Climate Compatible Growth

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Impact of Cost Decline of Renewable Technologies on Cross- Border Electricity Trade in the South Asia Region

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Summary

In order to assess the impact of power trade in the backdrop of falling Renewable Energy technology (RE) prices, we developed a power system model for each country in the South Asia BBIN sub-region (Bangladesh, Bhutan, India, and Nepal). High Trade and Low Trade scenarios are developed with unrestricted and restricted power trade possibilities respectively. Cost decline in RE increases Cross- Border Electricity Trade (CBET) from 13 TWh in 2019 to 976 TWh by 2050. The share of RE capacities in the total installed capacities for the region rises to 75% by 2050 under the High Scenario compared to 68% in the Low Scenario. Higher solar and wind mobilize more hydropower and reduce coal capacities and CO2 emissions. Thus, the electricity trade helps to reach higher utilization of power capacities and reduces costs and CO2 emissions.

Key Policy Recommendations

- Regional power trade among BBIN region can be a first vital step to achieving higher power sector growth and transformative opportunities in Nepal and Bhutan for economic growth from selling electricity.
- The recent cost decline in Renewable Energy Technologies and Storage can lead to a clean energy transition, giving further opportunities to reduce costs and increase the penetration of renewable energy. However, hydropower – especially from Nepal and Bhutan – could support such a RE expansion scenario.

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Background

Bangladesh, Bhutan, India, and Nepal, referred to as the BBIN region, have 21% of the world's population. The average per capita electricity consumption was approximately 900 kWh/capita in 2020, which is much lower than the global average of 3,300 kWh/capita [1]. Bhutan and Nepal's power systems are predominantly based on hydropower, whereas Bangladesh has almost 76% gas and India has 63% capacity based on fossil fuel [2–5]. The inter-regional trade is now growing at a greater pace than before. In 2019–20, India exported 1,839 GWh to Nepal, 6,168 GWh to Bangladesh, and 7 GWh to Myanmar, while importing 6,165 GWh from Bhutan [6]. However, the trade expansion is slow as the power systems and regulatory systems/mechanisms are not well developed and power markets are a new concept that is gradually getting acceptance. We address the following question:

What could be the potential of regional trade in the long-term, as well as the capacity mix and CO_2 savings from such trade (especially in the new context of falling costs of Renewable Energy Technologies and Storage which can compete with coal)?

To answer this, a multi-region power system model of each country, based on dynamic linear programming, has been developed in an inter-connected mode. This regional model contains technological details and options that balance demand and supply at an hourly level for each year (i.e., 288 sub-time periods each year) up to the year 2050 using Answer-Times software based on the TIMES[1] model. A number of scenarios, along with the possibility of unrestricted cross-border electricity trade (CBET), were developed. The model includes various existing generating station characteristics (vintage, techno-economic performance, etc.), transmission and distribution, electricity flows, demand, load characteristics, energy resources, and import/export links from various country reports and country experts through various stakeholders' consultations and meetings. For this paper, we present two scenarios: Low Trade and High Trade scenarios. Both the scenarios are based on some common assumptions and the major differentiating factors are as follows:

- **Low Trade (LT) Scenario:** Maximum import volume for each year is restricted to 20% of total domestic demand for each BBIN country. This is due to a number of reasons ranging from slow decision making, mistrust, inefficiency, and the time it takes for power market development. Each country has low renewable resource potential[2].

- **High Trade (HT) Scenario** has high renewable potential[3] and unrestricted CBET trade. The potential is high due to ongoing reassessment.
  **All Details available in IRADe-PR-72(2020); IRADe-SARI/EI-WP-2016-01; IRADe-SARI-08 (2017); IRADe-SARI-01 (2017)*

Outcomes

The total power trade (the total of either exports or imports) in the BBIN region in 2019 was 13 TWh, and it increases to 976 TWh in 2050 in the HT Scenario. Whereas, in the LT Scenario the trade is limited to 416 TWh in 2050. Nepal and Bhutan remain net exporters of electricity in both scenarios to the same degree and Bangladesh remains a net importer of electricity

[1] TIMES stands for The Integrated MARKAL-EFOM System. For more details on TIMES please refer to https://iea-etsap.org.
[2] Low Potential: Total Solar PV in BBIN region – 766.8 GW; Total wind-onshore in BBIN region – 303.8 GW.
[3] High Potential: Total Solar PV in BBIN – 1,343.3 GW; Total Wind-onshore – 732.8 GW.

in both scenarios. India remains a net importer in the LT Scenario; however, it turns out to be a net exporter in the HT Scenario, as it exports a significantly higher volume of electricity to Bangladesh. Trade in both scenarios not only increases the accessibility and affordability of electricity but also leads to a higher share of renewables in the energy mix of these countries. This is due to access to a bigger market for their domestically generated electricity, particularly from Nepal and Bhutan, where these natural resources are available in abundance.

The share of RE capacity in the total BBIN installed capacity increases to 68% in 2050 under LT Scenario and up to 75% in the HT Scenario. Wind and solar energy are not available uniformly and equally throughout the year; this increases the off-peak demand dependence on hydropower which is more carbon efficient. By 2050, the share of fossil-based installed capacity falls to 13% under HT Scenario (no trade restrictions) and remains close to 18% under the LT scenario. The share of coal-based installed capacity can reduce from 52% in 2019 to 18% in 2050 under the LT Scenario and to 12% under the HT Scenario. The absence of trade restrictions makes imported electricity a cheaper option over the domestic installation of coal to meet domestic electricity needs.

Due to a fall in fossil-based installed capacity and an increase in cross-border trade which is mainly renewable-based, CO2 emissions for the BBIN region decrease. At the country level, since their energy systems are largely based on renewables, the carbon emissions of Nepal and Bhutan are already low. But for Bangladesh and India, carbon emissions are significant. CBET also improves the carbon intensity of the power system of BBIN region. The CO2 emissions per kWh fall from 0.64 kg/kWh in 2020 to 0.26 kg/kWh in LT scenario and 0.19 kg/kWh in HT scenario by 2050. In HT scenario BBIN region saves approximately 405 MT of annual CO2 from power sector. This change is primarily contributed by Bangladesh because the country no longer has to establish coal or other fossil-based power plants domestically to meet its electricity demand. Expanded power cooperation can restrain carbon emissions in the long run in the region (see **Table 1** for detailed results).

	2050			
	LT SCENARIO		HT SCENARIO	
Total Trade* in BBIN (TWh)	416		976	
Installed capacity and Generation	Installed Capacity (GW)	Generation (TWh)	Installed Capacity (GW)	Generation (TWh)
Non-Fossil				
Solar	766	1,325	842	1,458
Wind	521	1,387	773	1,735
Total Renewable in GW	1,325	2,834	1,653	3,305
Nuclear	62	434	62	433
Hydro	214	833	214	833
Fossil				
Coal	344	1,783	271	1,304
Gas	5	9	6	5
Diesel	0	0	0	0
Total	1,949	5,882	2,206	5,916
RE share	68%	48%	75%	56%
Non-Fossil	82%	70%	87%	77%
Fossil share	18%	30%	13%	23%
CO2/kWh Emissions in BBIN region in kg	0.26		0.19	

Table 1: Key Outputs for BBIN Region

**Total Trade = total of either all exports or imports in the region*

Conclusion

Currently, the power trade in the BBIN region is expanding but it is based on a combination of fossil fuels in India and Bangladesh and hydropower from Nepal and Bhutan. As prices of solar and wind power fall and their potential increases – and if they are facilitated by free power trade policy total cross-border power trade can be reached 976 TWh by 2050 in the BBIN region. It will lead to the overall growth of the power sector, as well as clean energy transition in the region at lower costs and with a higher share of renewables (approximately 75%) in the capacity mix. However, this would require more investment in inter-country transmission lines, strengthening further Renewable Energy technology and hydropower development, and developing regional power markets.

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