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Power Generation and Regional Collaboration in South Asia

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Abstract:

Inadequate power generation and supply are considered to be the main hindrance of economic development and prosperity in South Asia. Limited indigenous energy resource of each South Asian nation is not suitable to generate sufficient power. Moreover, the availability of limited indigenous energy resources differs among South Asian nations. The power demand and power generation capacity notably vary among the countries due to seasonal variability. This paper highlights the need for a collective effort to develop mechanism for the utilisation of limited resources and enhance the cross-border power trade among South Asian nations. Bilateral and multi-lateral cooperation will allow overcoming regional power shortage and augmenting collective energy security.

Keywords: Energy, Power, Energy Security, Hydro Resource, Cross Border Power Trade

1 Introduction

South Asian nations- Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka are the home for over one-quarter of world's population (~1.7 billion). Despite having strong cultural and linguistic bonds, the region is least connected and less traded bilaterally and multi-laterally [1-6]. The shortage of power generation, power transmission and distribution infrastructure are considered to be the main deterrent for economic prosperity of the region [7-12]. The region aspires to be fully developed nations by the middle of 21st century. Rapid industrialization and attainment of sustainable development are vital to achieve this goal.

Currently the entire South Asian region is energy deficient [10-13]. They need to have secured energy, power generation, distribution and supply. The total installed power generation capacity in South Asia is approximately 401,706 MW. The power demand is rising by around 10% each year. Additionally, hundreds of million inhabitants have no access to grid connected power. The current installed power generation capacity in each South Asian nation is shown in Figure 1. The energy mix for power generation varies significantly in the region. The power generation in Bhutan and Nepal is propelled by hydro energy while Maldives' power generation is almost entirely based on imported fossil fuel. Coal is the primary energy for power generation in India while the natural gas is predominantly for Bangladesh.

In South Asia, grid connected power consumers face 4-8 hours power outages (load shedding) in each day due to insufficient power generation, power transmission and distribution. These outages cause significant economic losses. Table 1 shows the current, forecasted and peak power demand in South Asian nations.

Pakistan and Bangladesh face acute power shortages due to heavy reliance on domestic gas which is depleting rapidly. Nepal experiences severe power shortage during winter season. At present, five out of eight South Asian nations undertake cross border power trading from their neighbours. India imports power from Bhutan but exports power to Nepal, Bangladesh and Myanmar (Burma). Afghanistan imports nearly three-quarter of its power from Uzbekistan, Turkmenistan, Iran and Tajikistan. Pakistan has planned to import power from Central Asia by 2019. A cross-border underwater interconnection between Sri Lanka and India is currently under construction. A brief summary of current bilateral power trade is furnished in next sub-section.

1.1 Afghanistan (net importer)

Afghanistan's fragmented generation, transmission, and distribution, and security situation make it most difficult to provide grid connected power to consumer. Grid

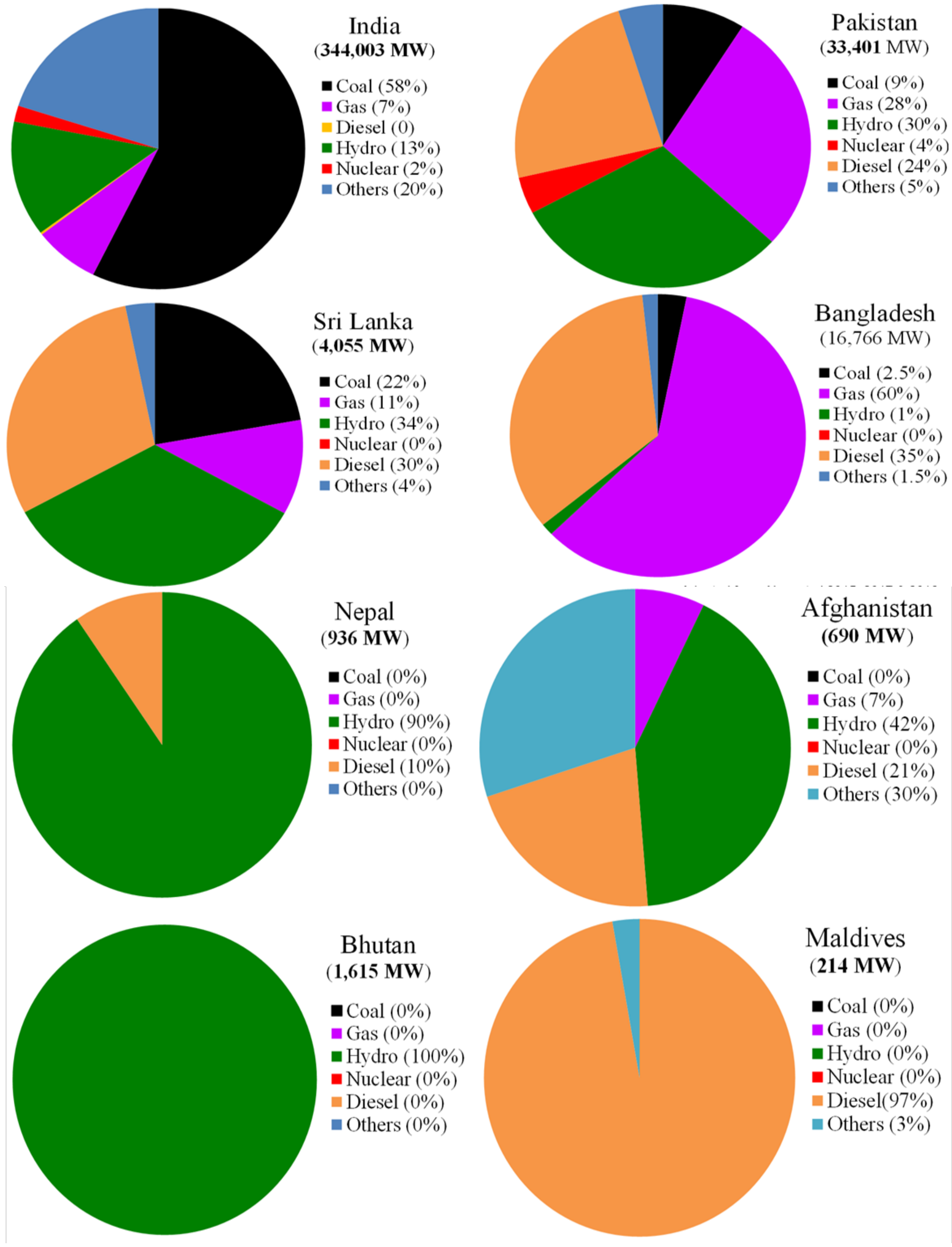


Figure 1: Present installed power generation capacity in South Asia, adapted from [1-9, 12-18]

Table 1: Installed & forecasted capacity in South Asia, adapted from [20]

Country	Installed Capacity (MW)	Forecasted Generation Capacity* (MW)	Current Grid Connected Peak Demand (MW)
Afghanistan	690	4790	5,000
Bangladesh	16,766	24,000	11,637
Bhutan	1,615	5,273	350
India	344,003	515,000	164,000
Nepal	936	4,000	1,200
Pakistan	33,401	40,700	25,700
Sri Lanka	4,055	19,370	2,523
Maldives	240	365	284

* All countries forecasted installed generation capacity in 2021 except Maldives which is in 2035

connected power supply largely consists of imports from neighbouring Turkmenistan, Uzbekistan, Tajikistan and Iran, supplemented by domestic hydropower plants. Most hydropower plants have minimal reservoirs and are unable to provide storage beyond few hours. Peak flow for hydro is normally in the summer months, in contrast to peak customer demand in winter months. Domestic thermal plants make a small contribution to the total supply but are fueled by imported diesel and are extremely costly to operate. According to the World Bank Report 2018, Afghanistan imports over 80% of its grid connected power. In 2016, it imported 1,284 GWh from Uzbekistan, 1,184 GWh from Turkmenistan, 827 GWh from Iran and 471 GWh from Tajikistan. Its domestic grid connected generation was only 1,007 GWh of which 96% was from hydro power plants [1-3, 8].

1.2 Bangladesh (net importer)

Current installed power generation capacity of Bangladesh is around 16,766 MW. Its peak demand for grid connected consumers is over 15% more than its highest generation (11,534 MW). Therefore, Bangladesh partially meets its power demand by importing 1,160 MW power from India through two connections shown in Table 2. The unutilised installed technical capacity is 5,229 MW due to either fuel shortage; lack of local technical expertise, maintenance and repair and in some cases transmission and distribution constraints. Nearly 40% of current generation is undertaken by imported liquid fuel that generates CO_2 similar to a coal fired power plant [7-12]. Bangladesh is currently negotiating with Nepal and Bhutan for joint investment in hydropower plants and import power from Bhutan and Nepal as well.

1.3 India (net exporter)

India is a net power exporter. It imports power from Bhutan but exports to Bangladesh, Nepal, and Myanmar (Burma). According to a report compiled by the Central Electricity Authority of India (2017), India has become a net exporter of power from a net importer. During 2016-17 (April to February 2017), India exported ~ 5,798 GWh to Nepal, Bangladesh and Myanmar while it imported 5,585 GWh from Bhutan. India exported 213 GWh more than it imported. India has been marginally exporting power to Nepal in radial mode at 33 kV and 132 kV from Bihar and Uttar Pradesh. India imports power from Nepal as well. It currently exports around 235 MW power through over 12 cross border interconnections at 11 kV, 33 kV, 132 kV and 400 kV levels. Around 145 MW alone is exported to Nepal with the commissioning of Muzaffarpur, Bihar, India – Dhalkhebar, Nepal 400 kV interconnection since 2016. Another, 145 MW export to Nepal is expected to begin through 132 kV Katiya, Bihar – Kusaha, Nepal and 132 kV Raxaul, Bihar– Parwanipur, Nepal interconnections.

India exports 1,160 MW power to Bangladesh through two high voltage interconnections (1,000 MW through Baharampur, West Bengal, India and Bheramara, Bangladesh; and 160 MW through Surjyamaninagar, Tripura, India and Comilla, Bangladesh).

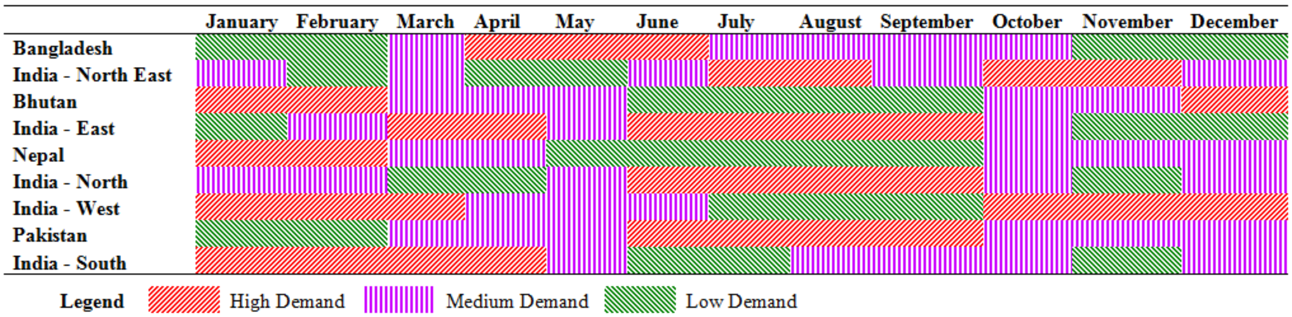
1.4 Nepal (net importer)

Nepal is a net power importer. It has been importing 380 MW power from India due to high local demands and local power generation constraint. It has planned to import over 500 MW power from India in 2018-2020. Nepal faces power outages (load-shedding) of up to 16 hours a day during the dry season, when the available capacity of Nepal's hydropower decreases to a third of installed capacity. Peak load outstripped domestic power generation capacity, causing serious power shortage, which was partly met with by the import from India. Nepal also exports small quantity power to India during summer period. It has an ambitious target of reaching 16,500 MW

Table 2: Existing & under-construction South Asia's cross-border interconnectors, adapted from [19]

Interconnectors	Description	Capacity (MW)	Estimated Cost (US$ million)
India-Bhutan (400 kV)	Hydropower Export to India	2100	140-160
India-Nepal (400 kV)	Power Exchange between India-Nepal	500	186
India-Bangladesh (HDVC)	Power Exchange between India-Bangladesh	500-1000	192-250
India-Pakistan (220/400 kV)	Power Exchange between India-Pakistan	250-500	50-150
India- Sri Lanka (HDVC)	Power Export to Sri Lanka (under construction under-sea cable)	500-1000	650

Table 3: Average monthly power demand variation in South Asia, adapted from [21]



of hydro power installed capacity by 2030, which includes the joint project with India at Pancheshwar and China. Once all planned hydro power plants will be operational Nepal will emerge a regional power exporter [10-11]. Nepal also needs huge investment to minimise the environmental and social impacts caused by hydro dams.

1.5 Pakistan (net importer)

Pakistan currently imports just over 100 MW power from Iran. It has planned to import 1,300 MW power from Central Asia mainly Kyrgyzstan and Tajikistan in 2019 through a 1,200 km long cross border transmission line via Afghanistan under the Casa-1,000 power project. The power will be imported from the beginning of May to the end of September to reduce power deficit in summer when the demand is high. As per current plan, Afghanistan will tap 300 MW from Pakistan's 1,300 MW power from Central Asia. Pakistan is keen to develop relationship with the energy-rich central Asian states to overcome its power shortages. Pakistan also planned to import power from India subject to improved bilateral relation [1-3, 22].

1.6 Bhutan (net exporter)

Bhutan generates currently around 1,615 MW out of its economically feasible 26,760 MW. The peak power demand in Bhutan is only 350 MW. Most of its surplus power is exported to India. However, the domestic power demand is increasing annually around 17% due to increasing economic activities and small-scale industrialization [1-3, 13-15]. As power export constitutes Bhutan's 80% export earnings, the Bhutanese government is pursuing more hydropower development to earn more foreign exchange. Till now most medium and small-scale power plants are mainly 'Run-of-the-River' type. However, the large-scale power plants under construction and future power plants will be predominantly dam based. Hence significant financial commitments and plans would be required to minimise the environmental impact.

1.7 Sri Lanka and Maldives

Sri Lanka and Maldives are island nations. At this point of time, both countries power needs are met by their installed power generation capacities. Power generation by fuel type is shown in Figure 1. Currently both Sri Lanka and Maldives do not export or import from other South Asian nations.

2 Discussion and Conclusion

All South Asian nations except Maldives and Bhutan face power shortages. The average installed power generation capacity is 0.50 kW per person in South Asia. The demand for the grid-connected power is growing at around 10% per annum, but the power supplies have not kept pace with the demand growth resulting in long outages and frequent unplanned interruptions. These uncertainties have imposed hardship on businesses that discourage business investment [1-3].

The installed power generation capacity varies from a low 0.03 kW/person in Nepal to a high 2.15 kW/person in Bhutan. Nepal faces load shedding over 16 hours a day during the dry season as its power generation capacity decreases to one-third of its installed capacity. Pakistan also experiences load shedding up to 8 to 10 hours a day during dry season. The shortage of power supply in India is over 5% [9,17]. Bangladesh also faces load shedding hampering its industrial growth and lowering its annual GDP.

There are seasonal variations in generation and consumptions of power in South Asian nations. The seasonal complementarity of South Asian power systems is shown in Table 3. It is evident from the table that the peak power demand varies significantly across India, Pakistan, Bangladesh, Nepal and Bhutan in different months of the year. For example, Bangladesh has installed surplus power from November to February (4 months) in contrast to Bhutan and Nepal where these two countries face high demand for power. Therefore, Bangladesh can export power to Nepal and Bhutan during these four months. Both Nepal and Bhutan possess higher power generation capacity from May to September when Bangladesh and northern and north eastern India face huge power demand due to summer season. Bhutan and Nepal are in a position provide surplus power to Bangladesh and India during this time. Pakistan has surplus power general capacity in January-February whereas western and southern India faces higher power demand. Pakistan can export power to India during these two months. Similarly, India can export power to Pakistan during its peak demand in June-September (4 months). This cross-border power trade will enhance collective energy security and economic prosperity.

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