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ENERGY SECURITY IN SOUTH ASIA

A case of transitioning to sustainable sources

UBAID UR REHMAN ZIA, ZAINAB BABAR & MAHNOOR ARSHAD

ANALYSIS

Imprint

Publisher
Friedrich Naumann Foundation for Freedom Pakistan

/freiheit.org/Pakistan
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/FNFPakistan

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Date
Dec 2023

Acknowledgements
The policy paper "Energy Security in South Asia and Transition to Sustainable Sources" has been produced by Sustainable Development Policy Institute (SPDI) in collaboration with Friedrich Naumann Foundation (FNF), Pakistan. The lead authors of this study are Ubaid ur Rehman Zia, Zainab Babar, and Mahnoor Arshad. Along with lead authors, the study also derives various insights and recommendations from Dr. Vaqar Ahmed, Dr. Khalid Waleed, Dr. Hina Aslam.
The authors would also like to thank following individuals for their technical assistance, inputs, and feedback on the study:

- Dr. Hassan Daud Butt, Senior Advisor and Research Fellow, SDPI
- Mr. Ahsan Javed, Research Fellow (Renewable Energy), SAARC Energy Centre
- Ms. Birgit Lamm, Director of Pakistan Office, FNF Pakistan
- Ms. Aniqa Arshad, Program Manager, FNF Pakistan
- Mr. Asad Mahmood, Energy efficiency and Renewable Energy Expert.
- Mr. Sunil Dahiya, Energy and Environmental Analyst, Centre for Research on Energy and Clean Air (CREA), India
- Mr. Avishek Malla, Energy Specialist, International Centre for Integrated Mountain Development (ICIMOD), Nepal
- Ms. Harshi Abhayawardhana, Energy & Environment Officer, Centre for Environmental Justice (CEJ), Sri Lanka
- Mr. Masood ul Mulk, Chief Executive Officer, Sarhad Rural Support Programme (SRSP).
- Dr. Zainab Naeem, Associate Research Fellow, SDPI
- Ms. Saleha Qureshi, Research Associate, SDPI.

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List of Abbreviations:

ADB	Asian Development Bank
ACGR	Annual Compound Growth Rate
BDP	Bangladesh Delta Plan
CO2	Carbon Dioxide
CBET	Cross Border Electricity Trade
GDP	Gross Domestic Product
GWh	Gigawatt hours
HDI	Human Development Index
IGCEP	Indicative Generation Capacity Expansion Plan
IPP	Independent Power Producers
IPCC	Intergovernmental Panel on Climate Change
IESS	India Energy Security Scenarios
LNG	Liquified Natural Gas
LCOE	Levelized Cost of Energy
Mtoe	Million tons of oil equivalent.
Mt	Million tons
MJ	Mega Joules
NGO	Non-Governmental Organization
PPPs	Public Private Partnerships
PV	Photovoltaic
RE	Renewable Energy
SAARC	South Asian Association for Regional Cooperation
SOPs	Standard Operating Procedures
SDGs	Sustainable Development Goals
SSWA	South and South-West Asia
TPEC	Total Primary Energy Consumption
TPES	Total Primary Energy Supplies
T&D	Transmission and Distribution

Executive Summary

Energy insecurity is becoming a pressing concern in South Asia. The constantly increasing energy demand, limited non-renewable resources, and a very high reliance on imported fossil fuels (around two-third of total energy demand) have exposed the region to price volatility and economic risks. Resultantly, as of 2021, around 8% of the population does not have access to reliable grid-based electricity, and 47% does not have access to clean cooking fuels and technologies. The recent crisis coupled with already existing inefficiencies of the system has led to a vicious cycle of a three-fold challenge i.e., energy security, energy equity, and environmental sustainability.

Regional collaboration among South Asian countries is seen as a key strategy to enhance energy security by providing stable energy supplies, reducing costs, and ensuring access to diverse energy sources. However, the regional trade share of South Asia stands at 5.6%, which is the lowest in the world. Most of the energy trade is being carried out under bilateral inter-governmental contracts and not under an enabling framework for cross-border energy trade. Based on an extensive review of the existing frameworks and their eventual impacts, this study indicates that the key challenges hindering growth includes political differences, unrest, and lack of credibility, absence of a legal protective cover and incentive mechanisms, efforts to meet demands instead of creating a competitive common energy market, country laws and regulations around cross border energy trade, difference in taxation methodologies, absence of standard contracts leading to challenges in harmonization of processes, and limited cross-border infrastructure between some member countries to integrate energy cooperation.

In the backdrop of challenges highlighted above, this report demonstrates the viability of regional cooperation and transition towards renewable energy as the key to addressing energy security concerns in South Asia. It analyses the energy sector landscape of South Asia, development plans for regional cooperation, policy focus towards renewable energy upscale, and devises a roadmap for a more inclusive and green future of the energy sector in South Asia.

1 Introduction

1.1 Introduction

Energy security is pivotal to regional development, as it is strongly linked to key socio-economic indicators including industrial growth, livelihood opportunities, infrastructure development, education, healthcare, poverty alleviation, environmental sustainability, technological innovation, and global competitiveness (Ahmed & Zeshan, 2014). Furthermore, the reliance on imported energy sources has also created a vulnerability against supplies and price fluctuations (Kundi, 2023) which has been exacerbated by the CCC (climate change, COVID19, and conflict between Ukraine and Russia) crisis, and worsening environment profiles due to increased burning of fossil fuels and their exploration.

Significant efforts have been made to address energy security concerns in the past decade, leading to an increase in global electricity access cover from 84% in 2010 to over 91% in 2021 (IRENA, 2023). Despite these advancements, global efforts are not aligned with the objectives set by SDG7, which aims to achieve universal access to clean energy by 2030. As of 2021, around 675 million individuals still lack access to electricity (IRENA, 2023). Progress around energy security has also exhibited variations in different regions and the recent polycrisis, driven by Climate change, COVID19, regional conflicts, and pressing fiscal burden on the countries (Ahmed & Ahmed, 2022), has derailed Asian countries from its 2030 energy goal.

> As of 2021, around 675 million individuals still lack access to electricity
>
> International Renewable Energy Agency 2023

Renewable energy (RE) transition also has a key role to play in addressing these issues. While significant strides have been made around RE in both developed and developing countries, the high costs associated have greatly hindered progress. Along with supporting regulations and policy frameworks, one key aspect which is currently lacking in the energy planning of South Asian countries is limited regional cooperation. Keeping this in mind, this report focuses on the case of South Asia (Pakistan, India, Bangladesh, Nepal, Sri Lanka, Bhutan, and Maldives) which is at the forefront of climate vulnerabilities and struggling to cope with its energy security issues.

1.2 Scope, objectives, and methodology of the study

To address the energy security concerns of South Asia, it is critical to analyse the role of regional cooperation, existing RE solutions, and develop a pathway for challenges persisting in the region. This study aims to analyse the status quo of energy sectors in different South Asian countries, highlight major bottlenecks, and provide key recommendations that can empower their energy transition plans, particularly through a strong regional cooperation.

Key objectives of the report include:

1. To analyse the status of energy access and progress on SDG7 across South Asia.
2. To analyse the energy transition plans of South Asian countries and policy/regulatory support provided for regional cooperation.
3. To analyse how cross-border cooperation can expedite energy transition for energy pressed countries in South Asia?
4. To take stock of different off-grid RE based models currently being practiced, and what role can community-based Public Private Partnerships (PPPs) play in expediting the implementation of affordable energy solutions.

This report presents findings from data that is collected through both desk review and stakeholder consultations. Secondary data has been aligned as follows:

- Current Status of energy sector: A review of the current status of energy sector of each South Asian country, particularly around the key indicators of SDG7 (energy access, energy efficiency, and renewable energy share). This also considers analysing their energy consumption patterns and the share of energy mix in power and different demand sectors.
- Policy Review: Analyse the energy policy and development plans of South Asian countries, particularly the policies in support of low-carbon development such as RE targets, Nationally Determined Contributions, Net zero targets, etc.
- Regional Cooperation around Energy: Review and analysis of existing and potential regional cooperation frameworks, projects, and plans of South Asian countries. This also considers in detail the key challenges that are still hindering their developments.

Along with secondary data analysis, primary qualitative data is also collected by engaging subject stakeholders from relevant countries during consultative discussions. Along with key informant interviews, two roundtable discussions were conducted.

- Roundtable discussion on “Energy Security in South Asia and Transition to Sustainable Sources”. (SDTV, 2023)
- Roundtable discussion on “Supporting Energy Security in Pakistan and Transition to Sustainable Sources through Regional Cooperation”. (SDTV, 2023)

1.3 Socio-economic conditions and climate vulnerability of South Asian countries

South Asia faces challenges of energy security, energy equity, and environmental sustainability. Being a major importer of coal, oil, and gas, its dependence on these imports makes it vulnerable to shocks in the global energy market. This presents a fundamental challenge for sustainable development in this region. Key economic indicators of South Asian countries for 2022 are further indicated in Annexure 1.

1.3.1 Economic profile of South Asia in the backdrop of CCC crisis

The economic challenge driven by the CCC crisis has majorly affected South Asian countries due to limited fiscal capacity and dwindling reserves. According to "South Asia Economic Focus" report (Spring, 2023), regional growth is anticipated to an average 5.6% in 2023, marking a slight downward adjustment from the October 2022 projection (SASEC, 2023). Growth is expected to maintain a moderate trajectory at 5.9% in 2024, following the initial post-pandemic rebound of 8.2% in 2021. Inflation in South Asia is predicted to decrease to 8.9% this year and fall below 7% by 2024 (ibid). However, the persistence of weaker currencies and delayed adjustments in domestic prices are contributing to a slower decline in inflation. As of 2021, the poverty headcount ratio stands at 22% in India, 21% in Bangladesh, 24% in Pakistan, 19% in Nepal, and 4% in Sri Lanka (World Bank, 2023). Figure 1 highlights the impacts of COVID19 on South Asia.

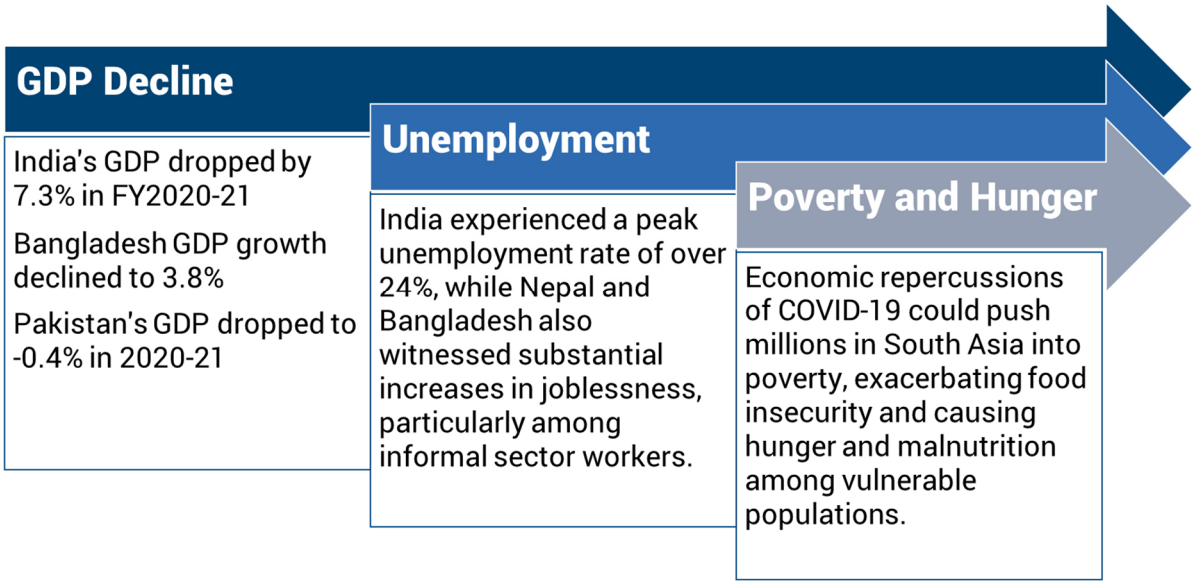


Figure 1: Economic Impacts of COVID in South Asia

***Source:** Figure designed by authors based on data collected from* (Yadav & Iqbal, 2021) .

1.3.2 South Asia's climate vulnerability

According to the Asian Development Bank (ADB), the consequences of climate change on agriculture, tourism, energy demand, labor productivity, human health, and ecosystems could shrink South Asia's economy by a staggering 11% by the end of the century (ADB, 2016). The Intergovernmental Panel on Climate Change (IPCC) warns of the region's susceptibility to a sea-level rise of up to 70 cm by 2100 and water resource changes, potentially displacing around 21 million people by 2080. South Asia's agricultural sector, with approximately 115 million hectares of cultivated land, is also under threat due to rising temperatures, water stress, extreme weather events, and climate-related pests and diseases. The environmental profile of South Asia and share of emissions from different sectors is depicted in figure 2. Figure 2

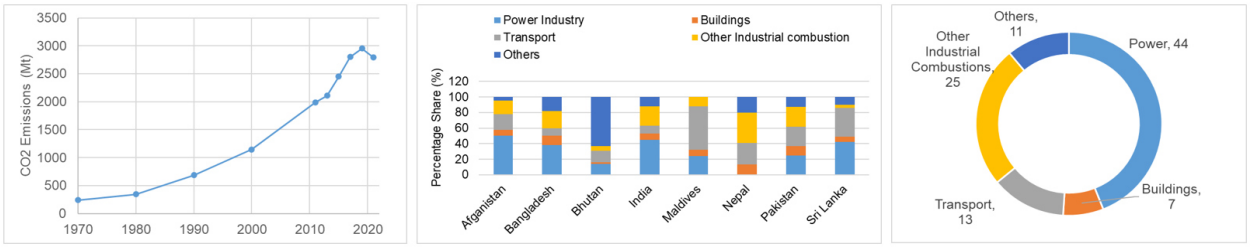


Figure 2 : CO_2 emissions and share of different sectors in South Asia

***Source:** Graphs plotted by authors based on data collected from South Asian Association for Regional Cooperation* (SAARC, 2022)

Based on figure 2, the major contributor to emissions in South Asia is the power sector, contributing to almost 44% of the total emissions. This can be attributed to 48.3% of coal-based power in overall power capacity, followed by 11% coming from natural gas and 4% from oil products. Impact of climate vulnerability on South Asian countries (excluding Afghanistan due to lack of available data) is depicted in Annexure 1.

1.4 Promoting energy equity: Significance of clean energy transition in South Asia

As of 2023, South Asia is home to around 2 billion people, accounting for almost 25.2% of the entire global population (Worldometer, 2023). A significant portion of the population does not have access to electricity, particularly in the rural areas where people are relying on the use of biomass. This poses a significant socio-economic risk in addition to environmental degradation. In areas with some electricity access, such as the Hindu Kush Himalayan (HKH) region in South Asia (Pakistan, Nepal), energy poverty persists due to frequent power outages, insufficient supply, and unreliable grid connections. Therefore, as the region progresses, it must prioritize effective interventions that can make the most substantial difference in enhancing the resilience and prosperity of the poorest and most vulnerable communities. Further details around energy equity indicators are also described in Chapter 2.

2 Energy Security in South Asia – The Status Quo

2.1 Energy outlook of South Asia

South Asia has large recoverable reserves of energy sources, especially hydropower solar and wind energy, as indicated in Table 1.

Table 1: Energy reserves in South Asia (Shukla, et al., 2017)

Source	Reserves
Coal	133 billion tons
Natural Gas	85 trillion cubic feet
Oil	816 million tons
Hydropower	296 Gigawatts
Solar and Wind	744 Gigawatt

Total primary energy consumption (TPEC) of South Asian countries (and projections up to 2030) and the share of member states are shown in figure 3.

Based on figure 3, TPEC of South Asia has increased from 761 Mtoe in 2012 to 1310 Mtoe in 2023. This is further expected to increase beyond 1670 Mtoe by 2030. India has the largest share of around 84% in total demand of South Asia, followed by Pakistan at 8.3%. The remaining countries have a combined share of around 7.5% in TPEC.

However, despite having a large energy potential, South Asian countries have been reeling under energy shortfalls to meet their needs. Given a strong index of energy security with other development indicators, this has consequently led to their low Human Development Index (HDI) .

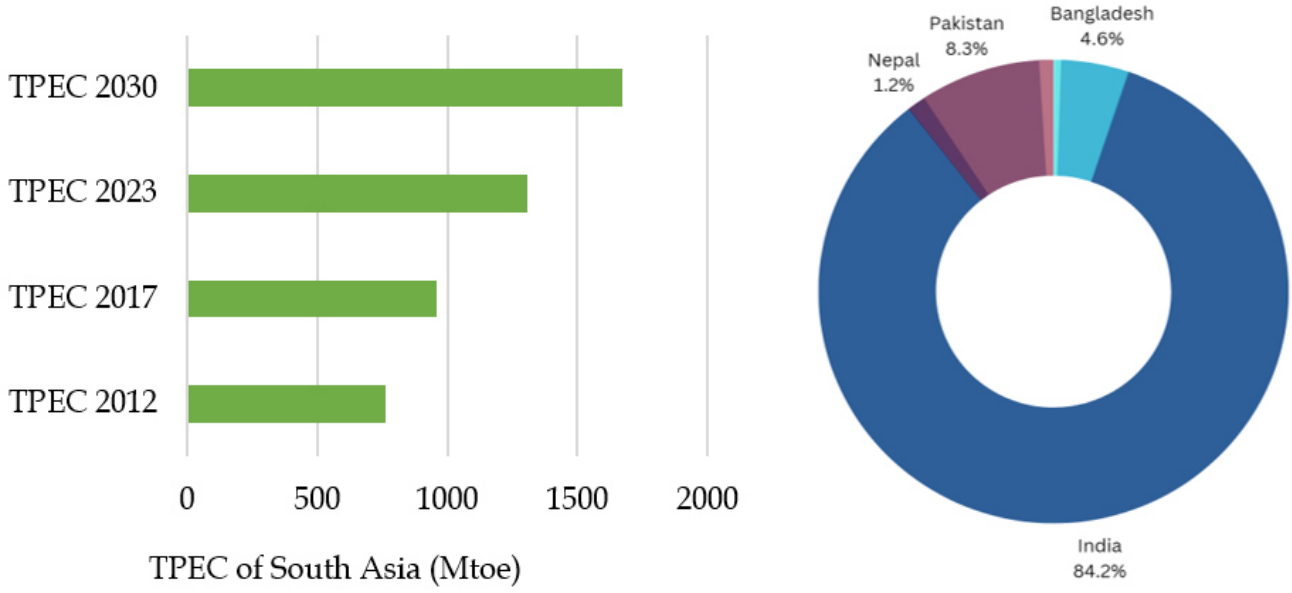


Figure 3: Total primary energy consumption(TPEC) of South Asia and share of different countries

Source: Figure plotted by authors based on data collected from South Asian Association for Regional Cooperation (SAARC, 2018).

The demand-supply gap for both electricity and petroleum products is indicated in Table 2.

Table 2: Demand supply gap of South Asia's power sector outlook

Countries	2024		Deficit / Surplus	2030		Deficit / Surplus
	Demand (GWh)	Domestic Supply (GWH)		Demand (GWh)	Domestic Supply (GWh)	
Afghanistan	7,428	5,466	-26%	11,028	7,473	-32%
Bangladesh	91,093	79,825	-12%	123,941	101,212	-18%
Bhutan	3,145	21,035	568%	6,572	23,691	259%
India	1,769,609	1,776,224	0.4%	2,470,238	2,452,106	-0.7%
Maldives	2,046	2,046	0%	3,172	3,172	0%
Nepal	9,305	11,094	19%	15,836	18,978	20%
Pakistan	151,583	150,301	-1%	191,828	190,781	-1%
Sri Lanka	19,985	20,610	6%	28,188	28,503	1%

Source: SAARC Energy Outlook 2030. (SAARC, 2018)

Based on the data in Table 2, Afghanistan and Bangladesh will continue to face deficits in their power sector over the next 7 years. Bhutan and Nepal are to remain in surplus, while Pakistan and India will meet their power demand. As for petroleum and diesel products, most of the countries are to face a deficit of products by 2030, except for India and Afghanistan. Overall, the region is expected to have a net deficit of around 15,035,000 Mt of petroleum products and net surplus of 6461,000 Mt of diesel products. However, there is high reliance on either imported fossil fuels or inefficient use of biomass, as shown in figure 4.

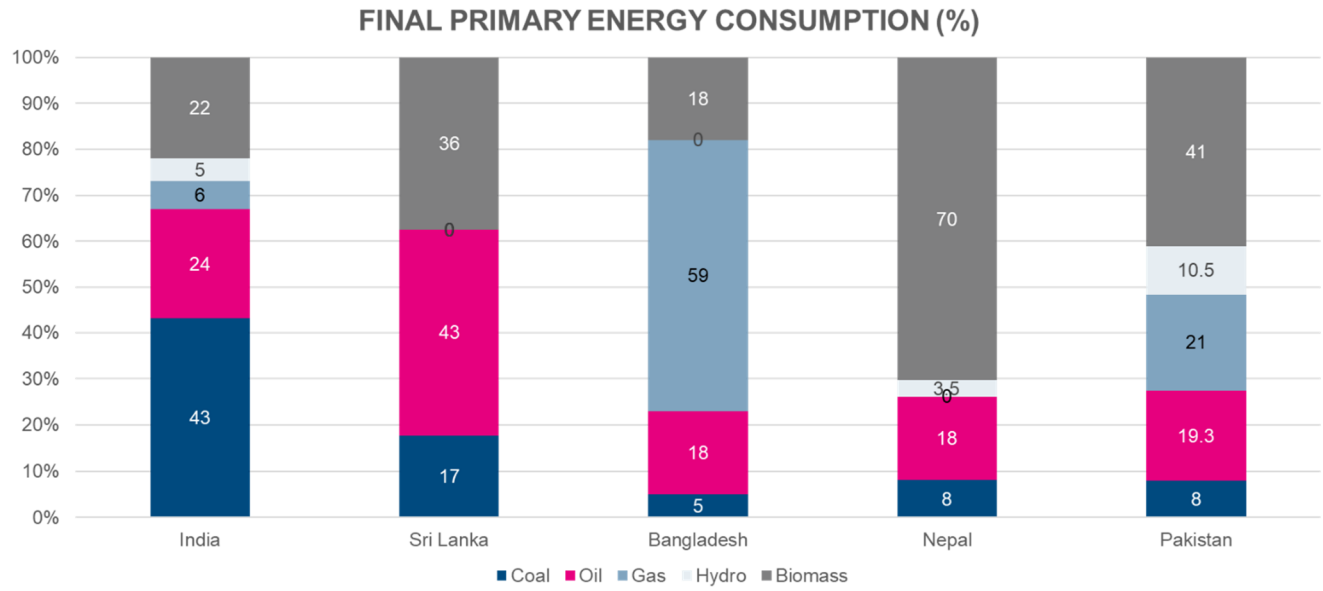


Figure 4: Share of different fuels in total primary energy consumption
Source: Graph plotted by authors based on data collected from (SAARC, 2018)

On average in South Asia, biofuels and waste constitute the highest share of around 37%, followed by Oil (24.4%), Gas (17.2%) and Coal (16.2%). The remaining share is coming from hydro-electric power-plants.

2.2 Progress of South Asia on SDG7

SDG7 focuses on ensuring access to affordable, reliable, sustainable, and modern energy for all. South Asia's progress on SDG7 is as follows:

2.2.1 Access to electricity and clean cooking fuels in South Asia

The average electricity access in South Asia (2021) is 93.2%, lowest being 77% in Pakistan to a 100% access in Bhutan, Sri Lanka, and Maldives. Figure 5 depicts the improvements in energy access values of South Asian countries since 2010, increasing with an annual compound growth rate of 1.17%. These numbers, however, represent basic tiers and do not take into consideration reliability and availability challenges such as power outages and fluctuations particularly in the rural areas. They also include the population that is connected to the off-grid solutions such as solar stand-alone and micro-grid systems.

For clean cooking fuels, accessibility is much lower with only 53.8% of the population having access to clean cooking fuels. Maldives has the highest share of almost 100% in 2021, while Bangladesh only 26% (Figure 6). The low access of clean fuel is mainly due to association of these countries with the agriculture sector, where rural residencies are using traditional biomass for fulfilling their energy uses and inefficient combustion of residues and woody biomass for cooking and heating applications within households is prevalent.

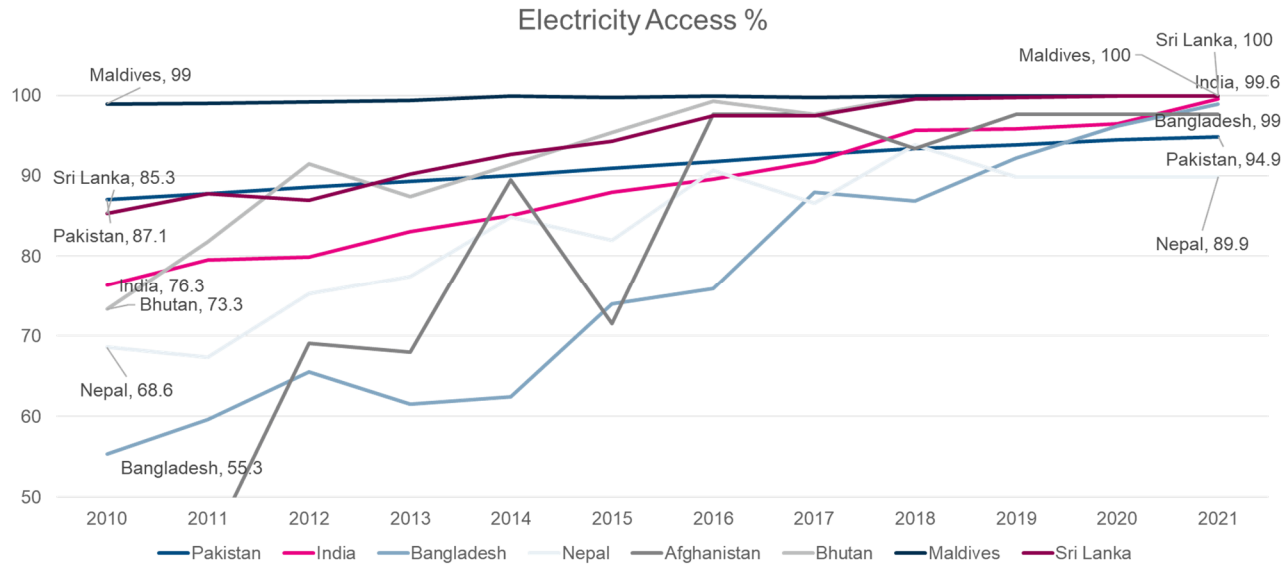


Figure 5: Electricity Access Trend in South Asia

Graph plotted by authors through data collected from world bank data repository (The World Bank Group, 2023)

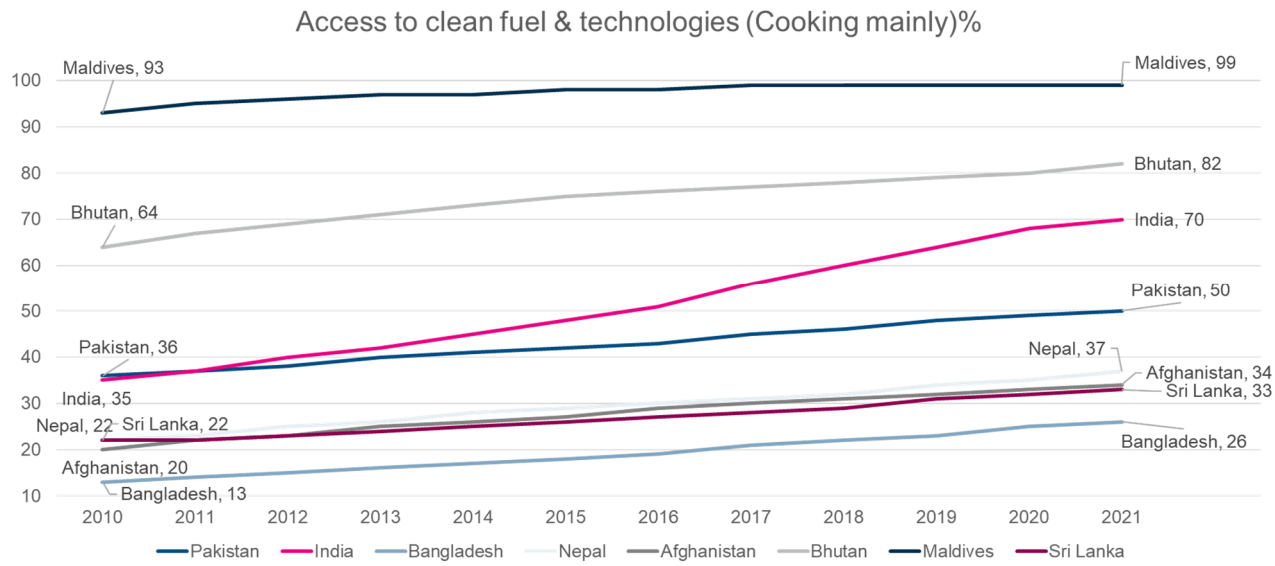


Figure 6: Access to clean fuel & technologies in South Asia

Source: Graph plotted by authors through data collected from world bank data repository (The World Bank Group, 2023)

2.2.2 Renewable energy consumption in South Asia

As of 2020, the average RE consumption share in Total Primary Energy Supplies (TPES) of South Asia including biomass was around 40%. Bhutan has the highest share of around 81%, while Maldives has a share of less than 2%. Figure 7 shows a downward trend for most countries, depicting a shift from traditional use of biomass towards clean cooking fuels and electrification of households. On the other hand, excluding non-conventional use of biomass as an RE source, the average share of RE in TPES of South Asian countries drops to around 10.4% in 2021 – significantly lower than the previous value and well off-track to meet the SDG7 targets. Over the past decade, RE share of India has increased from 6.6% in 2010 to 9.3% in 2020. The RE share of Pakistan, on the other hand, has decreased from 11.2% in 2010 to 10.6% in 2020.

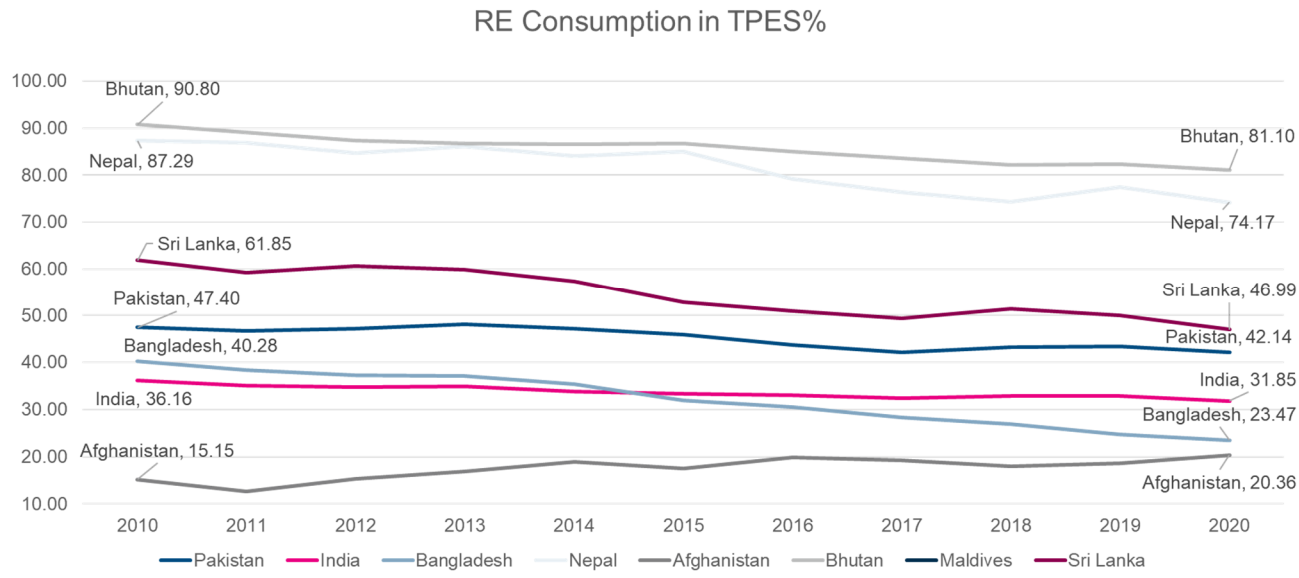


Figure 7: RE share in TPES of South Asian Countries (including biomass)

Source: Graph plotted by authors through data collected from world bank data repository (The World Bank Group, 2023)

2.2.3 Energy intensity trend across South Asia

Energy intensity under SDG7 is defined as the amount of primary energy required to produce a dollar of Gross Domestic Product (GDP) to track country-wide progress. As of 2021, South Asian countries have an average energy intensity value of 3.74 MJ/$2017 PPP GDP against the global average of 4.3 MJ/2017 PPP GDP. Over the past ten years, this has increased with an Annual Compound Growth Rate (ACGR) of 0.85%. Afghanistan has the lowest intensity of 2.16, while Bhutan has the highest intensity value of 7.34. The energy intensity trend across South Asia is indicated in Figure 8.

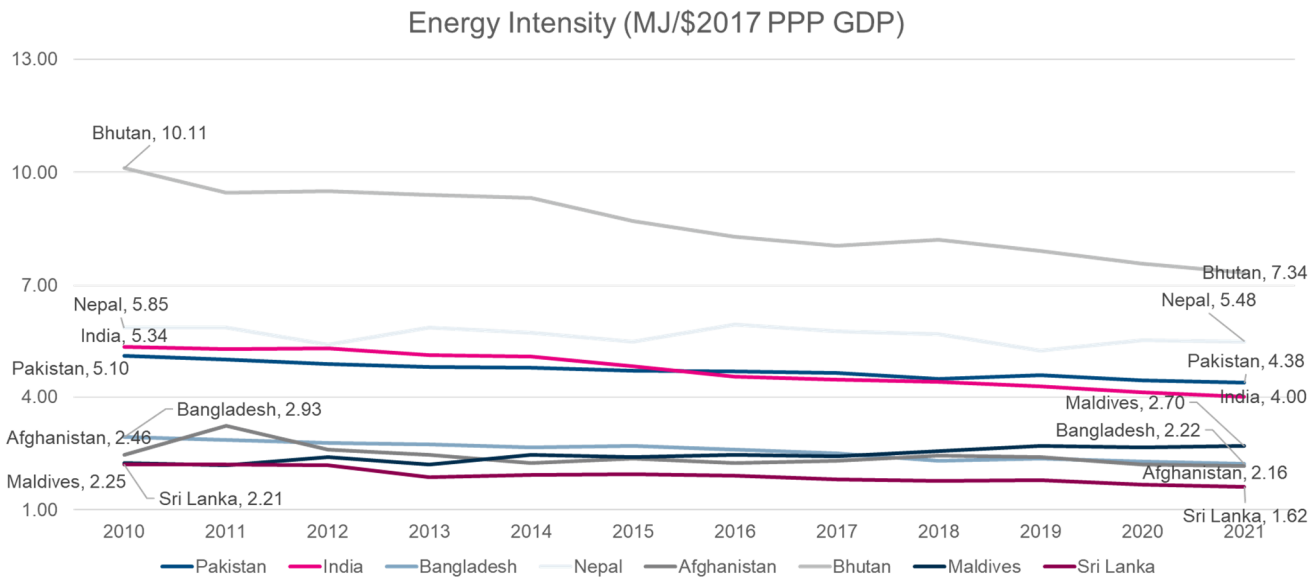


Figure 8: Energy Intensity (MJ/$2017 PPP GDP)

Source: Graph plotted by authors through data collected from world bank data repository (The World Bank Group, 2023)

2.3 Energy transition plans: Looking forward to 2030

The energy policies in South Asia are shaped by each country's specific circumstances, resources, and development goals, but collectively aim to address common energy challenges in the region. The energy transition plan of South Asian countries is indicated in Table 3.

Table 3: Plans for Energy Transition across South Asia

Country	Plans for Energy Transition	NDC targets	Net-Zero targets	Energy Trade Programs in Asia
Pakistan	As per the Alternate and Renewable Energy Policy 2019 and Indicative Generation Capacity Expansion Plan (IGCEP) 2022, Pakistan is planning to achieve a target of almost 30% share of RE by 2030 and 30% of Hydro by 2030.	50% conditional and 15% unconditional target and 35 % subject to provision of international grant(USD 101 billion)	Not committed	• CASA-1000 (Central Asia-South Asia Electricity Transmission and Trade Project) • TAPI (Turkmenistan-Afghanistan-Pakistan-India) Pipeline. • Iran-Pakistan Gas Pipeline (IP Gas Pipeline or Peace Pipeline)- (not south Asia) • Electricity Imports from Iran
Bangladesh	Bangladesh Delta Plan (BDP) 2100 aim to achieve 30% energy from renewable sources by 2041. Perspective plan 2021-41 aims to ensure 100% energy security by 2041. The eight 5-year plan is also committed to establish an efficient least cost production structure.	15% conditional and 6.7% unconditional target	Not committed	• India-Bangladesh Power Interconnections • India-Bangladesh electricity trade program. • Nepal-Bangladesh agreement for electricity cooperation. • Regional Cooperation for Power Sector Development (RCPSD)

Country	Plans for Energy Transition	NDC targets	Net-Zero targets	Energy Trade Programs in Asia
Bhutan	Maintain carbon neutrality by 2030.	Maintain carbon neutrality.	2030	• Indo-Bhutan Energy Cooperation • Hydropower export to India (Chukha, Tala, Mangdechhu, Punatsangchhu Hydroelectric Projects) • Cross-border transmission lines
India	According to India Energy Security Scenarios 2047 (IESS), 64% of electricity demand in India will be supplied through Renewable Energy.	Emissions reduction target of 45% below 2005 by 2030	2070	• Electricity interconnections with several neighboring countries, including Bangladesh, Bhutan, Nepal, and Myanmar • Bilateral power agreements with neighboring countries. • International solar alliance Project. • TAPI gas pipeline. • Gas trade agreements with Qatar, United States, and Australia.
Maldives	70 per cent power generation capacity from renewable energy sources by 2030	Conditional emissions reduction target of 26% by 2030	2030	Gas import agreements with India and Sri Lanka. Gas imports from other countries including UAE and Oman.

Country	Plans for Energy Transition	NDC targets	Net-Zero targets	Energy Trade Programs in Asia
Nepal	Nepal plans to generate 12,000 MW from Hydropower by 2030, 2,100 MW of solar energy by 2030, 220 MW of electricity from bioenergy by 2030, Additional 50 MW of electricity from small and micro hydropower plants	Conditional NDC would reduce 1.9 – 5.6 MtCO2e, by 2030 depending on the interpretation of the sectoral targets and the overlaps with the sector targets.	2045	• Electricity Trade with India and Bangladesh. • Cross border transmission lines primarily with India. • Other bilateral agreements with China for CBET.
Afghanistan	Afghanistan aims to deploy 350-450 MW of RE capacity by 2032	Conditional target of 13.6%	2050	• TAPI gas pipeline • CASA-1000 • Cross border transmission lines with Iran. • Electricity imports from Uzbekistan.
Sri Lanka	Sri Lanka had a goal to achieve 70% of its electricity generation from renewable sources by 2030.	14.5% conditional and 4% unconditional	2050 (conditional)	• Power trade with India • Cross-border transmission lines with India. • Gas import agreement with Qatar.

Source: Table designed by authors through data collected from Annual Report on Sustainable Infrastrutures for Future Needs (ADB, 2017)*, Energy Policies in South Asia towards Net Zero Targets* (CEJ, 2023), (Rahman, et al., 2023)*, and country NDC documents.*

2.4 Cross-border and regional cooperation programs in South Asia

South Asia currently faces significant electricity shortages, despite having the potential to generate enough electricity from their own resources. These shortages are hindering the socio-economic development of the region (Zeshan & Vaqar, 2013). However, cross-border power trade could help alleviate these shortages as some parts of the region have surplus energy while others face deficits according to United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP, 2020). Figure 9 represents the status of cross border electricity trade (CBET) in South Asia.

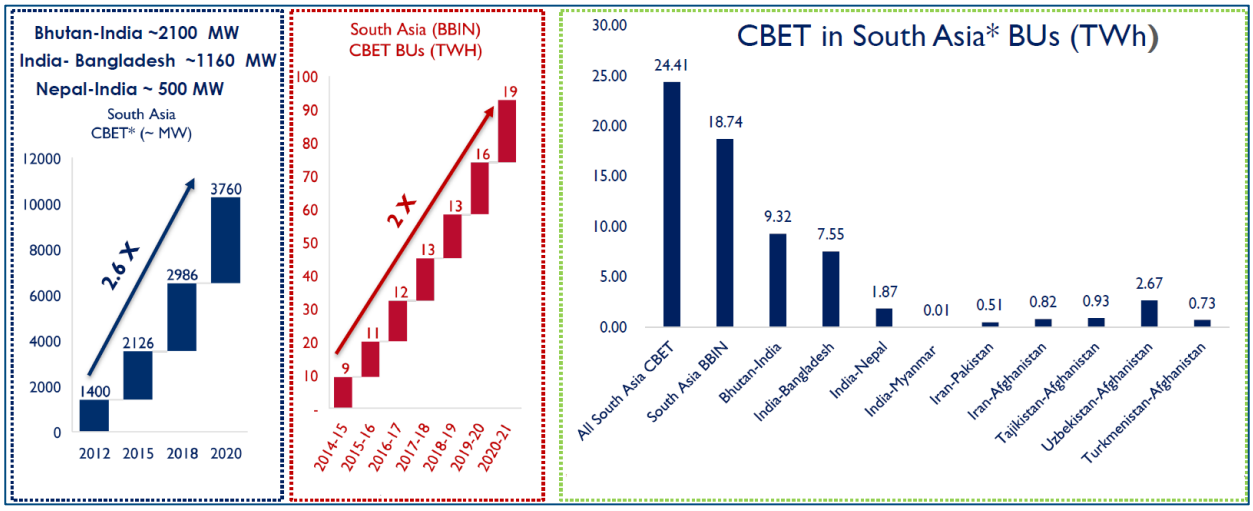


Figure 9: Current status of South Asia CBET
***Source:** South Asia Regional Initiative for Energy Integration* (SAR/EI, 2021)

For renewable energy zones, the CBET is indicated in Figure 10. CBETs can have various benefits, including optimum use of resources, improved security and reliability, optimized transmission networks, economic efficiency, and less spinning reserves. From an economic and financial perspective, enhanced productivity, increased revenues from trade and industrial activities, increased GDP growth, and foreign exchange rates can be ensured.

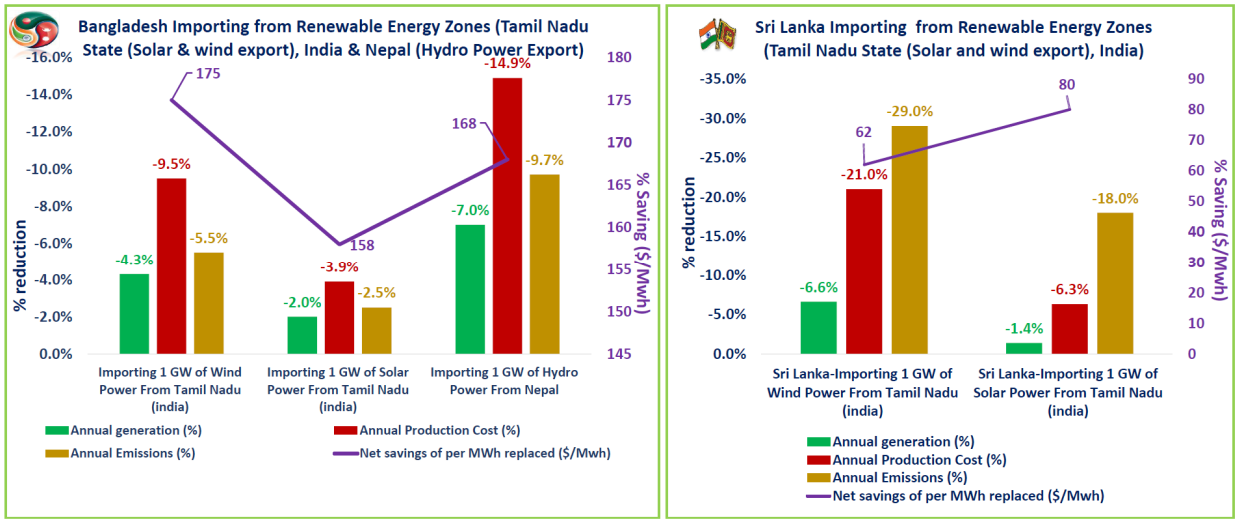


Figure 10: Cases of Cross boundary Renewable Energy trade across South Asia
***Source:** South Asia Regional Initiative for Energy Integration* (SAR/EI, 2021)

2.4.1 Requirements for regional electricity trade

Regional electricity trade holds numerous benefits for SAARC member nations. In a region where millions of people lack access to electricity, prioritizing energy supply through trade is essential. Table 4 highlights the key enabling interventions for regional electricity trade across South Asia. These interventions have been highlighted in detail under the study "SAARC Energy Outlook, 2030" (SAARC, 2018)

Table 4 :Enabling interventions for expediting regional cooperation in South Asia

Requirements	Interventions
Legal Requirements	Recognition of cross-border trade in law Open Access to T&D networks Transit freedom for third party countries Same playing field to Cross-border energy flows Enable regional/sub-regional power generation facilities.
Regulatory Requirements	Putting necessary licensing for cross-border trade. Put in fair-trade practices to minimize cost. Put in regulations for environmentally friendly regulations. Systems to be made reflective of market-based instruments.
Technical Requirements	Harmonizing the operational parameters. Detailed load-flow studies for optimized power flow. Protection systems for load segregation. Monitoring systems. Common metering standards
Commercial Requirements	Payment settlement mechanisms. Currency for payment settlements.

2.4.2 Ongoing regional cooperation programs across South Asia

South Asian countries have established laws and regulations governing their domestic electricity sectors, with limited provisions concerning taxes and duties on CBET. Most SAARC countries rely on bilateral or multi-lateral agreements when engaging in CBET, while only Bhutan and Nepal have incorporated specific provisions for CBET in their laws. An overview of existing laws and regulations addressing CBET across South Asia are attached as Annexure 2. Further, different agreements signed by South Asian countries around power trade are depicted in Figure 11.

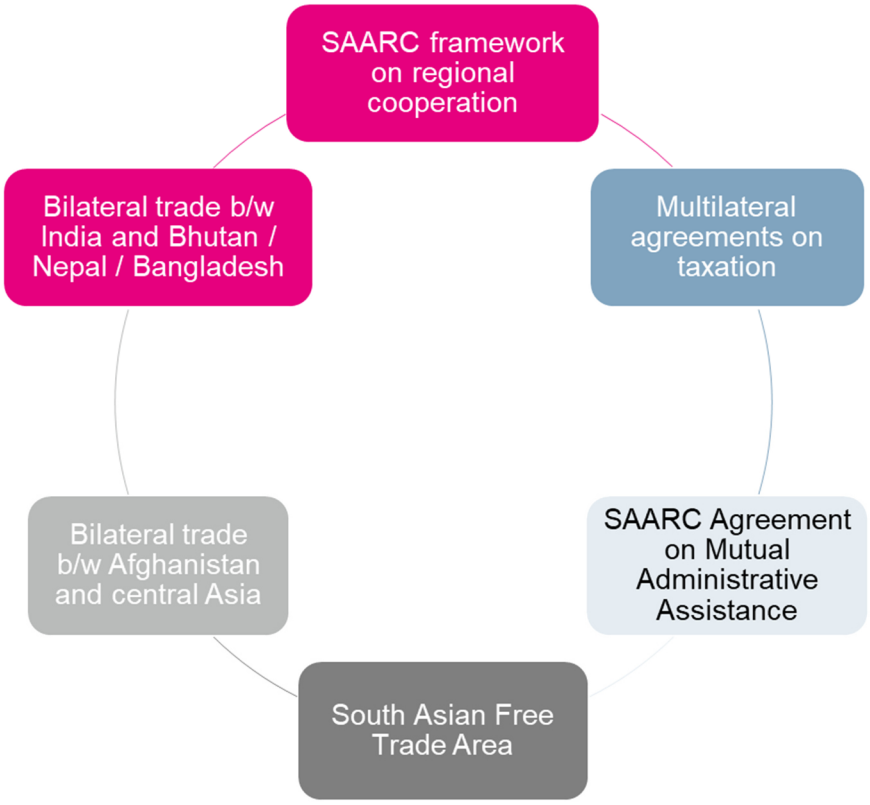
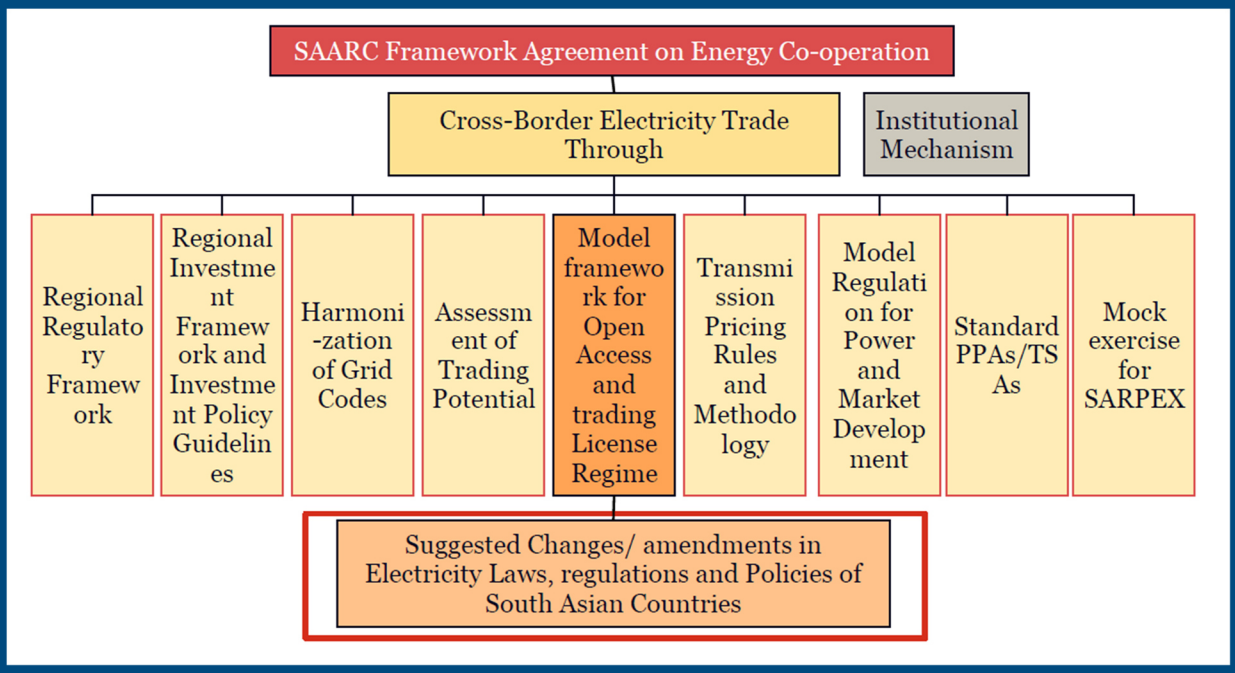


Figure 11: Regional cooperation programs across South Asia

SAARC Framework on Energy Cooperation (South Asia Subregional Economic Cooperation (SASEC, 2016)

The SAARC Member States signed the SAARC Framework Agreement for Energy Cooperation (Electricity) at the 18th SAARC summit on 26 November 2014. This agreement is a major step towards encouraging SAARC member states to increase cross-border electricity trade and exchange. This agreement binds the member states to move progressively towards a zero-tax regime as far as CBET is concerned.

Since its introduction, the framework has assisted in fostering better cooperation among member states, particularly in facilitating dialogues and information sharing between countries. Some key projects such as India-Bangladesh power transmission link and the Turkmenistan-Afghanistan-Pakistan-India (TAPI) gas pipeline have already been discussed under this project. However, the framework has faced various challenges in realizing its full potential due to border-disputes between countries, political tensions, and other factors.



2.4.3 Lack of regional integration in South Asia

South Asia boasts abundant natural resources, including coal, natural gas, hydropower, and RE. However, these resources remain significantly underutilized, leading to energy supply challenges. Afghanistan, for instance, imports 100% of its petroleum demands despite having sufficient crude oil reserves. Limited refinery infrastructure in these countries, except India, has driven substantial imports. Except for Bhutan, Nepal, and the Maldives, which face geographical challenges, expanding refining capacities would be economically viable for other members. Dwindling gas production in Pakistan and Bangladesh has also raised concerns about fuel security.

Energy trade within some countries is limited to petroleum products and electricity. Some electricity trade occurs between Bhutan and India, India and Bangladesh, and India and Nepal. The region heavily depends on petroleum, oil, lubricants import from the Middle East and Iran. Opportunities for expanding energy trade exist through India's open-access power transmission system, power interconnection among neighboring countries, and gas and oil transmission via pipelines connecting multiple countries. Figure 12 represents the inter-regional trade share of South Asia (5.59%) which is lowest across the world.

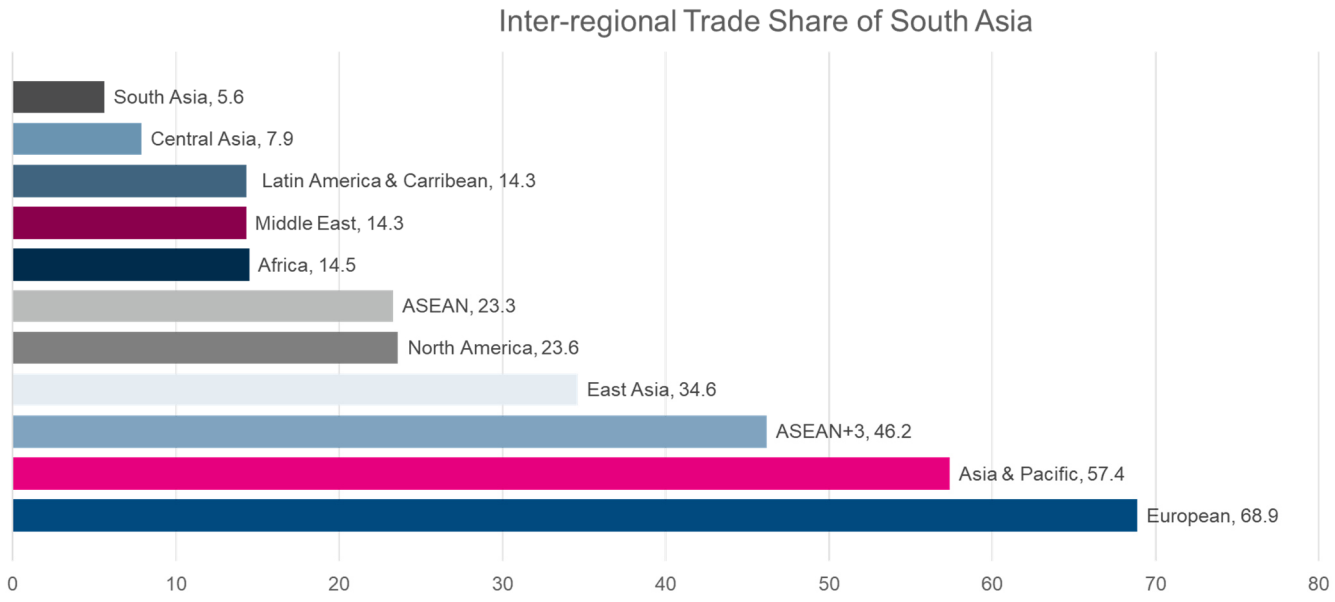


Figure 12: Inter-Regional Trade share of South Asia

Source: Figure designed by authors based on data collected from database of Asia Regional Integration Center (ARIC, 2020).

3 Prospects for renewable energy transition in South Asia

The geographic location of South Asia enables it to have an abundance of renewable energy sources (Ahmed, 2014). However, despite its abundance, the region is dominated by fossil fuels. The RE potential (including Hydro) of South Asia is shown in Figure 11, which largely remains untapped. Based on Figure 13, South Asia has a potential of 350 GW of hydro, 939 GW of solar, and 1289 GW of wind potential. However, of this, only 14.6% in hydro, 3.8% in solar, and 3% in wind has been realized.

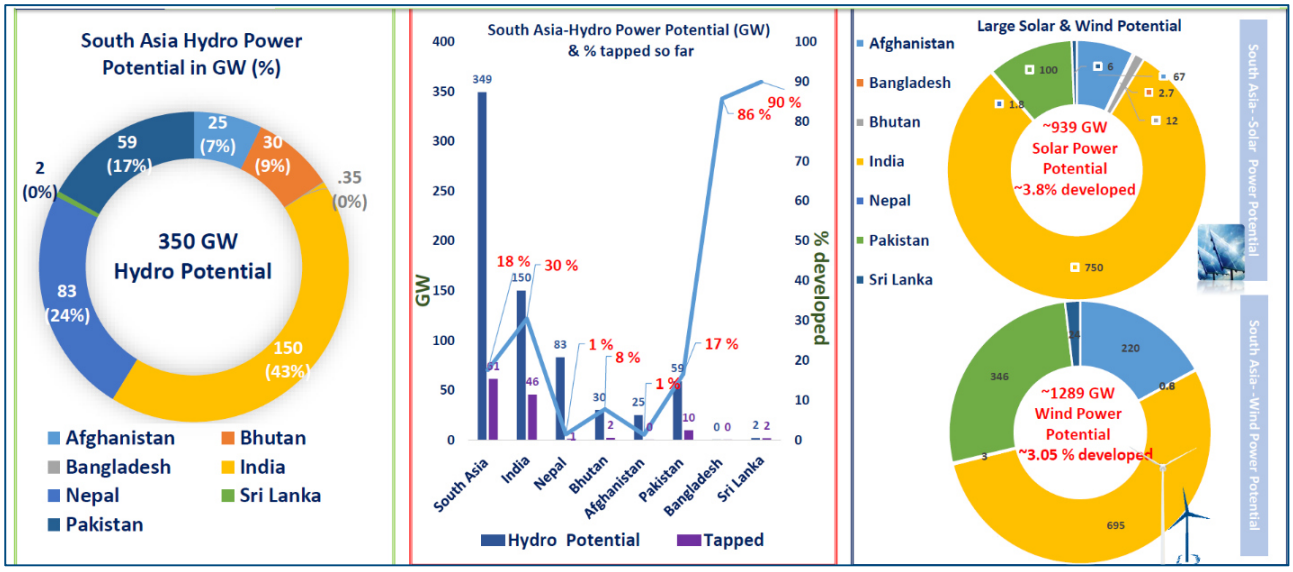


Figure 13: Renewable Energy potential and realized values in South Asia
***Source:** South Asia Regional Initiative for Energy Integration* (SAR/EI, 2021)

3.1 Decentralized Renewable energy solutions

Globally, RE adoption has rapidly increased over the past decade from 1227 gigawatts (GW) in 2010 to almost 4500 GW in 2023 (IEA, 2023). RE capacity additions are expected to be 107 GW, bringing the total to surpass 440 GW by the year 2023. Solar photovoltaic (PV) installations will be the driving force behind approximately two-thirds of this year's expansion in RE capacity, and this trend is expected to continue into 2024 (ibid). Elevated electricity prices are spurring the rapid growth of rooftop solar PV, granting consumers the ability to significantly reduce their energy expenditures. Figure 14 describes the RE generation increase over the past years and decline in technology cost

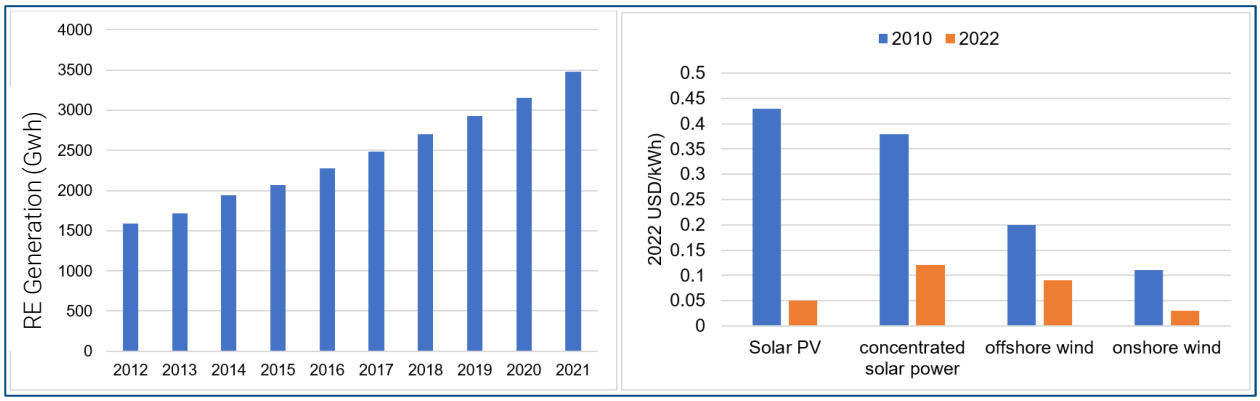


Figure 14: RE Generation Increase in Asia and cost decline of RE technologies over the past decade

***Source:** Graphs plotted by authors through data collected from International Renewable Energy Agency* (IRENA World Energy Transition Outlook 2023, 2023).

The capacity of off-grid renewable energy (RE) has also seen significant growth, increasing from under 2 GW in 2008 to over 8 GW by 2021 globally. This expansion represents a substantial investment of $28 billion, with an increasing emphasis on renewable sources like hydro and solar, making up 46% and 40% of planned capacity, respectively. To achieve universal access to electricity by 2030, it is estimated that over 210,000 mini grids will be necessary (PV Magazine, 2022). Mini grids have gained traction, especially for rural electrification, due to their low Levelized Cost of Energy (LCOE), which ranges from $0.03/kWh to $1/kWh globally (South Asian Association for Regional Cooperation (SAARC), 2021).

However, despite the potential of decentralized renewable energy solutions, progress in South Asia has been slow. Based on successful learnings from the SAARC countries, the policy elements required for scaling up these systems are indicated in Figure 15.

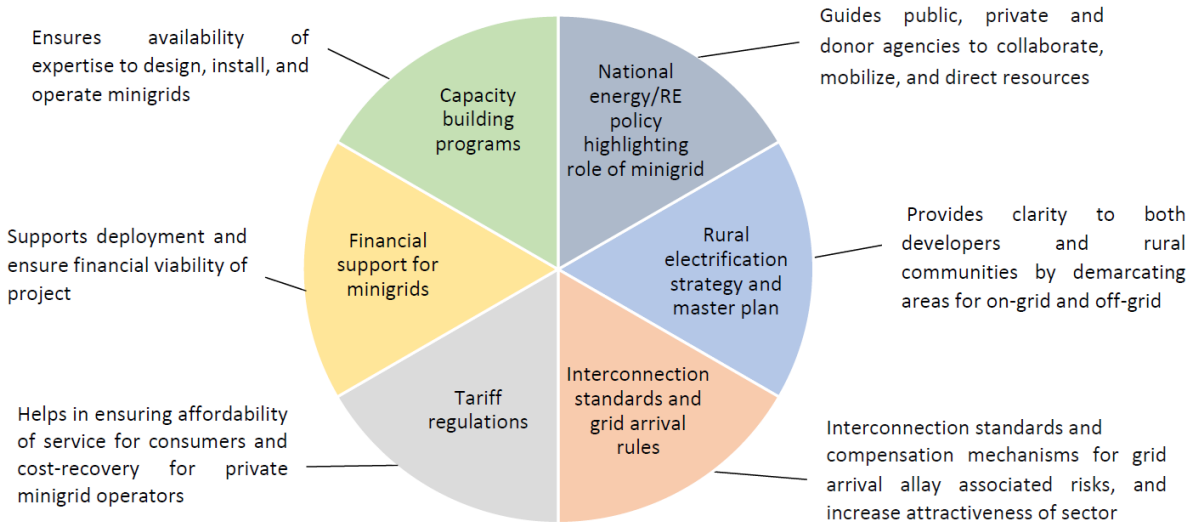


Figure 15: Source: South Asian Association for Regional Cooperation (SAARC, 2022)

3.2 Significance of regional Public Private Partnerships (PPPs) across South Asia to drive RE transition.

PPPs are and will continue to play a critical role in driving RE transition across the globe, by leveraging the strengths of both public and private sectors to address the challenges. In context of South Asia, PPPs can play a key role by fostering collaboration among multiple countries.

Their advantages are as follows:

- Cross-border energy trade: South Asian countries can collaborate on RE projects, where PPPs can assist in developing the necessary infrastructure and agreements for cross-border trade.
- Shared Infrastructure: Regional PPPs can facilitate interconnections and cross-border transmission lines for RE infrastructure development.
- Harmonization of policies: Regional PPPs can bring standardization and consistency in regulatory support and technical standards relevant to the RE projects. This can reduce market inconsistencies for private sector investors across South Asia.
- RE zoning: PPPs can enable joint efforts to map the RE resource across South Asia, including mapping of solar, wind, biomass, and hydropower projects. This could allow South Asian countries to prioritize their investments in RE projects.
- Mobilizing finance: PPPs can foster the establishment of green financing mechanisms such as investment funds, bonds, and grants to attract RE capital. Such mechanisms can pool resources from multiple countries and private investors for funding the large projects.
- Integration of Energy markets: PPPs can enable integration of the regional energy market, and enable efficient trading of RE, eventually reducing the costs.
- Research and Development: PPPs can upscale the RE innovations and identify technology interventions based on regional needs and conditions to support development.

4 Policy recommendations

Regional cooperation and transition towards sustainable and green energy resources are indispensable for resolving the issues pertaining to energy security and energy equity in South Asia. Based on the gaps highlighted and analysis provided in this report, the following area-wise policy recommendations are suggested.

4.1 Cross border trade of electricity (CBET)

- Draft and formulate extensive **"Standard Operating Procedures (SOPs)"** consisting of activities required to initiate and conduct CBET.

- To address institutional gaps, licensing and regulatory authorities for CBET should be designated in each country. Similarly, there is a need for proper designation of national transmission system operators for planning and coordination.

- Regulatory entities should recognize **energy trading as a separate commercial activity in power sector laws** of each member country.

- Government authorities to notify and put in-place the regulatory and fiscal framework for electricity trading across borders. This includes relevant taxes, duties, waivers, levies, etc. on CBET.

- To enable CBET, the regional and country-wide master plans should be setup, **identifying the demand forecast and upcoming generation capacities** to be integrated under the trading.

- Provision of **"Non-discriminatory energy access"** should be present for transmission infrastructure **under the country laws.**

- To address the technical gaps, regulations, and trading procedures of CBET should be drafted and standardized. This includes various aspects including price determination mechanisms, payment settlement and risk assurances, demand estimation, congestion management etc.

- Given that the transmission lines would pass through at least two countries, there is a need for a common price determining mechanism for transmission charges and losses.

- Setup negotiating forums and conditions to enable cross-discussions between governments and private sector stakeholders.

- South Asian countries should develop a system that fosters and promotes regular sharing of knowledge and collaborative research, which includes the exchange of experts and professionals. This collaboration should encompass various aspects, such as Power generation, T&D, improving energy efficiency, reducing losses, and integrating renewable energy sources into the grid.

Given that the transmission lines would pass through at least two countries, there is a need for a common price determining mechanism for transmission charges and losses.

4.2 Addressing grid intermittency for higher RE uptake

- To address RE intermittency issues, regulatory authorities and dispatch companies through a regional collaboration can ensure effective grid integration by bringing different RE sources to a common grid.

- National Governments should put in necessary reform measures for upgradation of national grids (and putting new lines if needed) which strengthens the infrastructure for its use within country as well as for regional grids.

4.3 Research and development for localization of RE in South Asia

- Initiate joint research programs of South Asian countries to **promote localization of the renewable energy supply chain.** This should extend beyond primary technology to storage units and materials.

- For assessment of economic cost and benefit and its cross-border sharing, there is a need to develop a regional database that can create awareness and promote collaboration around RE solutions.

4.4 Availing diversified RE potential of South Asian countries

- Planning departments across the region should collaborate to plan an effective regional integration to

harness the potential of diversified renewable energy resources.

- Develop a common "power exchange mechanism" for regional power trade where excess countries with excess power generation during summers can export it to other south Asian countries, while importing it during low generation seasons.

- Renewable Energy Trade should be accompanying with technology transfer to improve supply as well as reduce the T&D losses in both regions.

- Government collaboration of south Asian countries to revive and promote the bilateral/multilateral initiatives such as SAARC energy cooperation framework.

4.5 Upscaling off-grid RE solutions

- For exchange of good practices and learning across the countries, there is a need to develop a "regional Mini grid cooperation mechanism" with representation of relevant ministries/departments of the member countries.

- SAARC member countries can join and initiate a specialized course on "Design and operation of mini grids". This course can be offered to the relevant stakeholders (government RE departments, private sector/NGO representatives, and other key stakeholders of the member countries. The course contents could be tailored where possible to meet the requirements of relevant countries.

- Develop an online platform (or a facilitation desk) of south Asian countries that connects the mini-grid project developers, investors, service providers and other stakeholders of the region. This platform can support the mini-grid deployment by supporting the investors and securing finance more efficiently.

- Address the political challenges to foster cross-boundary trade agreements to enable the exchange of clean energy technologies between countries.

4.6 Mobilizing finance for RE transition

- Relevant government entities of South Asian governments can collaborate with MDBs and other FIs to establish a regional pool of "long-term investors" which can invest in long-term financing mechanisms such as issuance of bonds to attract investors.

- To improve the liquidity of financing instruments such as green bonds, there is a need for provision of historical data indicating the performance of RE projects to reduce the risks perceived by the investors and familiarize them with regional regulatory frameworks.

- Given that South Asia lacks a "deep capital market", there is need for a dedicated financial market for renewable energy projects. The regional financing tools may include R&D support, grants, soft loans and facilities, credit enhancement, credit lines, guarantees, incubators, public venture capital funds and public equity funds.

- Consider simplifying the procedures and realigning institutional incentives to support the use of risk mitigation tools. Furthermore, there's potential to create novel risk mitigation mechanisms, frameworks, funds, or facilities specifically addressing power off-taker risk and currency risk in emerging markets.

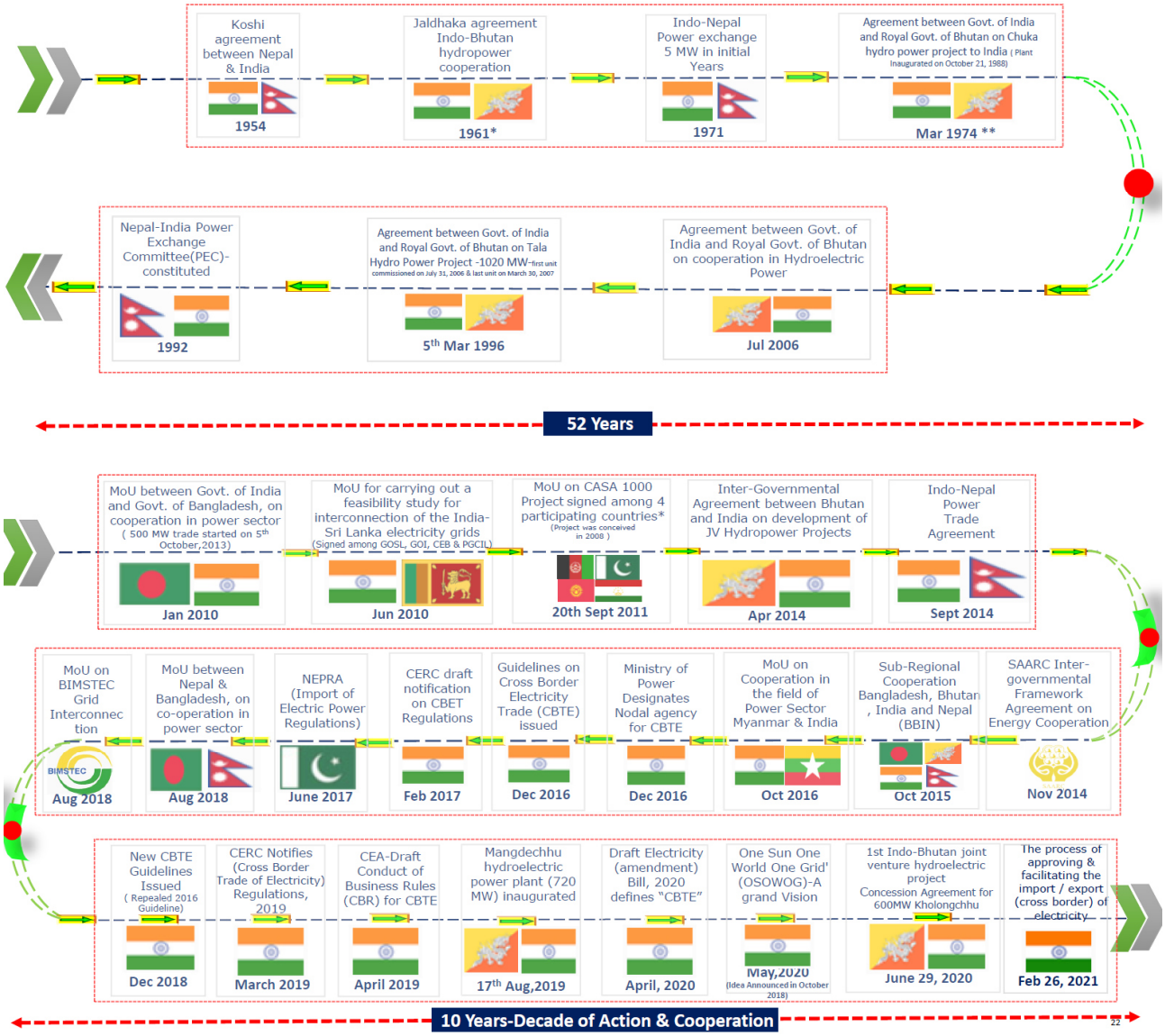
- Government and FIs to come together to develop a "South Asia Green Grid Integration Fund" that incorporates:
  - Prioritize financing of cross-border transmission.
  - Regional Transmission Master Plan and Investment Plans.
  - Focus on Regional Market Development-Price Signals.
  - Develop Risk Mitigation Instruments, Customized Risk.

Annexure 1: Economic and climate profiles of South Asian countries

Country	Real GDP Growth	Inflation (CPI)	Current account balance (% of GDP)	Net FDIs (% of GDP)	International Poverty Rate	GHG Emission Growth (mtCO2e)
Bangladesh	6	9	-0.8	0.4	5	3.6
Bhutan	4.6	4.6	-27.8	-	0	-1.6
India	7.2	6.7	-2	0.8	11.3	5.8
Maldives	13.9	2.3	-16.7	11.7	-	13.2
Nepal	5.6	6.3	-12.6	0.4	-	4.4
Pakistan	-0.6	29.2	-0.7	0.1	6.8	2
Sri Lanka	-7.8	46.4	-5.3	1.2	5.8	5.1

Country	CRI Score	Fatalities (Rank)	Economic Losses (Rank)	Losses/GDP (Rank)
Bangladesh	23.5	7	20	28
Bhutan	118	106	130	130
India	16.7	1	1	13
Maldives	97.3	106	114	76
Nepal	20	10	42	27
Pakistan	25	8	14	25
Sri Lanka	41.8	33	48	61

Annexure 2: Timeline of energy cooperation across South Asia



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