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Transitioning into the Rural Clean Energy Issues in Developing Country: South Asian Perspectives

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Abstract

Background: Energy transitions are a key topic in emerging economies, driven by fuel price fluctuations, environmental concerns, technological advancements, and energy accessibility goals. South Asia faces challenges in achieving clean, sustainable energy access, with energy poverty in rural areas despite economic growth.

Objectives: This study investigates the challenges encountered in rural energy transitions across South Asia, intending to foster connections and academic understanding. It also critically examines current events and trends in energy transformation within the region.

Methods: This study uses a systematic literature review (SLR) to identify trends and gaps in the transition to clean energy, employing clear objectives, inclusion criteria, comprehensive searches, relevance screening, data extraction, and critical appraisal.

Results: The Maldives leads with 99.5 percent clean energy access, followed by Bhutan at 79.5, India at 56.9, and Bangladesh at 9.5 percent. Key issues include underdeveloped Information communication and technology (ICT), limited regional cooperation, inadequate capital investment, energy equity disparities, socioeconomic factors, political and legal issues, and tariff and subsidy concerns.

Conclusion: The region faces various socioeconomic barriers to rural clean energy access. It advocates for implementing evidence-based interventions to facilitate the transition to renewable energy and effectively mitigate the challenges identified in the analysis.

Keywords: Rural Energy, Transition, South Asia, Renewable Energy, Sustainability, Energy Policies

JEL Classification: Q2, Q3, Q4, Q5

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Introduction

Energy sources are key to human society. Addressing rural energy inequalities is a solution for promoting sustainability. Enhancement of modern energy access in the rural region would be essential in improving rural sustainability. On a global scale, rural regions experience a lower infrastructure than urban areas. Traditional and fossil fuel sources contribute to negative consequences (Lee et al., 2021). Facilitating the shift towards sustainable energy in rural regions is a crucial component of worldwide endeavours to address rural sustainability issues. The South Asian regions consistently encounter obstacles in achieving energy equity (Shakya et al., 2022). Historically, rural inhabitants in these areas have depended on biomass, including firewood, crop wastes, and animal dung, to meet their energy requirements. These sources contribute to significant health and environmental problems. Many developing nations have observed a substantial rise in modern and environmentally friendly energy solutions, transitioning from conventional to contemporary energy sources (Pressburger et al., 2022). Technological advancements, the falling cost of renewable energy, and a growing awareness of people have fueled it. The insufficient renewable energy policies in South Asia, countries have hindered their growth (Salam et al., 2020). South Asian economy is facing a critical juncture due to its increasing population, and growing energy requirements (Falendra, 2019). To meet sustainable development goals within the given timeframe, overcoming green energy challenges in the region is essential. The study of rural energy transitions pinpointed energy inequality and promoting economic, environmental, and social progress. In regions like South Asia, rural areas face unique challenges, such as affordability, limited infrastructure, and policy gaps, which hinder renewable energy adoption. With growing energy demand and climate change concerns, timely interventions are crucial. This review aims to synthesize current knowledge, identify challenges, and offer best practices to guide policymakers, researchers, and practitioners in advancing rural energy transitions.

Review of Literature

Ensuring electricity accessibility remains a significant challenge in rural regions of South Asia. Qudrat-Ullah et al. (2023) discovered that despite notable progress, many rural areas still suffer from a dearth of reliable electricity, impeding economic development and overall welfare in South Asia. Despite the advancements in electricity provision in countries like India and Bangladesh, there are still disparities, particularly in remote and neglected regions (World Bank, 2020). Rasel et al. (2024) concluded that traditional energy sources significantly impact rural sustainability and socioeconomic factors. Education, income, and remote residential locations influence the adoption of renewable energy in villages. The study emphasizes the need for clean energy implementation policies. However, policy implementation often faces challenges such as administrative, and financial constraints, and inadequate local capacities (Sovacool, 2012). As to the findings of Khandker et al. (2014), the availability of electricity enhances educational prospects, healthcare provisions, and economic productivity. Implementing the Solar Home System program in Bangladesh has improved living circumstances and reduced the prevalence of energy poverty (Mondal et al., 2010). Moreover, women's empowerment is often linked to energy accessibility, as it reduces the time spent collecting traditional fuel and allows for participation in economic activities (Clancy et al., 2012). Notwithstanding the advancements, certain obstacles impede the rural energy transition in South Asia. The challenges comprise insufficient infrastructure, financial constraints, and reluctance to abandon conventional energy practices (Bhattacharyya & Palit, 2016). It is recommended that future investigations focus on analyzing integrated energy planning, innovative funding mechanisms, and community-driven activities to ensure sustainable and inclusive energy transitions (Rao et al., 2019). Table 1 summarizes the primary literature, study areas, and key findings on the rural energy transition in South Asia.

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Table 1

Inferences of Literature on Rural Energy Transition in South Asia

Objective of research	Inferences	References
Influence of ICTs on energy	ICT is key for energy sustainability in the region.	Murshed (2020)
ICT's importance in renewable energy growth.	Digitization for renewable energy generation is beneficial.	Rehman et al., (2023)
Rural people's acceptability of energy sources.	People in rural areas don't trust electric cooking because of safety concerns and tests on food quality.	Chapagai et al., (2024)
Energy equity issues	Energy equity is a crucial factor in sustainable energy policies.	Shakya et al., (2022)
Cross-country cooperation and switching to renewable energy.	Collaboration among South Asian nations advocating for the incorporation of a green energy supply.	Murshed et al., (2020)
Energy measures and their impact on socio-economic growth.	Technical and regulatory constraints are prime renewable consumption.	Salam et al., (2020)
Growth of renewable energy in Sunbelt regions.	Low-cost solar photovoltaics drive growth in Africa and South Asia.	Breyer et al., (2023)
To explore household energy usage patterns	Family labor supply, education, and wealth status impact fuelwood gathering sources	Behera et al., (2015)
Examine the possibility of transboundary energy security in South Asia.	Share resource management policies, regional leadership cooperation, and diplomatic negotiation cooperation are key.	Saklani et al., (2020)
To identify the elements for a country's sustainable energy use.	The success of Pakistan's renewable energy sector depends on feed-in tariffs (FiTs) and the establishment of long-term financing schemes.	Rasheed et al., (2020)
Trade promotion and foreign capital (FDI) in boosting renewable energy.	Trade openness and foreign currency inflow are key to clean energy expansion levels in the region.	Murshed et al., (2021)
To examine the energy transition pathways.	Electricity expenses, public trust, and energy instability are key elements.	Gulagi et al (2020)
To assess energy security in South Asia.	Inter-country energy trade and facilitating investment opportunities are crucial solutions.	Singh (2020)
Effects of global volatility in South Asian renewable energy transition	Variations in gasoline prices have impacted the transition to renewable energy in South Asian economies.	Murshed et al., (2021)
Challenges on renewable energy, efficiency, and policy frameworks.	Uniform laws, regulations, political aspects, and investment are the biggest obstacles.	Asif et al., (2024)
Barrier of renewable energy in rural regions.	Financial and political issues are at the forefront.	Chapagai et al., (2024)

Source: Author's construction.

Electrification initiatives in South Asia have been commendable, with significant success in providing household access to electricity. Figure 1 illustrates the gradual growth of electricity distribution in South

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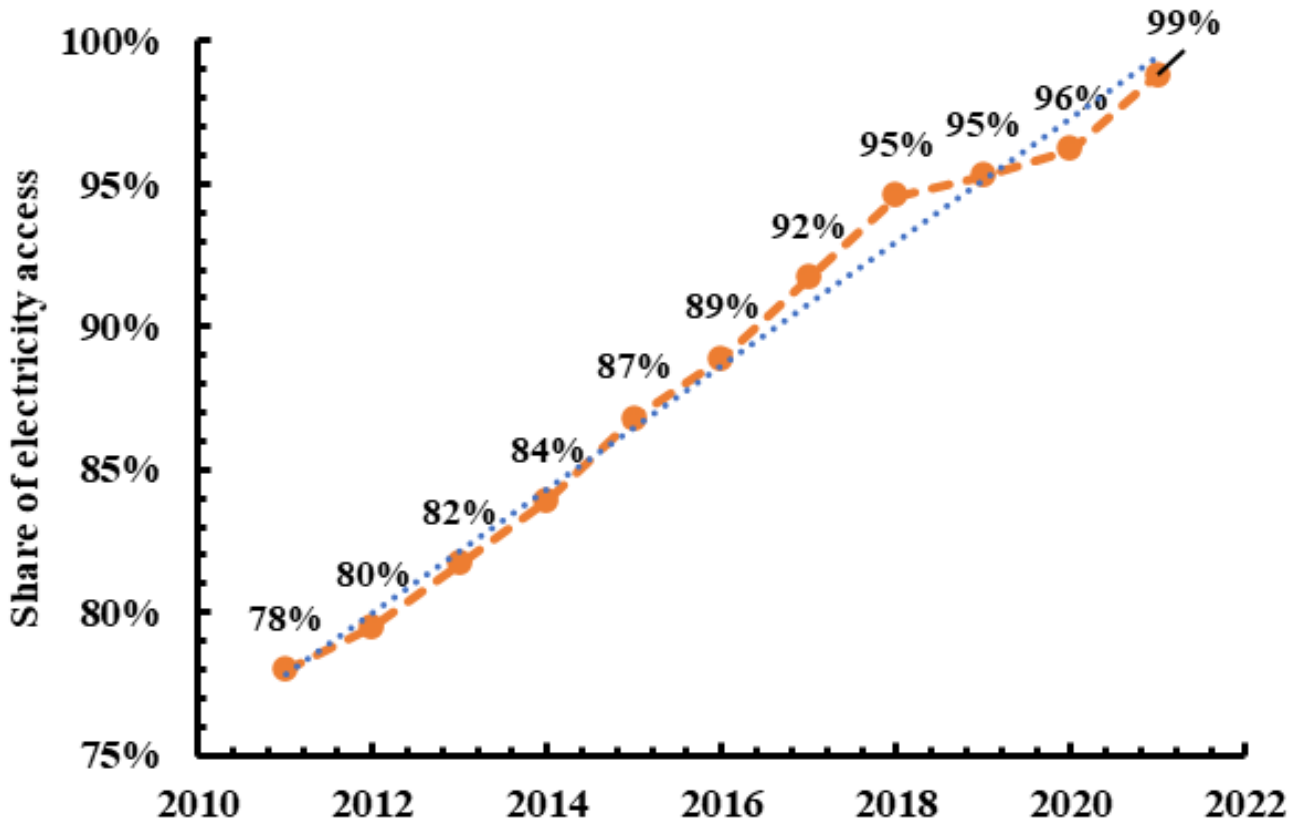
Asia. The regions had 78 percent access to electricity in 2011. Over the past 10 years, this rate climbed by 20 percent reaching approximately 99 percent in 2021.

Figure 1

Electrification Trend in South Asia



Source: Author's construction.

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Figure 2

Rural Electrification Trends in South Asia

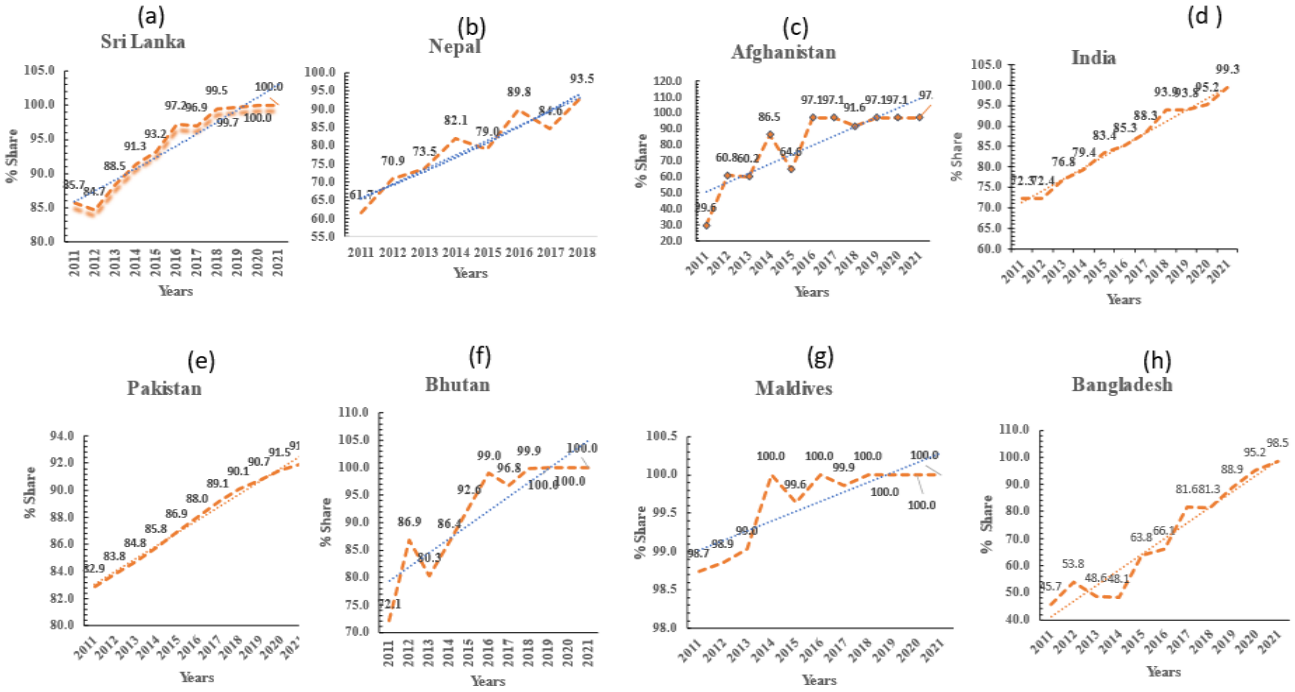
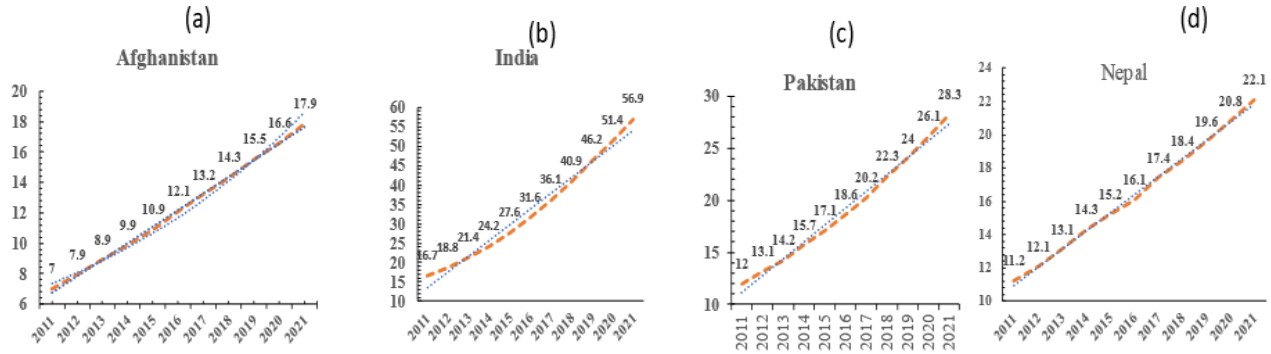


Figure 3 depicts the accessibility of clean fuel and cooking technology in rural areas in the region. Maldives and Bhutan have made significant strides in renewable energy solutions, ensuring technological accessibility in rural areas (Figures 3: f, h). Both countries have prioritized the integration of sustainable energy systems, particularly in providing clean, renewable energy alternatives for cooking, a critical aspect of daily life, in isolated communities. Maldives boasts a far higher rate of clean energy and technology access for cooking, standing at 99.5 percent, compared to Bhutan's rate of 79.9 percent. India's rate of 56.9 percent. Afghanistan, Nepal, Pakistan, and Sri Lanka had 17.9, 22.1, 28.3, and 24.2 percent respectively. Bangladesh occupies the lowest position regarding this issue. In 2021, rural regions of Bangladesh had restricted access to clean energy and technology, with only 9.7 percent availability.

Figure 3

Trends in Rural Clean Energy Access in South Asia



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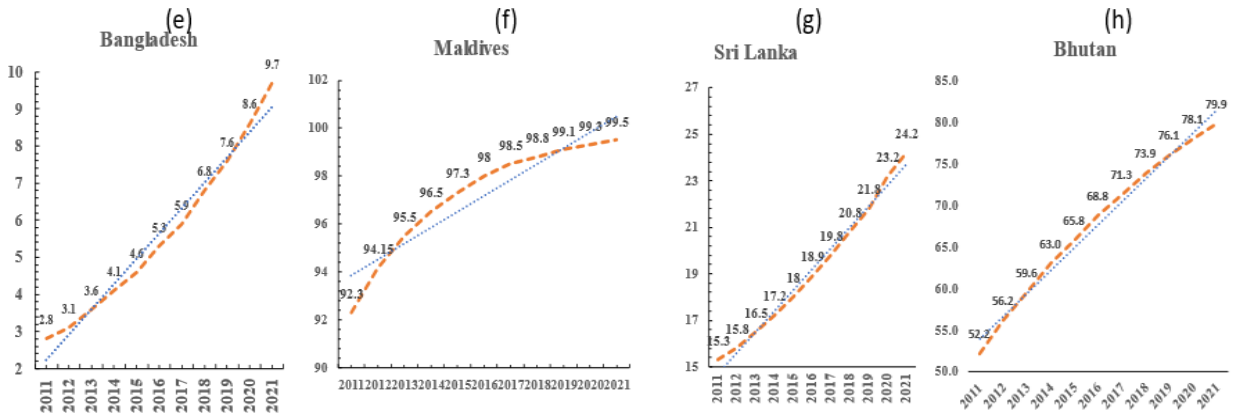
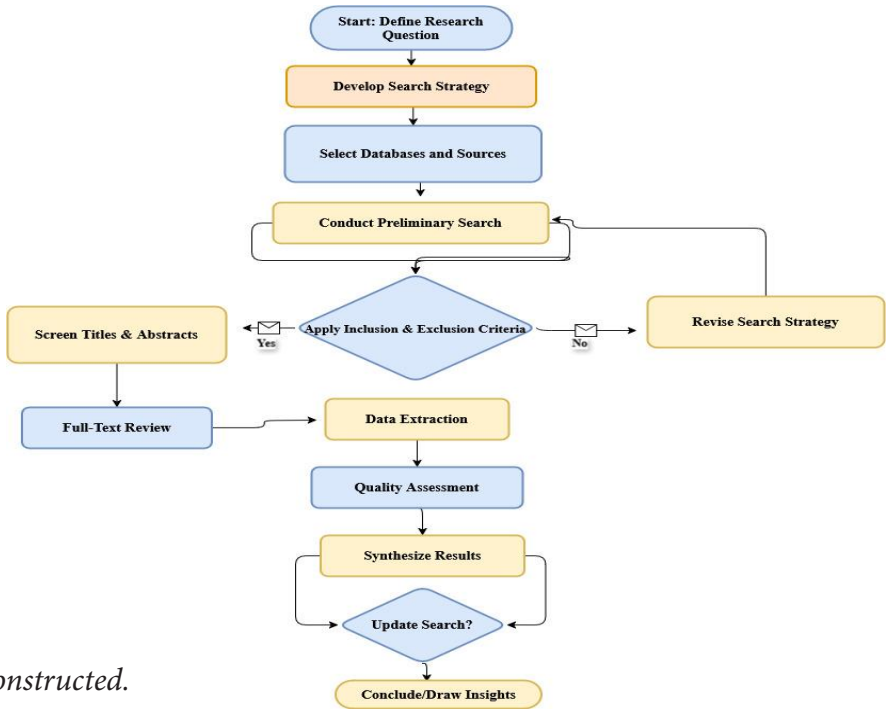


Materials and Methods

The study conducts a literature survey focusing on rural energy transition. Figure 4 illustrates the data extraction process. A review involves defining the research question and outlining its scope, such as exploring the impact of renewable energy on rural communities. The process begins by developing a search strategy. The researcher utilized multiple databases such as Scopus, Web of Science, Dimension, and Google Scholar. The search strategy involved querying databases using specific keywords. The search focused on rural energy transition and the issues associated with energy. The search criteria employed keywords, including "Energy Transition", "challenges of rural energy in South Asia", and "South Asia energy". The inclusion criteria of the literature for this study are peer-reviewed research papers, published between 2013 and 2024 in English and written in the South Asian context. Titles and abstracts are screened, and full-text reviews ensure the articles meet relevance and quality standards. Initially, 89 papers were identified. After removing duplicates, 54 articles remained. Moreover, studies that did not concentrate on South Asia or failed to engage with issues related to energy transition were systematically excluded. As a result, 34 articles were selected for analysis.

Figure 4

Literature Search Process



Source: Author constructed.

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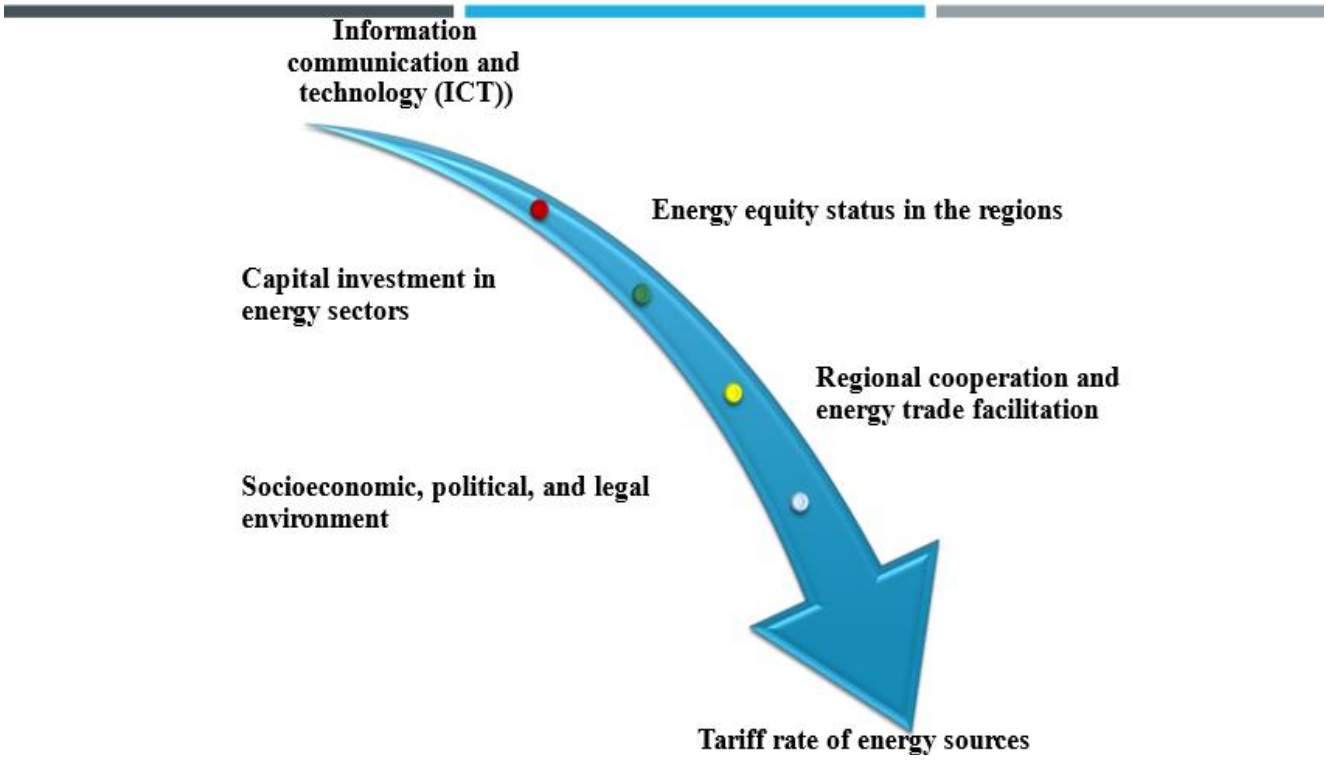
Results and Discussion

The rural energy transition in South Asia drives economic growth, environmental sustainability, and social welfare by shifting from biomass to modern energy and promoting renewables. The research indicates significant prospects in the transition to sustainable energy sources in rural regions of South Asia. Figure 5 exhibits grassroots challenges to renewable energy access in rural areas, insights from Table 1, and the literature review.

Figure 5

Clean Energy Transition Issues in South Asia



Source: Authors constructed from the synthesized outcomes of Table 1.

Information Communication and Technology (ICT) Issues in the Region

Several studies have highlighted the role of ICT in advancing and managing intelligent energy systems with substantial renewable energy integration and decentralized frameworks (Zhao et al., 2023). ICT increased the adoption of renewable energy sources and their demand (Yakubau et al., 2022). It will enable the shift to renewable energy, enhance energy efficiency, expand access to cleaner cooking fuels, and diminish CO2 emissions in South Asian regions (Murshed 2020). The access to ICT increased the attraction of foreign investors to fund renewable energy production projects have led to a favourable influence on renewable electricity development in South Asia. This is due to the technology spillover effect that these countries have prioritized to ICT (Rehman et al., 2023). In contrast, reducing ICT hurts RET investment (Evans 2024). Figure 5 depicts the ICT index scores attained by South Asian countries, ranging from 28.9 to 79. The Maldives has the highest score of 79, followed by Bhutan with 76.5, India with 70.1, Sri Lanka with 69.9, Bangladesh with 61.1, Nepal with 64.5, and Pakistan and Afghanistan have the lowest scores of 48.7 and 28.9 respectively.

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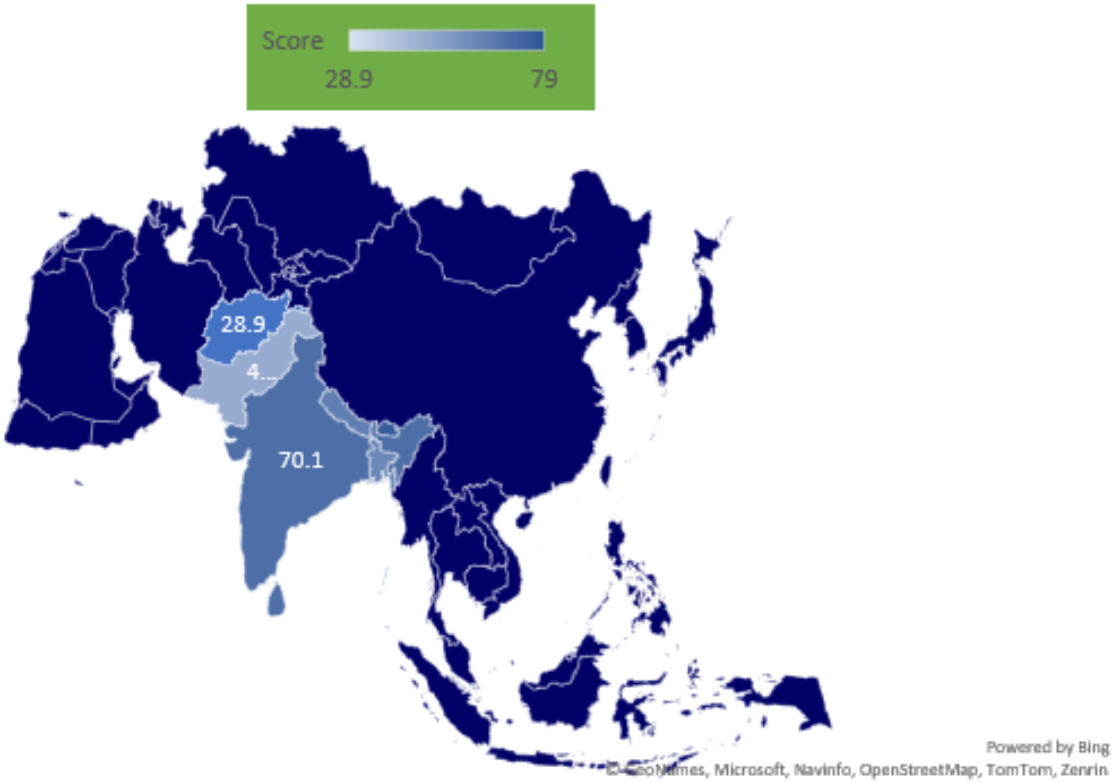
Figure 6

South Asian ICT Index Profile

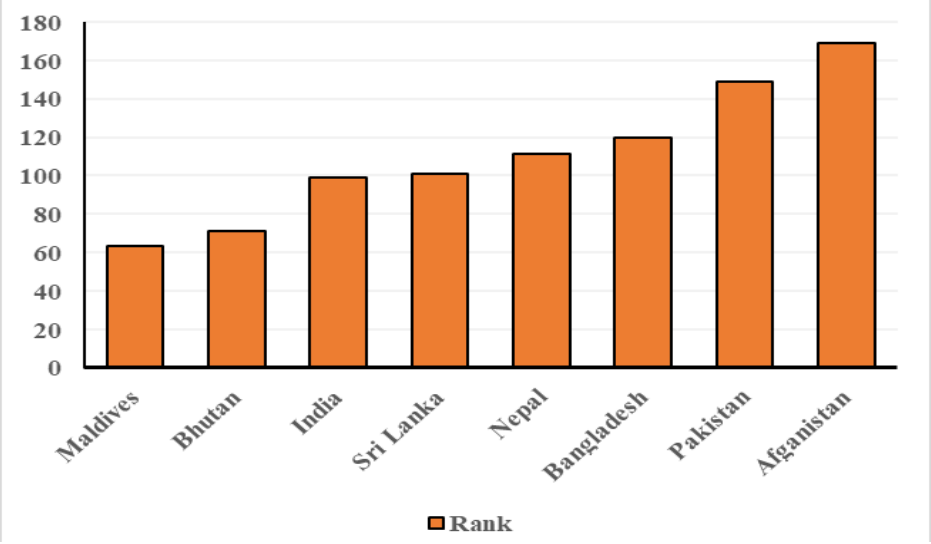


Source: International Telecommunication Union, (2023).

Figure 6 depicts a compilation of international rankings of ICT in South Asia. The countries lie within the range of 63 to 169. The Maldives is ranked highest at 63, while Afghanistan is ranked lowest at 169 among the regions. Bhutan and India are placed 71 and 99, respectively, in the worldwide ICT development ranking. Sri Lanka, Nepal, and Bangladesh are ranked 101, 111, and 120, respectively.

Figure 7

South Asian ICT Rankings Worldwide



Source: International Telecommunication Union, (2023).

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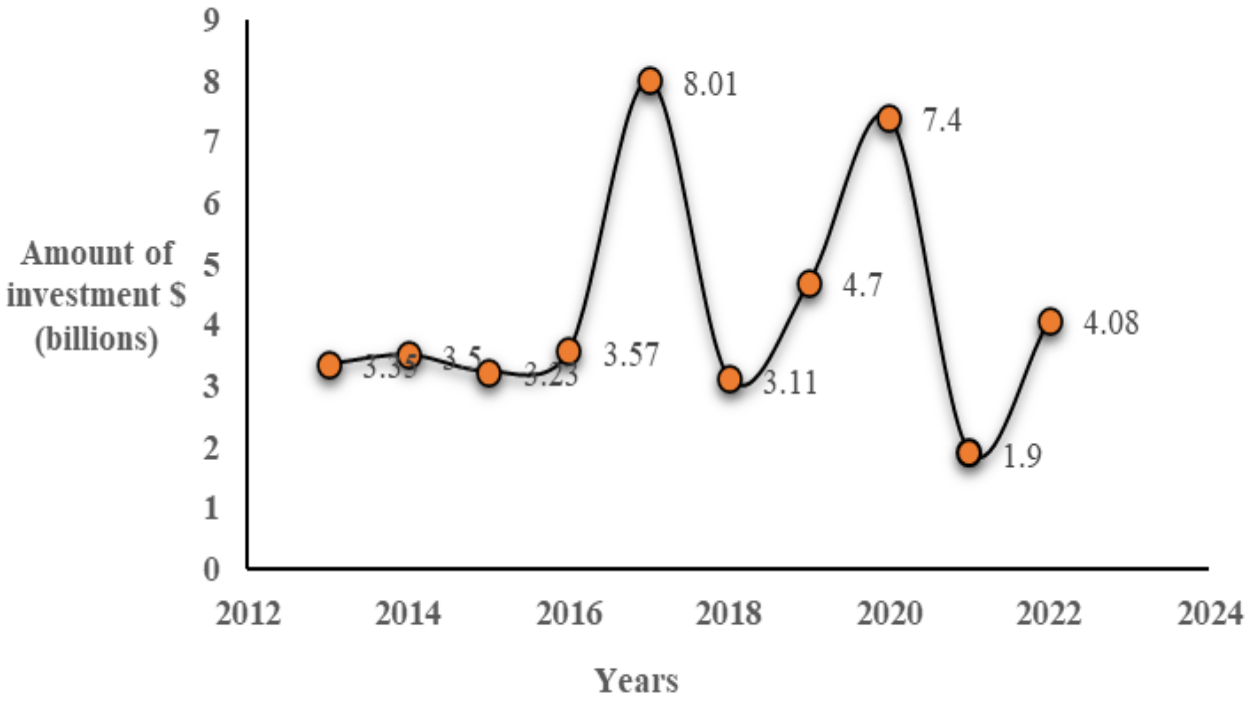
Capital Investment Issues in Energy Sectors

Rural development requires investment in green energy to improve living conditions, boost local economies, job creation, and agricultural and small business productivity. These investments improve infrastructure, promote sustainability through renewable energy, and improve quality of life. Insufficient investment in green energy led to disparities in technology deployment and made it harder to maintain a balanced national energy system. Strategically control and oversee investment streams in the clean energy industry to guarantee the sustained advancement of energy. Figure 7 shows South Asia's total energy investment. In 2013, the energy sector in the region attracted a cumulative investment of $3.343 billion. In 2017, the total amount rose to $80.17 billion. Investment in the regional energy sector was $7.36 billion in 2020, declining to $4.08 billion by 2022.

Figure 8

South Asian Investment Trends in Renewable Energy (Billions of dollars)



Source: World Bank, 2024.

Figure 8 illustrates the collective investment in renewable energy by four nations—India, Nepal, Pakistan, and Bangladesh—in 2022. India is the leading investor in the region, contributing $2.503 billion. Nepal, Bangladesh, and Pakistan allocated $858.74 million, $613 million, and $100 million, to their renewable energy sectors. In addition, Bhutan invested $51.03 billion in 2017, while Afghanistan invested $190.5 million in 2019 (World Bank, 2024).

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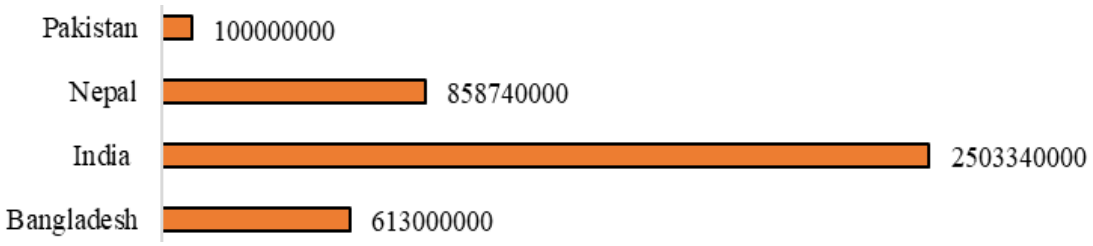
Figure 9

South Asian Public-Private Investment in Renewable Energy (2022)



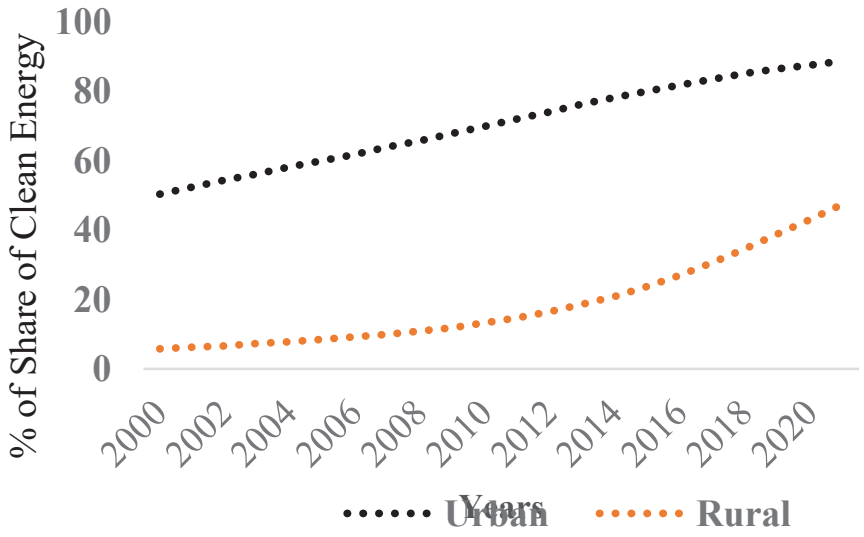
Source: World Bank, 2024.

Energy Equity Concerns in the Regions

Energy equity in South Asia is complex and influenced by economic, social, and geopolitical factors (Rhaman et al., 2018). The region faces significant challenges in ensuring equitable and unbiased access for its residents. Energy policy must prioritize marginalized social groups to ensure equitable distribution of the benefits associated with the transition to clean energy, particularly households with lower socioeconomic status and those residing in rural areas (Rahurt et al., 2024). The energy intensity of South Asia is influenced by energy equity, availability, and per capita energy consumption (Shyaka et al., 2022). The adoption of renewable energy enhances social equity. Furthermore, the advancement of social equity is impacted by a nation's socioeconomic status. Underdeveloped countries struggle to implement clean renewable energy policies due to insufficient public awareness and low income (Frasher et al., 2023). Goal 7 of sustainable development focuses on achieving widespread and efficient access to clean energy at the village level. Figure 9 shows energy fairness patterns and inequalities in urban and rural South Asia between 2000 and 2021. Urban regions exhibited consistent expansion, rising from 50.34 to 88.62 percent in the last two decades. In parallel, there was noticeable progress in electrification in rural areas, with an increment from 5.72 percent to 47.50 percent during the same timeframe.

Figure 10

Energy Equity Status in South Asia



Source: World Bank (2024).

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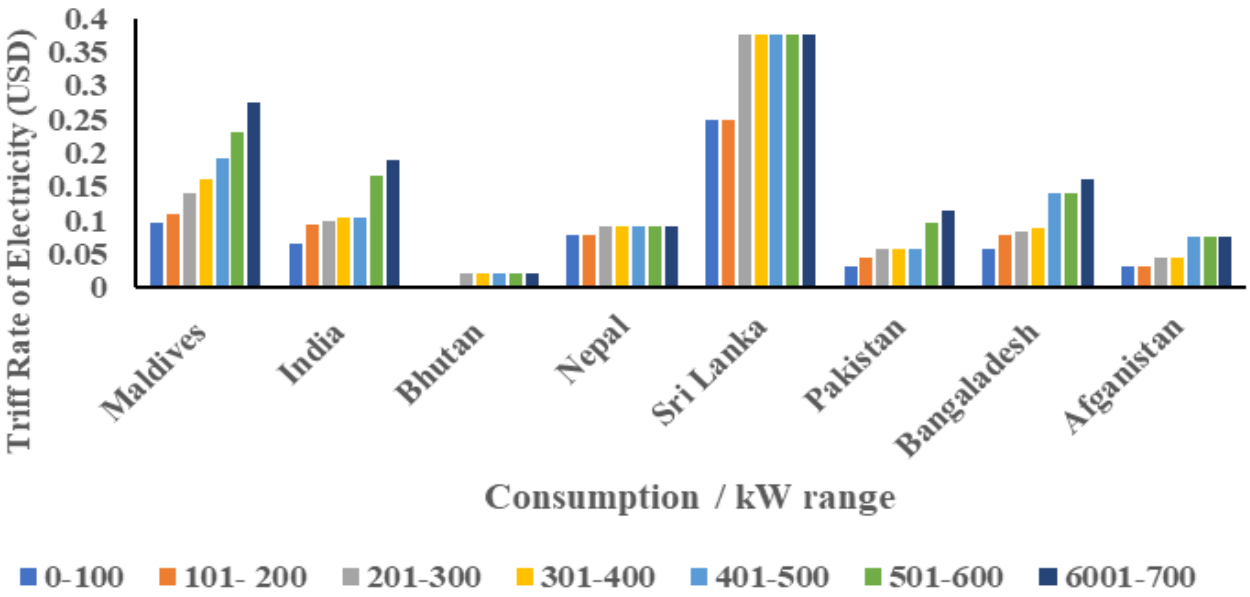
Energy Tariff and Subsidies

An increase in energy prices indicates a heightened scarcity of energy resources, thereby encouraging the exploration of more cost-effective and sustainable alternatives, ultimately influencing energy supply (Shimomura et al., 2024). Lowering the price of fossil fuels, often through subsidies, makes them cheaper than renewable energy. This reduces the use and growth of green energy because it becomes harder for renewable sources to compete. To build a sustainable future, it is crucial to improve energy pricing mechanisms and implement specific energy pricing rules (Sha et al., 2021). The consumption of all energy sources is highly responsive to changes in the price of crude oil. Positive price increases have a greater impact on consumption than negative fluctuations (İçen & Tatoğlu, 2021). Figure 10 illustrates a household electricity pricing structure in South Asia. Many countries have implemented customized tariff rates for electricity. Sri Lanka has an average electricity tariff rate of $ 0.25 to $ 0.4 per kilowatt (kW) unit, the highest tariff rate in South Asia. Bhutan's tariff rate ranges from $0 - $ 0.05 - kW unit, indicating a relatively low cost. The price range in the Maldives is between $ 0.1- $ 0.3- kW. Nepal's range of prices is between $ 0.07 - $ 0.091- kW, whereas India's range is between $ 0.065 - $ 0.19 - kW. Pakistan, Afghanistan, and Bangladesh have a range of prices between $ 0.032 - $ 0.114 -kW, $0.03 - $ 0.075 -kW, and $ 0.058 - $ 0.61 -kW unit, respectively.

Figure 11

South Asian Residential Electricity Tariff - kW unit



Source: Author Collection from a distinguished source on 1st September 2024 (Nepal Electricity Authority, Bangladesh Power Development Board, Utility Regulatory Authority Maldives, Public Utilities Commission of Sri Lanka, Central Electricity Authority India, Kabul electricity Tariff, Afghanistan, National Electricity Power Authority, Bhutan).

Subsidies and incentives are essential for attracting private investments and advancing the utilization of renewable energy across the region. South Asian nations have implemented various subsidies and incentives to promote renewable energy sources. India provides capital subsidies, viability gap funding ( ), and generation-based incentives) schemes (Sharma et al., 2022). These incentives include support for the solar, wind, biomass, and small hydro sectors, and provide tax benefits such as accelerated depreciation and renewable purchase obligations ( ), which require procurement from renewable sources in Bangladesh. Infrastructure Development Company Limited ( ) offers low-interest loans and financial subsidies for off-grid solar installations. Feed-in Tariffs guarantee a steady income for renewable energy

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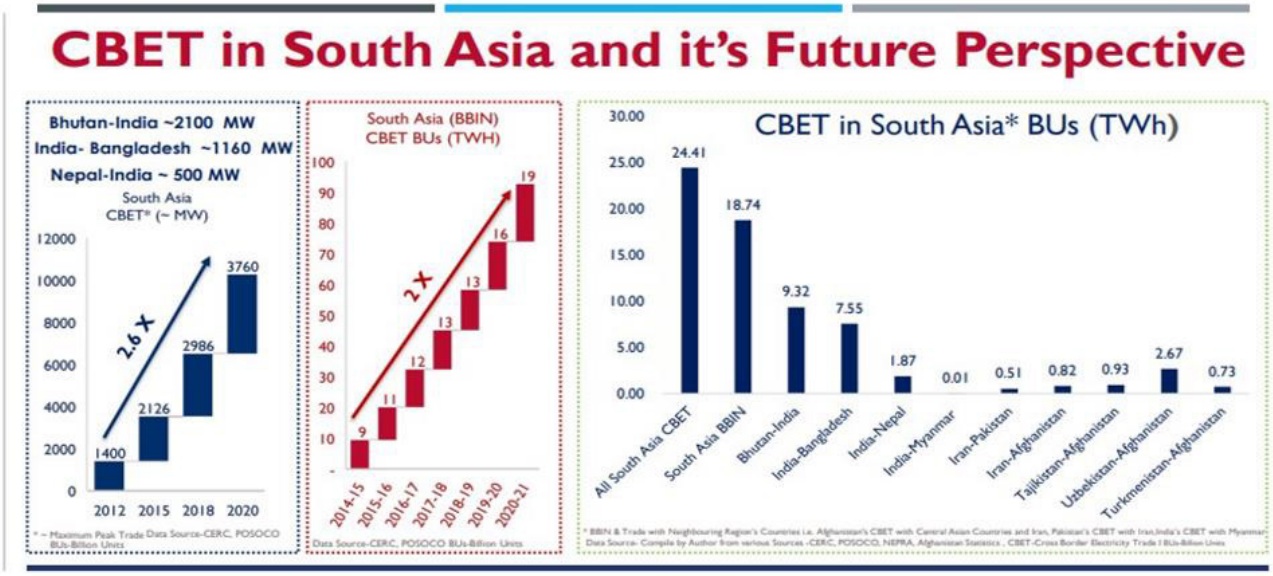
providers. Pakistan has adopted for wind, solar, and biomass projects. Nepal provides grants and concessional loans through the Alternative Energy Promotion Centre ( ) to increase renewable energy. Sri Lanka utilizes ( ), tax exemptions, and soft loans to encourage investment in wind, solar, biomass, and small hydropower projects. which are supervised by the Sri Lanka Sustainable Energy Authority. The subsidies and incentives are pivotal in attracting private investments and promoting the use of renewable energy throughout the region.

Regional Cooperation and Energy Trade Facilitation

Regional collaboration presents a substantial prospect for nations to tackle obstacles to long-lasting economic expansion in energy sectors. Notable instances of success include Europe achieving a 7 -10 percent decrease in expenses related to generating electricity by implementing interconnections inside their electricity system, the United States reaping $20 billion in advantages, and Southeast Asia's Greater Mekong Subregion experiencing a 20 percent reduction in energy expenses (Rahaman et al., 2012). The South Asian region possesses plenty of energy resources. However, the region encounters difficulties in meeting the increasing energy demands due to poor cooperation among countries. To ensure sustainable economic growth, inter-region cooperation is necessary. Energy is essential for fostering socioeconomic growth in South Asian nations such as Bhutan and Nepal, which possess considerable potential for energy exports. These countries can bolster a sustainable economy through clean sources proactive exploration and the promotion of trade practices to address the increasing need for green energy in the region. It is imperative to have supportive legislation, rules, and mutual agreements that promote regional energy trade. Effective collaboration and favourable legislation can optimize energy interchange and bolster regional power security.

Figure 12

Cross-Border Electricity Trade (CBET) Status in South Asia



Source: SAARC Energy Center Database (2024).

Figure 12 depicts the CBET in South Asia. It emphasizes the significant surge in CBET from 2012 - 20, demonstrating a 2.6 times expansion in the region. The CBET growth between 2014-15 and 2020-21 highlights the increasing trend, particularly in the South Asia BBIN region (Bangladesh, Bhutan, India, and Nepal). The volume of CBET is 3760 among countries in South Asia, emphasizing the substantial contributions of India – Bhutan, Bangladesh - India, and India-Nepal to the overall CBET volume in 2020, valuable information regarding the growing significance of CBET in South Asia. This

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trend represents a shift towards increased regional integration and cooperation in the energy industry. However, the data also indicates certain constraints, such as lower or no volumes of CBET between countries other countries including Pakistan, Afghanistan, and Sri Lanka in the region. This emphasizes the necessity for cooperation among nations.

Socioeconomic, Political, and Legal Concerns

The transition from traditional to clean energy in South Asia is influenced by energy policies, political stability and commitment, economic conditions, public awareness, attitudes, and perceptions regarding renewable energy (Nkhoma, 2024). Despite the potentiality, green energy sources are underutilized due to inadequate political support, weak legal frameworks, and insufficient investment in energy sources (Asif et al, 2024). Table 2 examines the business risks linked to different energy projects throughout South Asia. The provided matrix assesses risks associated with various energy sectors in the region. It evaluates risks related to long-term financing, project financing, high and uncertain project development costs, and equity finance. Table 2 exhibits an overview of the risk levels and corresponding insights.

Table 2

Risk Assessment Matrix for the Energy Sector in South Asia

Identify Risk	CET	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
	Wind	↑	↑	↑	↔	↑	↑	↑	↑
Long-term financing	solar	↑	↑	↑	↔	↑	↑	↑	↑
	Hydro	↑	↑	↑	↔	↑	↑	↑	↑
	Bio	↑	↑	↑	↔	↑	↑	↑	↑
	Wind	↑	↔	↑	↓	↑	↔	↔	↔
	solar	↑	↔	↑	↓	↑	↔	↔	↔
Project financing	Hydro	↑	↔	↑	↔	↑	↔	↔	↔
	Bio	↑	↔	↑	↔	↑	↔	↔	↔
	Wind	↑	↔	↔	↓	↔	↔	↔	↔
High and uncertain project development costs	solar	↑	↔	↔	↓	↔	↔	↔	↔
	Hydro	↑	↔	↔	↓	↔	↔	↔	↔
	Bio	↑	↔	↔	↓	↔	↔	↔	↔
	Wind	↑	↑	↑	↓	↑	↑	↔	↔

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Equity finance	solar	↑	↑	↑	↓	↑	↑	↔	↔
	Hydro	↑	↔	↔	↓	↑	↔	↔	↔
	Bio	↑	↔	↔	↓	↑	↔	↔	↔

{ ↓ Low or minimal impact (risk mitigation is advisable); * ↔ Medium or moderate impact (risk mitigation is probably necessary); * ↑ Major or Substantial impact (risk mitigation is necessary) * Clean Energy Technology (CET)}*

Source: Matrix Based on SAARC Energy Center Risk Assessment Report, 2024.

Afghanistan has been identified as facing the most significant risks among all energy projects in South Asia. These risks are particularly prominent in long-term financing, project financing, and equity financing. This indicates a clear requirement for strong mitigation strategies and international assistance. India and the Maldives, on the other hand, have lower levels of long-term financing risks. However, they face medium to high risks for project financing, and equity finance. Nepal, Pakistan, Bangladesh, Bhutan, and Sri Lanka are facing significant risks in long-term financing, and project financing. Table 3 highlights the South Asian energy business environment summary indicating variations in private sector involvement, fiscal strategies, and tariff frameworks. Afghanistan, Bhutan, Nepal, and Maldives demonstrate limited private-sector participation and a deficiency in decentralized energy frameworks. India and Pakistan display significant private sector involvement and well-established decentralized systems for energy project development. Corporate income tax rates exhibit variation, with Bangladesh and Bhutan boasting the highest rates, whereas the Maldives presents a more appealing flat rate of 15 percent. Nepal and Sri Lanka have implemented Value Added Tax (VAT), whereas some countries have Goods and Service Tax (GST) policies. Feed-in Tariffs) vary in their implementation and availability across countries. India and Sri Lanka have implemented FiTs, whereas Afghanistan and Bangladesh have not. Nepal implemented the in solar projects whereas Sri Lanka applied it to micro projects less than 10 .Bangladesh decided to provide to energy projects in 2022 has not been implemented yet. The payback periods and returns on investment (ROI) and internal rate of return (IRR) differ greatly, as they are influenced by various regulatory and financial factors that affect the appeal and viability of energy investments in the region.

Table 3

South Asian energy sectors business environment summary

Indicator	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Private sectors participation	Low	Medium	Low	High	Low	Low	High	Medium
Decentralization	No	Yes	No	Yes	No	No	Yes	Yes
Corporate income tax	Flat tax of 20%	25% – 45%	30%	25%	15%	25%	29%	30%
VAT	-	-	-	-	-	13%	-	8%
GST	-	5%	7%	5%	8%	-	17%	-
Capital Gains (Moveable Properties)	1%	15%	-	10% -20%	-	25%	15%	10%

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	Payback period 5- 7 years	FiTs have been finalized (2022)	No FiTs	FiT	IRR 25.5%	FiTs ROI	FiTs	FiTs below
Tariff & Return	No FiTs				No FiT	ROI 16% -20%		below 10 Mw

Source: Author's collection from SAARC Energy Center database assessed on 24th August 2024, Azhgaliyeva,et al (2023).

Conclusion and Suggestions

The study examines the challenges of transitioning to renewable energy in rural South Asia, where traditional biomass fuels are predominant. Despite progress in electrification, clean energy adoption remains limited due to slow ICT development, inadequate investment, and minimal subsidies for users and developers. Poor sustainable business conditions and restrictive policies limit private sector participation. Unstable energy supplies and high costs hinder economic growth and disrupt societal functions, including education, healthcare, and daily life, exacerbating urban-rural disparities. Environmentally, reliance on outdated energy sources results in pollution, deforestation, and resource inefficiency. Politically, energy insecurity fosters instability, and ineffective policies obstruct long-term progress. Additionally, Cross-Border Energy Trade (CBET) remains underutilized, restricting regional collaboration development. It is imperative to tackle these problems to promote sustainable development, improve the well-being of people, and guarantee environmental sustainability in the region.

To address these challenges, it will recommend cross-border energy collaboration among South Asian countries and strengthen their regulatory frameworks to support renewable energy initiatives. Furthermore, awareness programs are essential for promoting green energy in rural areas, and digital platforms at the rural level play a significant role in supporting these initiatives. Additionally, fostering community participation and implementing innovative financial structures, such as community bonds or blended financing models with the participation of diverse stakeholders, are essential to overcoming affordability and infrastructure barriers, thereby accelerating the transition to sustainable energy systems in the region.

Author contribution statement

D.P.C.: Conceptualization, writing, analyzing, and reviewing, communicating. **N.D.S.** Supervising. **M.K.R.:** Supervising and reviewing. **A.K.R.:** Supervising. All authors addressed the comments of reviewers and finalized the manuscript.

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Declaration statement

The authors declare no conflict of interest.

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References

Asif, M., Khan, M. I., & Pandey, A. (2024). Navigating the inclusive and sustainable energy transitions in South Asia: Progress, priorities, and stakeholder perspectives. *Energy Conversion and Management, 313*, 118589. https://doi.org/10.1016/j.enconman.2024.118589

Azhgaliyeva, D., Le, H., Olivares R. O., & Tian, S. (2023). Renewable energy investments and feed-in tariffs: Firm-level evidence from Southeast Asia (Working Paper No. 1400). *Asian Development Bank*. https://doi.org/10.56506/VRNO2480

Bambawale, M. J., D'Agostino, A. L., & Sovacool, B. K. (2011). Realizing rural electrification in Southeast Asia: lessons from Laos. *Energy for Sustainable Development, 15*(1), 41-48. https://doi.org/10.1016/j.esd.2010.11.001

Bangladesh Electricity Regulatory Commission (2022). *Bangladesh electricity national portal BERC* https://berc.org.bd/#

Behera, B., Jeetendra, A., & Ali, A. (2015). Household collection and use of biomass energy sources in South Asia. *Energy, 85*, 468-480. https://doi.org/10.1016/j.energy.2015.03.059

Breyer, C., Oyewo, A. S., Gulagi, A., & Keiner, D. (2023). Renewable energy enables pathways towards prosperity in Africa and South Asia. *Solar Compass, 8*, 100057. https://doi.org/10.1016/j.solcom.2023.100057

Cantarero, M. M. V. (2020). Of renewable energy, energy democracy, and sustainable development: A roadmap to accelerate the energy transition in developing countries. *Energy Research & Social Science, 70*, 101716. https://doi.org/10.1016/j.erss.2020.101716

Chapagai, D. P., Dhusia Sharma, N., Roy, A. K., & Roy, M. K. (2024). A fuzzy approach to environmental scanning (ES) of multi-factor bottlenecks to renewable rural energy sustainability in Nepal. *Energy Sources, Part B: Economics, Planning, and Policy, 19*(1), 2384544. https://doi.org/10.1080/15567249.2024.2384544

Chapagai, D. P., Sharma, N. D., Roy, A. K., & Roy, M. K. (2024). An evaluation of people's acceptability of rural household energy: A study of Kaski district, Nepal. *International Journal of Energy Economics and Policy, 14*(3), 422–433. https://doi.org/10.32479/ijeep.15867

Chernyakhovskiy, I., Joshi, M., Palchak, D., & Rose, A. (2021). *Energy storage in south asia: understanding the role of grid-connected energy storage in South Asia's Power Sector Transformation* (No. NREL/TP-5C00-79915). National Renewable Energy Lab. (NREL), Golden, CO (United States). https://doi.org/10.2172/1811299

Evans, O. (2024). The investment dynamics in renewable energy transition in Africa: The asymmetric role of oil prices, economic growth and ICT. *International Journal of Energy Sector Management, 18*(2), 229-247. https://doi.org/10.1108/IJESM-03-2022-0002

Fraser, T., Chapman, A. J., & Shigetomi, Y. (2023). Leapfrogging or lagging? Drivers of social equity from renewable energy transitions globally. *Energy Research & Social Science, 98*, 103006. https://doi.org/10.1016/j.erss.2023.103006

Gasimli, O., Haq, I. U., Gamage, S. K. N., Prasanna, R. P. I. R., Khattak, Z. Z., & Abbas, A. (2023). Energy, environmental degradation, and health status: evidence from South Asia. *Environmental Science and Pollution Research, 30*(5), 13639-13647. https://link.springer.com/article/10.1007/s11356-022-22979-w

Gulagi, A., Ram, M., Solomon, A. A., Khan, M., & Breyer, C. (2020). Current energy policies and

ISSN 2350-8868
Volume VIII | Issue 2 | December 2024

possible transition scenarios adopting renewable energy: A case study for Bangladesh. *Renewable Energy, 155*, 899-92. https://doi.org/10.1016/j.renene.2020.03.119

Hassan, M., Afridi, M. K., & Khan, M. I. (2022). Regional energy policies, trade and energy security in South Asia: A Quest for Diplomacy. In Handbook of Energy Transitions (pp. 405-424). CRC Press. https://www.taylorfrancis.com/chapters/edit/10.1201/9781003315353-25/regional-energy-policies-trade-energy-security-south-asia-mabroor-hassan-manzoor-khan-afridi-muhammad-irfan-khan

İçen, H., & Tatoğlu, F. Y. (2021). The asymmetric effects of changes in price and income on renewable and nonrenewable energy. *Renewable energy, 178*, 144-152.

International Telecommunication Union (ITU), Measuring digital development, ICT Development Index 2023 https://www.itu.int/itu-d/reports/statistics/IDI2023/

Kabir, M.H., Maknun, S.S., Jakariya, M. (2017). Energy interdependency in South Asia. In: Bandyopadhyay, S., Torre, A., Casaca, P., Dentinho, T. (eds) Regional Cooperation in South Asia. *Contemporary South Asian Studies. Springer*, Cham. https://doi.org/10.1007/978-3-319-56747-1_14

Kaygusuz, K. (2011). Energy services and energy poverty for sustainable rural development. *Renewable and sustainable energy reviews, 15*(2), 936-947. https://doi.org/10.1016/j.rser.2010.11.003

Khadka, S. (2023). Potential of solar energy in south Asia: current challenges and opportunities. *International Journal of Contemporary Issues in Social Sciences, 2*(1), 85-90.

Khan, D., Nouman, M., & Ullah, A. (2023). Assessing the impact of technological innovation on technically derived energy efficiency: a multivariate co-integration analysis of the agricultural sector in South Asia. *Environment, Development and Sustainability, 25*(4), 3723-3745. https://doi.org/10.1007/s10668-022-02194-w

Khan, I. (2020). Sustainability challenges for the South Asia growth quadrangle: A regional electricity generation sustainability assessment. *Journal of cleaner production, 243*, 118639. https://doi.org/10.1016/j.jclepro.2019.118639

Khan, I., Chowdhury, S., & Techato, K. (2022). Waste to energy in developing countries—A rapid review: Opportunities, challenges, and policies in selected countries of Sub-Saharan Africa and South Asia towards sustainability. *Sustainability, 14*(7), 3740. https://doi.org/10.3390/su14073740

Lee, C. C., Wang, C. W., Ho, S. J., & Wu, T. P. (2021). The impact of natural disaster on energy consumption: International evidence. *Energy Economics, 97*, 105021. https://doi.org/10.1016/j.eneco.2020.105021

Mainali, B., Luukkanen, J., Silveira, S., & Kaivo-oja, J. (2018). Evaluating synergies and trade-offs among Sustainable Development Goals (SDGs): Explorative analyses of development paths in South Asia and Sub-Saharan Africa. *Sustainability, 10*(3), 815. https://doi.org/10.3390/su10030815

Murshed, M. (2020). An empirical analysis of the non-linear impacts of ICT-trade openness on renewable energy transition, energy efficiency, clean cooking fuel access and environmental sustainability in South Asia. *Environmental Science and Pollution Research, 27*(29), 36254-36281. https://doi.org/10.1007/s11356-020-09497-3

Murshed, M., & Tanha, M. M. (2021). Oil price shocks and renewable energy transition: Empirical evidence from net oil-importing South Asian economies. *Energy, Ecology and Environment,*

ISSN 2350-8868
Volume VIII | Issue 2 | December 2024

6(3), 183-20. https://doi.org/10.1007/s40974-020-00168-0

Murshed, M., Abbass, K., & Rashid, S. (2021). Modelling renewable energy adoption across south Asian economies: Empirical evidence from Bangladesh, India, Pakistan and Sri Lanka. *International Journal of Finance & Economics, 26*(4), 5425-5450. https://doi.org/10.1002/ijfe.2073

Murshed, M., Mahmood, H., Alkhateeb, T. T. Y., & Banerjee, S. (2020). Calibrating the impacts of regional trade integration and renewable energy transition on the sustainability of international inbound tourism demand in South Asia. *Sustainability, 12*(20), 8341. https://doi.org/10.3390/su12208341

Murshed, M., Nurmakhanova, M., Al-Tal, R., Mahmood, H., Elheddad, M., & Ahmed, R. (2022). Can intra-regional trade, renewable energy use, foreign direct investments, and economic growth mitigate ecological footprints in South Asia? *Energy Sources, Part B: Economics, Planning, and Policy, 17*(1), 2038730. https://doi.org/10.1080/15567249.2022.2038730

Narula, K., Nagai, Y., & Pachauri, S. (2012). The role of decentralized distributed generation in achieving universal rural electrification in South Asia by 2030. *Energy Policy, 47*, 345-357.8. https://doi.org/10.1016/j.enpol.2012.04.075

Nkhoma, R., Mwale, V. D., & Ngonda, T. (2024). Socioeconomic indicators and their influence on the adoption of renewable energy technologies in rural Malawi. *International Journal of Energy Sector Management*. 18- 6, pp. 1870-1884. https://doi.org/10.1108/IJESM-10-2023-0001

Pressburger, L. D., Evans, M., Yu, S., Cui, Y., Somani, A., & Iyer, G. C. (2022). A comprehensive economic coal transition in South Asia (No. PNNL-32383). *Pacific Northwest National Laboratory (PNNL)*, Richland, WA (United States). https://doi.org/10.2172/1910045

Qudrat-Ullah, H. (2023). A review and analysis of green energy and the environmental policies in South Asia. *Energies, 16*(22), 7486. https://doi.org/10.3390/en16227486

Rahman, M. M., Paatero, J. V., & Lahdelma, R. (2013). Evaluation of choices for sustainable rural electrification in developing countries: A multicriteria approach. *Energy Policy, 59*, 589-599. https://doi.org/10.1016/j.enpol.2013.04.017

Rahman, Sultan Hafeez, Wijayatunga, Priyantha, Gunatilake, Herath (2012). *Energy trade in south Asia opportunities and challenges*, Asian Development Bank All rights reserved. Published 2012. Printed in the Philippines. ISBN 978-92-9092-630-6 (Print), 978-92-9092-631-3 (PDF) Publication Stock No. BKK124531.

Rasel, S.M., Siddique, A.B., Nayon, M.F.S. …… and Hossain, M. S. (2024). Assessment of the association between health problems and cooking fuel type, and barriers towards clean cooking among rural household people in Bangladesh. *BMC Public Health 24*, 512 (2024). https://doi.org/10.1186/s12889-024-17971-7

Rasheed, R., Rizwan, A., Javed, H., Yasar, A., Tabinda, A. B., Bhatti, S. G., & Su, Y. (2020). An analytical study to predict the future of Pakistan's energy sustainability versus the rest of South Asia. *Sustainable Energy Technologies and Assessments, 39*, 100707. https://doi.org/10.1016/j.seta.2020.100707

SAARC Energy center database 2024, https://www.saarcenergy.org (assessed on 24th August 2024)

Sadiqa, A., Gulagi, A., & Breyer, C. (2018). Energy transition roadmap towards 100% renewable energy and role of storage technologies for Pakistan by 2050. Energy, 147, 518-533. https://doi.org/10.1016/j.energy.2018.01.027

Saklani, U., Shrestha, P. P., Mukherji, A., & Scott, C. A. (2020). Hydro-energy cooperation in South

ISSN 2350-8868
Volume VIII | Issue 2 | December 2024

Asia: Prospects for transboundary energy and water security. *Environmental Science & Policy, 114*, 22-34. https://doi.org/10.1016/j.envsci.2020.07.013

Salam, R. A., Amber, K. P., Ratyal, N. I., Alam, M., Akram, N., Gomez Munoz, C. Q., & Garcia Marquez, F. P. (2020). An overview on energy and development of energy integration in major South Asian countries: the building sector. Energies, 13(21), 5776. https://doi.org/10.3390/en13215776

Sarker, T. (2017). Understanding the challenges involved in transitioning to a low-carbon economy in South Asia. *Sustainable Economic Development: Green Economy and Green Growth*, 273-292. https://doi.org/10.1007/978-3-319-45081-0_16

Sha, R., Li, J., & Ge, T. (2021). How do price distortions of fossil energy sources affect China's green economic efficiency? *Energy, 232*, 121017. https://doi.org/10.1016/j.energy.2021.121017

Shaikh, M. (2017). Sustainable rural energy access in rural communities of South Asia.

Shakya, S. R., Adhikari, R., Poudel, S., & Rupakheti, M. (2022). Energy equity as a major driver of energy intensity in South Asia. *Renewable and Sustainable Energy Reviews, 170*, 112994. https://doi.org/10.1016/j.rser.2022.112994

Sharma, A., Mahajan, P., & Garg, R. (2022). Analysing the impact of various incentives on solar tariff in India. *International Journal of Sustainable Energy, 41*(2), 126-147. https://doi.org/10.1080/14786451.2021.1900184

Shimomura, M., Keeley, A. R., Matsumoto, K. I., Tanaka, K., & Managi, S. (2024). Beyond the merit order effect: Impact of the rapid expansion of renewable energy on electricity market price. *Renewable and Sustainable Energy Reviews, 189*, 114037. https://doi.org/10.1016/j.rser.2023.114037

Singh, B. K. (2013). South Asia energy security: Challenges and opportunities. *Energy policy, 63*, 458-468. https://doi.org/10.1016/j.enpol.2013.07.128

Sudan, F. K. (2019). Addressing climate change and energy security through energy cooperation: Challenges and opportunities in South Asia. *Achieving energy security in Asia: diversification, integration and policy implications*, 3-30. https://doi.org/10.1142/9789811204210_0001

Sun, H., Awan, R. U., Nawaz, M. A., Mohsin, M., Rasheed, A. K., & Iqbal, N. (2021). Assessing the socio-economic viability of solar commercialization and electrification in South Asian countries. *Environment, Development and Sustainability, 23*, 9875-9897. https://doi.org/10.1007/s10668-020-01038-9

World Bank Open Data, 2024 https://data.worldbank.org/indicator (accessed on 20 August 2024)

Yakubu, I. N., Kapusuzoglu, A., & Ceylan, N. B. (2022). ICT trade and energy transition in the BRICS economies. *In Sustainability in Energy Business and Finance: Approaches and Developments in the Energy Market* (pp. 13-24). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-94051-5_2

Zhao, N., Zhang, H., Yang, X., Yan, J., & You, F. (2023). Emerging information and communication technologies for smart energy systems and renewable transition. *Advances in Applied Energy, 9*, 100125. https://doi.org/10.1016/j.adapen.2023.100125

Zhao, S., Hafeez, M., & Faisal, C. M. N. (2022). Does ICT diffusion lead to energy efficiency and environmental sustainability in emerging Asian economies? *Environmental Science and Pollution Research*, 1-10. https://doi.org/10.1007/s11356-021-16560-0