

# Electricity Trade in the BBIN Region: Economic benefits and Technological Implications

## Policy Brief

### Current Situation

Countries in the South Asia region, some of the poorest in the world, have low levels of per capita electricity consumption. In 2012, it was 119 kWh in Nepal (WDI, 2015), when only 76.3 per cent of its population had access to electricity. In India, per capita electricity consumption in 2013–14 was 957 kWh with about 21.3 per cent of its population without access to electricity in 2012. Bangladesh, with per capita electricity consumption of 251 kWh in 2014-15, was amongst the countries with the lowest consumption level. The region is characterised by lack of electricity access, blackouts and brown outs. Availability of reliable and adequate electricity is vital for economic growth.

### Why Should We Have Cross Border Electricity Trade (CBET)?

Much of the combined hydro potential of 350 GW in the region remains unexploited. It offers a huge scope for tapping clean energy and addressing the chronic problems of electricity supply shortage. Nepal has exploited around one gigawatt (GW) of its economically viable potential of around 45 GW. Development of this potential can only grow as demand for electricity grows.

Electricity trade with India will give Nepal the market needed for development of its hydro potential. The earnings from power export can provide it the resources for economic and human development, like that happened in the case of Development of hydro potential in Bhutan and electricity trade with

India benefited Bhutan significantly in its socio-economic development. Currently, Bhutan's per capita income is 3 times as high as India. Bangladesh on the other hand is running out of gas, which was its mainstay for power generation. It is looking for shifting to coal based generation and also diversifying its sources of power supply including imports. It can also be the market for Nepal's power.

Given the complementarities among these countries, pooling the resources can help more efficient and intensive use of electricity for economic growth. In addition, development of hydropower will help countries to balance larger shares of renewable power from solar and wind and reduce their CO<sub>2</sub> emissions. Cross border electricity trade (CBET) can be enhanced if the benefits are more widely appreciated. Thus, the primary objective of the study is to estimate the economic potential for trade and the benefits to the economies of the countries to engage larger groups of stakeholders for consensus building.

### The Approach to Assessing Benefits of CBET

The study analyses electricity trade among Bangladesh, Bhutan, India and Nepal (BBIN) region and is carried out in three parts. The first part considers bilateral trade between Nepal and India. The second part analyses bilateral electricity trade between Bangladesh and India and the third part of the study examines the benefits of multilateral trade involving India, Bangladesh, Nepal and Bhutan and its benefits over and above the benefits of bilateral trade.

The Study deploys two types of models for each country, a power system model and a macro-economic model with iterative linkage between them. The macro-economic model for India, Bangladesh and Nepal is a multi-period, inter-temporal dynamic linear programming Activity Analysis model based on the latest available Social Accounting Matrix (SAM). The model solution maximizes the present discounted value of private consumption provides growth of GDP, outputs of various sectors, levels of electricity consumption as well as the generation from different types of power plants over time. All these meet the various consistency requirements, namely demand equals supply for each sector, investment equals savings and cost of imports equals export earnings plus foreign exchange inflows.

The power systems of the countries are modelled using TIMES (The Integrated MARKAL-EFOM System model) software, which permits different types of generation technologies and their availabilities over different time periods of the year, balances demand to supply for each time period, which in our case is every hour. It is a dynamic linear programming model that minimizes the cost of meeting exogenously prescribed demand. For modelling electricity trade, the power system models of each country are run simultaneously in an integrated mode and trade takes place every hour when the opportunity cost of generating power is higher than the cost of import and for the exporting country the opportunity cost of generation is lower than the price at which it is exported. By iterating between the two models, we obtain a technologically feasible and economically viable solution.

To analyse the impacts of multilateral trade, the power systems for all the four countries are connected and exchange of power among them on an hourly basis is determined simultaneously. This trade must be through India, and we assume that India will facilitate this<sup>1</sup>. The power system modelling framework for Bangladesh, India and Nepal is the same as one used for the bilateral trade studies. For Bhutan, since many of the needed power sector details were not available, levels of electricity exports for different years are specified using National Electricity Plan of India prepared by Central

<sup>1</sup> India has recently agreed to let Nepal export electricity directly to Bangladesh

Electricity Authority, India which factors in Bhutan's power development. As in bilateral studies, trade takes place only where opportunity costs in the trading countries are conducive to trade.

## Findings and Policy Recommendation

Power trade benefits all the countries of the region. Specific benefits for each country are given in the sections below.

### Nepal

- To develop its hydropower potential, Nepal needs a market. Opportunity to trade electricity provides markets for Nepal's hydropower. It will spur the development of its hydropower potential at a faster pace than the rate at which it will develop without the trade opportunities.
- By 2045, Nepal can exploit 34.4 GW of its hydropower capacity due to bilateral trade with India and 37 GW of hydropower capacity due to multilateral trade in the BBIN region out of its total hydro potential of 43 GW compared to only 9 GW when it generates only for the domestic market.
- Hydropower trade can help Nepal to significantly expand its economy, boost manufacturing, increase its GDP and per capita household consumption by channelizing the foreign revenues earned from exports of electricity into the economy. This is possible as with long-term power purchase agreements with India or Bangladesh, Nepal can get foreign investments or loans at concessional rates that it can service through earned export revenue and still have a surplus to invest in other sectors.
- Trade will also permit Nepal to import electricity occasionally to meet its demand. At present, Nepal is short of electricity and power cuts hamper its industry and economic growth. Thus, imports in the next few years while it develops its own capacity can spur economic development.
- By 2045, the trade will improve GDP by nearly 40 per cent in comparison to business as usual. It will improve per capita household consumption by 23 per cent. In addition, the share of industry

in GDP will increase to 30% due to trade as compared to 21% without trade. In absolute terms, with 40 per cent higher GDP, industrial GDP will be twice as large as without trade.

- Without power trade, if Nepal develops its power sector for its own domestic demand, it will need more generation capacity in storage plants to meet the seasonal variability in generation and demand. However, with trade much of the capacity can be in the form of ROR plants, which are cheaper and easier to construct and have less environmental consequences compared to storage plants.
- If the construction of hydro power plants is delayed by even five years, the benefits are significantly lower.

With multilateral trade, Nepal can export electricity to not only India but also to Bangladesh. Therefore, it can exploit more of its hydropower and its gains will be larger. Thus, Nepal should push for electricity trade with India and for multilateral trade among the BBIN countries and should not delay in developing its hydro power potential.

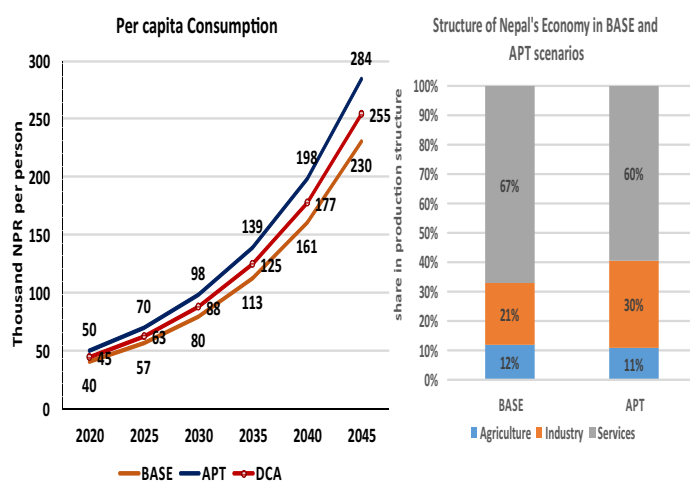


Figure 1: Benefits of Electricity Trade to Economy of Nepal<sup>2</sup>

## Bangladesh

- Bangladesh has a power sector master plan (PSMP) which suggests diversification of generation by different fuels and restricts imports of electricity to 15 per cent of total supply. Since Bangladesh is short of fuels and is running out of gas, this will involve import of gas and coal. If the 15 per cent import cap is relaxed to 30 per cent, and if choice of what type

of plant to build is determined on economic considerations, the total power sector import bill (capital, fuel and electricity) will be lower than what it will be in the PSMP strategy.

- Thus, the trade-off is between electricity import from India and diversification of supply. Thus, the question for Bangladesh is how much reliance on foreign exchange is worth the diversification of energy supply sources. Import from or through India is an economic option for Bangladesh as it is cheaper than all the other options, including generation from coal. If there is multilateral trade among BBIN countries, then Bangladesh can diversify its import of electricity from India, Nepal and Bhutan. Thus, a part of its diversification goal can be met.
- Import of electricity by 15 per cent or 30 per cent requires less domestic power generation capacity and hence less investment not only in power generation capacity but also in fuel infrastructure development in comparison to import at the current level. The savings in investment and foreign exchange can be diverted to the non-energy sectors (agriculture, manufacturing) or for consumption leading to higher growth. With 30 per cent import of electricity, aggregate consumption of households increases leading to welfare gain.
- While the PSMP scenario limits the import (inter-connection) capacity to 5 GW in 2030 and 9 GW in 2040 and beyond, the 30% import scenario offers a potential import capacity of 7 GW in 2030, 18 GW in 2040, and 25 GW in 2045. Since in both bilateral and multilateral trade scenarios import by Bangladesh is restricted to 30 per cent, there is no change in the level of imports only the sources of imports change.

- The 30 per cent import scenario significantly reduces the cost of power supply as well as the fuel import bill. It reduces fuel imports for power generation, particularly that of gas, which has a more volatile market. Thus, adopting the enhanced electricity import option enhances energy security and significantly reduces CO<sub>2</sub> emissions to Bangladesh.
- The PSMP scenario provides a higher GDP with lower welfare (household consumption) at the

<sup>2</sup> APT denotes free and optimal trade scenario (accelerated power trade scenario), DCA denotes a scenario of delay of 5 years in building power plants for electricity trade and BASE is the reference scenario

cost of higher economy wide total investments. The 30 per cent import scenario provides a lower GDP with higher welfare (consumption). The savings in investment and foreign exchange can be diverted to other sectors of economy to promote growth or increase consumption. Since our model maximizes consumption, it increases consumption.

Larger electricity import is a cost effective strategy to meet Bangladesh’s power requirements than a strategy to import fuel to produce electricity domestically and it also provides higher energy security in some sense. With multilateral trade, it will be able to diversify its imports from Nepal, India and Bhutan. Bangladesh should have a strategy to increase electricity imports.

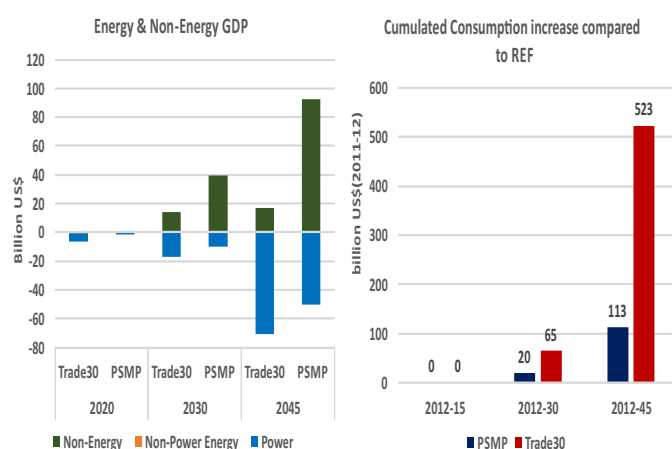


Figure 2: Benefits of Electricity Trade to the Economy of Bangladesh<sup>3</sup> compared to REF

## India

- Benefits to India although not highly visible because of the size of the India’s power system and its economy, are comparable in absolute terms to benefits to Nepal and Bangladesh. Hydropower from Nepal helps in balancing the integration of renewable power into the grid in India and meeting the evening peak in India at a cheaper rate when its large solar PV capacity would not be available.
- Bilateral trade with Nepal also helps India save financial resources by reducing its future capacity

development needs, which can be used to develop other sectors or to increase household consumption. It also reduces fossil fuel consumption in India and hence reduces CO 2 emissions in the region.

- Exports demand from Bangladesh in bilateral trade scenario can be easily met by India without any increase in capacity up to 2025 and with small 1 per cent to 1.5 per cent additional coal-based capacity by 2030 and 2045. Bilateral trade with Bangladesh increases coal consumption and emissions in India. However, with multilateral trade, the use of coal and gas in India’s power generation reduces, which reduces the cumulated CO 2 emissions in the region.
- In multilateral trade, India’s net imports of electricity increases indicating that India has nothing to lose compared to bilateral trade. Multilateral trade also provides options to Nepal and Bhutan to sell electricity to Bangladesh, which reduces their market risk. Multilateral trade meets electricity demand in the BBIN region in the most cost-effective way.

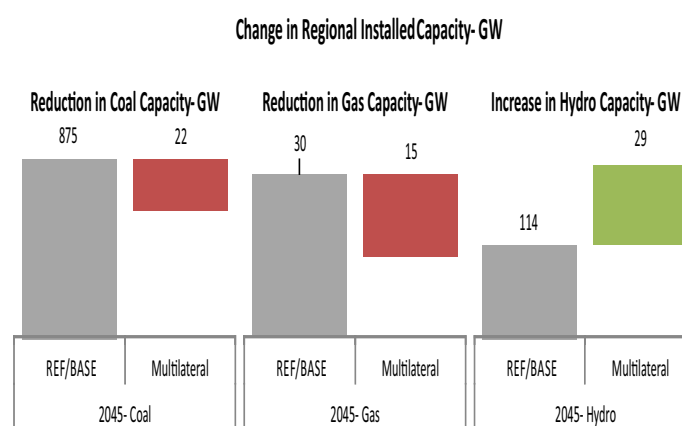


Figure 3: Change in Regional Installed Capacity-GW

**To summarise, multilateral trade helps reduce investments in the power sector, increases efficient use of fossil fuel and natural resources and reduces environmental damage. India should facilitate and promote multilateral electricity trade in the BBIN region.**

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<sup>3</sup>PSMP assumes the power sector master plan of Bangladesh, TRADE-30 denotes 30% bound for electricity import and domestic generation by the cheapest technology and REF denotes the reference scenario