack of success in the RE sector can also be attributed to China's uneven regional energy investments. South Asian countries have considerable potential for RE resources (**Table 2**), but there is a significant investment gap and payment issues for carbon-intensive power plants. Pakistan and Bangladesh are growing concerned that the capacity may increase if the investment planned with the Chinese partners is implemented (H. Chen & Springer, 2021).

Table 2 Capacity of South Asian countries for RE. Source(Neupane et al., 2022)

Indicators	Afghanistan	Bangladesh	Bhutan	India	Nepal	Pakistan
Theoretical hydropower potential	23,000	-	30,000	184,700	80,000	100,000
Commercially feasible hydropower potential	23,000	755	24,000	84,004	43,000	59,000
Hydropower installed	442	230	1615	51,756	867	7320
Current utilization (%) (of the technical feasible)	1.9	30.4	6.7	61.61	2.01	12.4
Wind Potential	66,000	20,000	760	102,778	448	131,800
Wind installed	0.375	1.9	0.6	22,456	-	20,000
Solar Potential ($kWh/m^2/day$)	6.5	5	4	5	4	5.3
Installed solar photovoltaic (MW)	11	368	-	4060	-	1600

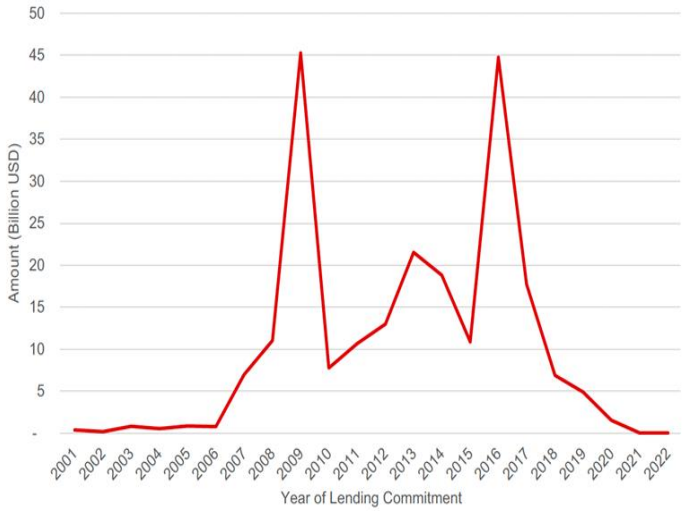

Figure 5 China's global energy finance. Source("Green Horizons? China's Global Energy Finance in 2022," n.d.)

There are International and Chinese organizations, i.e., Green Development Guidance for BRI projects, that have provided useful tools for evaluating the impacts of the BRI projects on the environment and pledged Chinese companies to invest in more sustainable grounds (Xiaoying, 2023). This is prompting the fact that, in BRI nations, Chinese private enterprises have emerged as key financiers of RE projects. For instance, although private companies represented only 8 percent of Sino foreign BRI energy investments in 2018, they contributed funding for approximately 65 percent of non-hydro renewable power production initiatives (Zhou et al., 2018). This underscores the predominance of major state-owned BRI financiers in providing energy funding primarily directed towards fossil fuel ventures. Research conducted by Boston University indicates that between 2000 and 2022, policy banks that are state-owned, such as the CDB and the CHEXIM furnished 73% of loans for power production projects involving coal, oil, and gas in BRI states ("Green Horizons? China's Global Energy Finance in 2022," n.d.). **Figure. 5** illustrates the argument. Meanwhile, specifically the Investments of BRI in the energy sector in the context of South Asia is illustrated in the **Table. 3.**

Region	Countries	Total investment	Total energy investment	% energy sector
South Asia	Afghanistan, Bangladesh, Maldives, Nepal, Pakistan, Sri Lanka	91.47	51.06	55.8

Table 3 South Asian region distribution of Chinese BRI energy investments. Source(Luthra & Gupta, 2023)

Despite China's pledge in 2021 to enhance its green BRI commitment (Zhai, 2021) and its subsequent cessation of issuing new loans related to the energy sector to the BRI nations in the year 2021 and year 2022, a substantial shift towards RE investments has yet to materialize.

Financing is the primary obstacle hindering RE investment expansion in BRI countries:

1. The Chinese and the host country spend a long time negotiating and renegotiating the projects.

2. The costs of financing associated with RE schemes in the mentioned nations are notably higher than those of the costs in China. This disparity can be attributed, in part, to the intricate administrative processes that lead to delays in the disbursement of subsidies provided by China's RE Investment Fund to developers engaged in the upscaling of solar and wind power schemes abroad.
3. China's fiscal framework grants dealing to state-owned enterprises, potentially constraining the access of private sector RE firms to scheme funding from domestic fiscal institutions.
4. Enterprises that are state-owned are more ready to accommodate less attractive risk-return profiles, partially due to their ability to secure project financing at lower interest rates from commercial banks and policy banks of China (Bian, 2023). Furthermore, other obstacles include lower project financing and a mismatch between the return on investments and risk(*Opportunities and Challenges for China's Renewable Energy Overseas Investment Case Country Study (Vietnam)*, 2020).

Inadequate institutional and information capacities present additional significant challenges. Sino scheme developers often need more experience navigating the request procedure for RE schemes in BRI states, where auction projects are prevalent. Moreover, Chinese companies need more expertise in collaborating with international financial institutions to develop financing structures for RE schemes in BRI realms, such as risk-sharing mechanisms, as mentioned above, to enhance economic feasibility. This led China to take a more international approach to financing infrastructural projects based overseas, a viable alternative option for corporate finance(Chinese Firms Turn to Project Finance for Overseas Ventures, n.d.). Furthermore, Chinese Export Credit Agencies (ECAs) are pivotal in furnishing two-sided export money to bolster Sino financial engagement with BRI realms. However, suitable fiscal inducements are yet to be offered by them to promote trade related to RE with the BRI nations. For instance, the actions related to export fundings of the CHEXIM majorly target enterprises that are state-owned in the sector of fossil fuel. Another state-owned ECA, the China Export & Credit Insurance Corporation (SINOSURE), needs more experience evaluating realm risks in BRI states. Therefore, China's ECAs may not provide innovative financial instruments, modalities, or products like guarantees to enhance the fiscal viability of RE schemes.

It is noteworthy that ECAs in G20 states, mainly those of Japan, South Korea, and Canada, have been amongst the leading investors of fossil fuel investments in evolving markets and emerging states from 2006 to 2020, with a primary focus on the region of Asia-Pacific (Peterson & Downie, 2024). In 2022, spearheaded by the Japan Bank of International Cooperation, Asian export-import banks and the CHEXIM issued a collective statement pledging to enhance collaborative efforts in addressing climatic changes (*Joint Statement with Asian Export and Import Banks on Efforts to Address Climate Change*, 2022). CHEXIM, in June 2023, entered into a series of cooperation agreements with the Asian Development Bank (ADB) that aims towards jointly identifying opportunities of co-financing for climate-related schemes in the BRI states (*ADB, CEXIM Sign Agreement to Support Co-Financing of Private Sector Investments in Asia and the Pacific*, 2023). Nevertheless, this debate raises an important question: Is the China BRI poised to transition toward sustainability? Because RE projects are yet to appear in the fold, even though new coal power projects are mainly being halted globally (Suarez, 2022), many experts say that a few projects are still edging forward in South Asia. For instance, a 300 MW coal power plant in Pakistan. Moreover, another project in Gwadar, Southwestern Pakistan, is not classified by China as 'new.' Wang Xiaojun, who is the founder of 'People of Asia for Climate Solutions,' argued that even though

many thermal power projects are being stopped, they have not yet been transformed into renewable energy. According to him, a possible cause may be that Xi's one-line pledge does not specify how the pipelined coal power projects may be dealt with. Wang said. "Many previously committed coal projects might be under renegotiation to be converted into renewable energy projects" (Xiaoying, 2023). However, another expert, Oyintarelado Moses, a data analyst for the 'Global China Initiative at the Boston University Global Development Policy (GDP),' says it will need time. "I think we are still in that initial time lag period of [Xi's] announcement. I do expect there to be more low-carbon and renewable energy projects from 2023"(Xiaoying, 2023). As mentioned, Chinese investors must learn to structure new deals and push for small and beautiful projects.

Energy Cooperation *Vis-à-vis* Investments in South Asia

Energy production and consumption in South Asia have substantial complementary and cooperative effects. A nearby country's grid can advantageously use one country's excess. Altering energy resources by using renewable energy can benefit participating nations enormously. This necessitates building trust, coordinating legislation, and sharing information to develop South Asia's integrated energy collaboration network. Hydropower progress needs substantial assets to address energy deficits. The positive development is that, over the past decade RE costs have significantly decreased, with prices for onshore wind and solar energy falling by 89 percent and 70 percent (Toussaint, 2020), respectively. These technologies offer more cost-effective alternatives to fossil fuels. For example, in its energy mix, India has boosted the proportion of renewables, with solar and wind at the present accounting for 7 percent of the total production, which is double the share of production counted in the year 2014 (G. Chen, 2021). Nonetheless, achieving "net-zero emissions" in the future will necessitate the development of several disruptive technologies to ensure clean energy is safe and affordable. To support the transition to net zero, regional countries can concentrate their efforts on four key areas aligned with the objectives of COP26 (Conference of the parties, 26th summit).

First, the countries must concentrate on necessary energy adjustments that involves the developing of alternatives to the fossil fuels. This comprises of promoting the widening of RE sources such as onshore wind, hydropower and solar energy. Additionally, it involves increasing the acquiring of advanced and new technologies such as battery storage systems and offshore wind, that allows energy from renewables such as wind and solar to be stored and used when there is high demand. Moreover, in alignment with COP26's climate adaptation goals, nations can enhance their grid infrastructure to accommodate and integrate RE sources effectively, ensuring resilience.

Second, the countries can focus on decarbonizing the transportation and industrial sectors by encouraging well organized use of raw materials and energy, hence decreasing dependence on coal used. In the transportation sector, efforts can be made to expand electric movability options and investigate substitute fuels, such as green hydrogen.

Third, ensuring that the energy transformation is equitable and inclusive is crucial, so no one is left behind. Speeding up the energy transition in the region of South Asia will involve phasing out power plants that are coal-fired, that will affect both the jobs and industries.

Fourth, in the realm of energy transition it is necessary to boost private sector investment. South Asia's objectives for energy on low carbon necessitate a substantial rise in investments in energy sector. For this the role of COP26 is crucial, that aims to spearhead climate finance. Furthermore,

the World Bank Group is dedicated to securing resources to assist countries in reaching their sustainable energy targets.

Nepal and Bangladesh face methodological, fiscal, and terrestrial challenges. With its high energy demand driven by its targeted economic growth, India is exploring a broad range of energy markets. Nepal, Bangladesh, and Bhutan are unlikely to secure the necessary financing for hydropower development independently, and their return on investment in this sector is significantly longer than others. Consequently, northern nations would benefit from transferring their LNG and electricity to India. In the medium to long future, India and Pakistan will rely heavily on natural gas resources and the utilization of domestic stocks. Bangladesh's substantial natural gas reserves could mitigate these countries' rising needs and expected energy shortages. South Asia's larger countries have been experiencing increasing power shortages, enhancing the potential for electricity trade through integrated power systems. The significant bilateral electricity trade between Bhutan and India highlights the sub-regional potential for electricity trade in South Asia. Ensuring energy security in the region requires restructuring internal energy consumption and engaging in energy trade to address power shortages during dry seasons. Given that India's strategic location precludes direct connections between Bangladesh, Bhutan, and Nepal, energy trade cooperation in South Asia would not have been possible without India's involvement. Bhutan and Nepal, being landlocked, rely on India for transit. Regional energy cooperation would increase competition between local and regional generators by expanding markets, encouraging knowledge exchange, and attaining efficiencies of scale in decentralized rural electrification. Unfortunately, regional rules or agreements governing natural gas and electricity trading have yet to be established in South Asia. India now has bilateral energy cooperation agreements with its northern neighbors, Bangladesh, Bhutan, and Nepal (*Landmark Bangladesh-India-Nepal Energy Agreement in Final Discussion*, n.d.) (*Nepal-India Electric Power Trade Agreement Renewed for Three Months*, 2024). The rising urbanization, increasing reliance on fossil fuel imports, susceptibility to external shocks and price volatility, limited electricity availability, and underutilization of surplus hydropower markets in Bhutan and Nepal are all driving the need for South Asian energy cooperation. A trilateral agreement between Bangladesh, India, and Nepal, expected to be finalized soon, will allow some of Nepal's surplus electricity to be transmitted to energy-deprived Bangladesh through India's infrastructure, starting with an initial 50 MW. According to Reuters analysis, critics argue that this amount is negligible compared to Bangladesh's power shortfall, which can exceed supply by up to 25% during peak times (Varadhan & Chew, 2023). However, the significance of this development lies not in the quantity of electricity but in the fact that such cooperation is occurring at all, marking a notable breakthrough in a region historically characterized by mutual suspicion among its neighbors.

Three key factors have driven the progress of the deal:

1. The escalating energy cost has made it challenging for South Asia to meet its needs amid global market disruptions caused by the Ukraine conflict.
2. The region is grappling with the impacts of climate change, including more frequent and severe heatwaves and floods.
3. Increasing apprehension about China, particularly its assertive stance in and around the Himalayas, has prompted India to pay greater attention to its smaller neighboring countries.

Integration is vital for South Asia's transition to green energy. Nepal and Bhutan have an estimated hydropower potential of nearly 70 GW, of which only a tiny portion has been utilized. Bangladesh needs significant renewable energy capacity and space to expand wind and solar power. India aims

to achieve 500 GW of renewable capacity by 2030. It will need to add approximately 950 GW—equivalent to the size of Europe's power market—by 2040 to meet its projected demand, in addition to its current 418 GW. Hydropower from neighboring countries could provide a stable source of renewable energy. The shift to cleaner electricity could also lead to immediate benefits, including improved air quality in the region's highly polluted cities("Climate and China Fears Are Bringing South Asia's Countries Closer," 2023). The potential for developing interconnected networks in the power sector among South Asian nations already exists. Therefore, cross-border energy purchases offer several benefits, such as practical natural resource application, increased energy supply consistency, operational cost efficiency, and mutual support during contingencies. Furthermore, it would spur large-scale reform in sectors that contribute to economic growth, promote regional energy security via diversification of fuels and the creation of a local electricity grid, and benefit from seasonal demand differentials. It would also facilitate technology transfer, human resource development, and the adoption of region-based practices to mitigate environmental hazards. The primary cause for the dearth of investment in infrastructure in the South Asian region is often attributed to political instability, which needs to be addressed, and other initiatives must be introduced, including large-scale investment projects, technical support, feasibility studies, and advice services. These initiatives would support current bilateral energy, environmental, and financial growth programs, such as hydropower growth in Nepal, energy sector reforms in Bangladesh, distributing reforms in India, and competitiveness efforts in Sri Lanka.

To fulfill the escalating demand, addressing the barriers, such as the political instability within the power sector in South Asia, requires substantial investments. Reduction of fossil fuels is imperative for environmental conservation; investing in alternative green energy sources is essential to fulfill the energy needs of industrial and commercial sectors and ensure energy security. However, securing support remains a significant challenge for green energy schemes like hydropower, solar, and wind energy. According to Yoshino (Yoshino & Taghizadeh-Hesary, 2018), one key impediment is the relatively low rate of return on green schemes compared to conventional fuels. The resurgence of regional energy cooperation in South Asia, particularly amid rising concerns about climate change, has several causes. These include the discovery of gas reserves in Gujarat (reference), significant hydropower potential in Nepal, significant untapped gas reserves in Bangladesh and India, abundant hydropower resources in Bhutan, India, and Nepal, and favorable wind conditions in Sri Lanka, many oil and gas localities in Pakistan and tidal power, something of the future (refer to table 3). The availability of reliable energy sources directly impacts production, efficiency, and economic growth in South Asian countries. However, political leadership in the region has often been poorly informed about the impact of regional energy trade agreements on energy security. Currently, bilateral, populist political agendas, including Great Powers such as the USA and Russia, are hindering electricity and gas exchanges within South Asia, which creates immense geopolitics of the energy trilemma in South Asia(Tol, 2023). In addition, climate change represents both challenges and prospects for local energy cooperation in the region.

Geopolitical imperatives whilst traversing the Geopolitics of Energy vis-à-vis South Asia

Ivleva & Tänzler, (2019) relates the origin of geopolitics as the relationship between geography and the political dynamics of Western imperial states initially referred to as merely a geostrategic struggle between the Union of Soviet Socialist Republic (USSR) and the United States of America (USA). Currently, it is concerned with investigating and clarifying the significance of geographical considerations, including access to resources, in influencing national and international politics (Högselius, 2018). Energy geopolitics is a subfield influenced by the same fact. Timothy C. Lehmann, (2017) centers on the effect of terrestrial aspects, like the circulation of supply and need

centers, on state and non-state actions to ensure a suitable, affordable, and reliable energy supply. Dalby, (2020) gives Anthropocene geopolitics, which determines future climate and human-to-natural activity. Introduction of new areas of contest made, Criekemans, (2018) a research agenda focusing on the geopolitics of renewables is emerging, necessitating energy diversity and recognizing the political implications of the geo-technical characteristics of various energy sources. For example, Scholten(Scholten et al., 2020) focuses on interstate renewable energy relations, whereas Overland, (2015) explores excellent power competition for essential locations and natural. These approaches provide an understanding of changing energy systems, geographical areas, and international politics. They contend that politics and policymaking drive energy system change and related geopolitical discourses.

South Asian role (Guterres, 2023) is important and crucial in its energy prospects and position. The countries are caught in the crossfire of geopolitics of 'Greater powers' such as Russia and China on one side and the US on the other side, making the region prone to energy security and climatic changes (Ichord, 2023), bringing the countries of the region into a difficult situation and although they are taking positive steps for sustainable energy, these dynamics affect their investment efforts and policies. South Asia mainly depends on energy imports, i.e., India is the major importer of crude oil and Liquified Natural Gas (LNG) and heavily relies on Russia. Ukrainian invasion has a butterfly effect on South Asian supply because this dependency ties South Asia to the volatile global energy and makes it subject to geopolitical pressure. As there is a diversified regional shift to mitigate the energy crises, countries like Pakistan and Bangladesh are exploring discounted Russian oil.

Challenges vis-à-vis energy trilemma in South Asia

The South Asian region has consistently faced energy deficiencies, not due to a scarcity of natural resources but rather because of inefficient resource utilization, a large population, rudimentary technology use, poor management of distribution networks, insufficient financial investment, slow structural improvements, and extensive subsidies. Although there have been technological advancements in the region, progress is impeded by limited financial investments. While innovative electricity systems are being introduced, their implementation is primarily confined to urban areas. Consequently, energy access remains a significant challenge, posing the greatest obstacle to the region's economic development and the overall well-being of its society. South Asia, with its low per capita income, is on the front lines of the climate crisis. It faces severe impacts from floods, droughts, and heat waves while its Carbon dioxide (CO_2) emissions continue to rise. To support the economic growth of its nearly two billion people, the region demands an increasing supply of energy. Further, as earlier mentioned more than seventy-seven million people in South Asia are still lacking the access to the electricity. Since 2010, India, Bangladesh, Nepal, and Sri Lanka have significantly advanced in this area, connecting nearly 350 million individuals. However, according to World Bank data, Pakistan has made minimal progress in addressing its unserved population, which remains around fifty-four million. In 2021, the region contributed approximately 8.6 percent of global energy-related carbon dioxide emissions, drawing international focus on the future of coal. India, the second-largest consumer of coal worldwide, used it for 57 percent of its primary energy and 71 percent of its electricity generation that year. Following the construction of several coal plants financed by Chinese, Japanese, and Korean investments, Pakistan and Bangladesh implemented coal moratoriums in 2021, aiming to replace coal with LNG, renewables, and nuclear energy. However, due to concerns about energy security and pricing, Bangladesh announced in September 2022 plans to increase its coal-fired capacity by 4.3 GW. Similarly, in February 2023, Pakistani Federal Minister for Energy Khurram Dastgir Khan reversed the policy and called for

developing ten GW of domestically fired coal plants over the next decade. It remains to be seen whether these new coal projects can be financed, given the severe debt issues these countries face and the recent announcements by China, Japan, and South Korea to halt funding for overseas coal plants (Ichord, 2023).

For a long time, the inhabitants of this region have struggled to meet basic needs for human Shelter, water, food and security and now, very importantly, the access to energy is essential to fulfill these requirements. Generally, the population is naturally sensitive and efficient in resource utilization; whether it involves electricity or fuel, there is a strong tendency to avoid wastage. This behavior is rooted in the region's mental profile and is evident in various choices, from space utilization in construction to automobile purchases, space exploration programs and even financial savings. However, conservation does not necessarily equate to efficiency; hence, the challenge of energy efficiency lies not on the demand side but on the side of supply. Structural improvements in grid management, transformers, electric utilities and transmission networks are urgently required because the region's network system is outdated and frequently fails, leading to transmission losses and supply interruptions. This issue is particularly acute during peak loads or when demand is higher in the summer. Regrettably, the unreliable energy supply system exacerbates environmental stress, leading to deforestation to meet basic needs for water supply, heating and cooking. Additionally, the excessive use of electricity for agriculture, aimed at mitigating the intermittent supply issue, further complicates the situation. Under the framework of the Energy Trilemma, these challenges can be summarized in broad nature and is illustrated in **figure 6**.

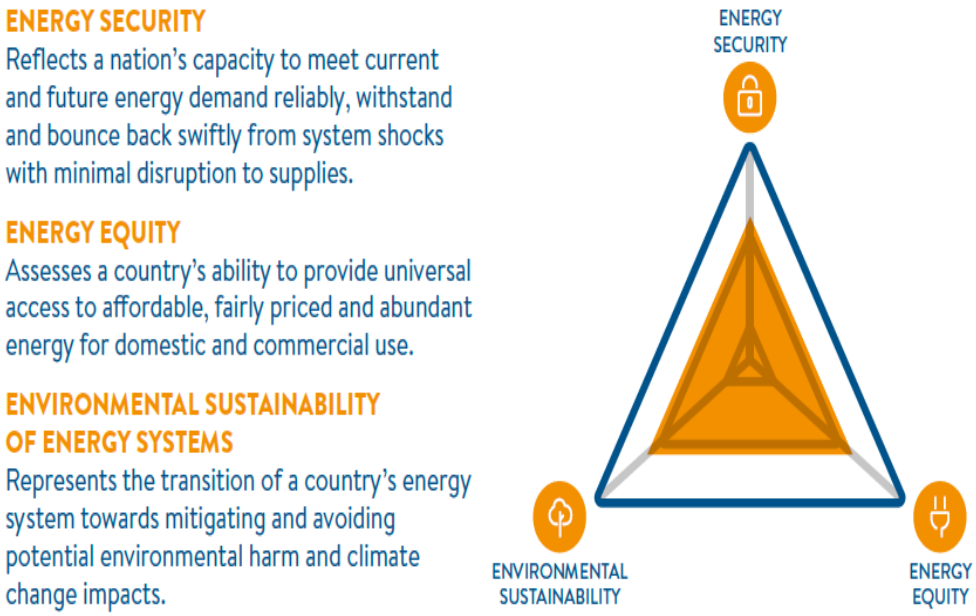

Figure 6 Energy Trilemma. Source(In Partnership with Oliver Wyman ABOUT THE WORLD ENERGY TRILEMMA INDEX, 2019)

"*The World Energy Council's definition of energy sustainability is based on three cores dimensions: Energy Security, Energy Equity, and Environmental Sustainability of Energy Systems. Balancing these three goals constitutes a "Trilemma" and balanced systems enable prosperity and competitiveness of individual countries*"(In Partnership with Oliver Wyman ABOUT THE WORLD ENERGY TRILEMMA INDEX, 2019).

Policy Recommendations

Due to the South Asia's immense share of the global populace, there is need for systematic energy planning in order to meet the long and short-term social and economic objectives. Based on the preceding debate, the policy consequences for sustainable energy growth are addressed:

1. Given China's leadership in the global RE industry, the time is ripe for the country to cultivate a varied range of renewable technologies (IRENA, 2014) and provide Incentive mechanisms for establishing support for innovation, technological development, and market creation.
2. The energy trilemma poses a significant challenge to South Asia's sustainable development for the foreseeable future. Firm governmental commitments, innovative thinking and technological advancements, multilateral partnerships, increased support from Western nations, and public-private collaborations are essential to address this. These efforts can help this rapidly growing emerging market provide financial development, ecological protection, increased living standards, and efficient and affordable energy to its population and industries while minimizing environmental damage and advancing global climate progress.
3. It is imperative for Sino to navigate the delicate balance between short-term fiscal development imperatives and the imperative of long-term sustainable progress. Moreover, there is a pressing need to strengthen the alignment between energy security imperatives and RE policies to maximize their synergistic benefits.
4. The framework of achieving energy transition in South Asia necessitates integrating various stakeholders, partnerships between private and public enterprises, and implementing firm regulations to secure energy supply access and promote emissions reductions.
5. Intra and interregional energy cooperation presents a promising opportunity. For instance, Russia and the US, as key players in the region, can enhance energy cooperation. Washington's potential to expand its clean energy initiative in the region is a beacon of hope. Effective planning is crucial for the energy transition towards a greener economy, which will not only benefit the regional countries but also contribute positively to mitigating regional climate change.
6. Urgency of transitioning from the coal-dominated energy system to a cleaner alternative.
7. RE should be a pivotal and indispensable component of transitioning toward a low-carbon future. Hence, increased public consciousness and presenting climatic changes and air pollution are crucial to gain public acceptance of RE initiatives and associated projects. This public engagement is not just desirable, but necessary for the success of the transition.
8. Legislators should decisively prioritize facilitating RE integration into the energy system.

Conclusion

It is concluded that South Asia's energy challenges, characterized by heavy reliance on fossil fuels and inadequate grid connectivity, pose significant barriers to Sustainable Development and achieving the Sustainable Development Goals (SDGs). Despite robust economic growth rates, a region's energy insecurity hampers its potential, exacerbates environmental degradation, and limits access to reliable electricity, particularly in rural areas. Transitioning to Renewable Energy (RE) sources offers a promising pathway for addressing these challenges, providing cleaner alternatives, enhancing energy security, and mitigating the impacts of climate change. However, technological constraints, insufficient infrastructure, and financial limitations hinder the widespread adoption of RE. Moreover, China's influence through initiatives such as the Belt and Road Initiative (BRI) presents opportunities for advancing RE investments internationally. While China has made strides in domestic RE deployment and pledged to reduce coal investments abroad, challenges such as financing barriers and institutional capacities constrain the scalability of RE projects in BRI countries. Overcoming these obstacles requires enhanced collaboration among stakeholders, improved

policy frameworks, and increased investment in clean energy technologies. Addressing these challenges promotes sustainable energy transitions in South Asia and contributes to global efforts to achieve energy security, environmental sustainability, and inclusive economic growth.

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