A power substation in Hazaribugh, Dhaka

BANGLADESH–INDIA ELECTRICAL GRID INTERCONNECTION PROJECT

South Asia's First Interconnection of Two National Grids

- The People's Republic of Bangladesh is grappling with energy deficiencies in the face of rapidly increasing demand for energy. Securing its energy supply demands action to strengthen power generation capacity, upgrade the transmission and distribution network, and diversify energy sources.
- The Asian Development Bank helped Bangladesh secure energy supply through the Bangladesh–India Electrical Grid Interconnection Project, an initiative that enabled Bangladesh to import 500 megawatts of electricity from India.
- To connect the transmission networks of both countries, the project installed more than 100 kilometers of 400-kilovolt double circuit transmission line between electricity substations in Baharampur, India and Bheramara, Bangladesh.
- Successfully completed during the third quarter of 2013, the project provides Bangladesh with more affordable electricity while reducing its energy deficiency.

CONTEXT

Bangladesh has a rapidly growing market-based economy and is among the Next Eleven countries.[1] However, insufficient domestic power supply threatens sustained growth. In 2009–2010, major cities such as Dhaka frequently endured 12-hour power disruptions. Therefore, Bangladesh urgently needs to find ways to bridge its energy gap. As a stopgap measure, the Government of Bangladesh tapped rental power plants with a rated capacity totaling 50–100 megawatts (MW) or less. However, the plants were unfeasible as a long-term strategy because they provided minimal electricity at significantly greater expense than other energy sources

In 2009, the dependable power-generating capacity in Bangladesh was only 3,800 MW of electricity against a peak demand that totaled about 5,500 MW, implying a peak deficit of 1,700 MW.[2] With help from the private sector, the government plans to provide more power from a mix of sources (e.g., imported coal, liquefied natural gas, and renewable energy including solar photovoltaic systems). A nuclear power plant scheduled to open in 2018 will help meet long-term energy needs. To complement its infrastructure plans, the country is also planning to implement a fuel price reform to correct electricity tariff rates that are significantly lower than supply costs. This strategy aims to promote energy conservation and efficiency initiatives that could reduce demand.

However, implementation of such initiatives will require a significant amount of time; even upon completion, they may not satisfy projected demand for energy, forcing Bangladesh to find energy sources outside its own territory. Studies by the Asian Development Bank (ADB) for the South Asian Association for Regional Cooperation (SAARC)[3] and by the United States Agency for International Development (USAID)[4] for its South Asia Regional Initiative in Energy showed that a regional approach would provide more comprehensive, cost-effective, and sustainable solutions to Bangladesh's energy security problem. In 1997, ADB initiated a discussion about interconnecting the power systems of Bangladesh and India. India, Bangladesh's neighboring country, had a 156,780 MW installed energy capacity in January 2010; already planned power plants will add another 80,000 MW by 2017. In 2014, India

PROJECT SNAPSHOT

LOAN APPROVAL DATE:
August 2010, with additional financing approved in September 2013

LOAN AMOUNT:
$100 million with an additional $12 million

BORROWER:
Government of Bangladesh

EXECUTING AGENCY:
Power Grid Company of Bangladesh

GEOGRAPHICAL LOCATION:
Bheramara, Bangladesh to Baharampur, India

TYPE OF ENERGY PROJECT:
Grid interconnection

PROJECT COMPLETION DATE:
October 2013

1 Goldman Sachs Investment identified the Next Eleven as countries having the highest potential to become part of the largest economies in the 21st century.

2 Asian Development Bank (ADB). 2010. *Proposed Loan to People's Republic of Bangladesh for the Bangladesh–India Electrical Grid Interconnection Project.* August. Manila. http://www.adb.org/sites/default/files/project-document/63167/44192-01-ban-rrp.pdf

3 Established on 8 December 1985, SAARC was the first regional cooperation initiative in South Asia. Member countries include Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka.

4 USAID is the leading US agency for ending extreme global poverty and enabling resilient democratic societies to realize their potential.

announced that it will generate 100,000 MW of solar power and 60,000 MW of wind power by 2022. Projections suggest that India's energy demand will increase 3% per year, from 692 million tons of oil equivalent (Mtoe) in 2010 to 1,442 Mtoe in 2035.

SOLUTIONS

Improving bilateral relations. The Bangladesh–India Electrical Grid Interconnection Project prioritized strengthening relations between Bangladesh and India to lay the groundwork for cross-border cooperation. Following an unsuccessful attempt to interconnect the grids in 1997, ADB consistently supported initiatives and created opportunities to bring Bangladesh, India, and other South Asian countries together. In 2001, ADB advocated the South Asia Subregional Economic Cooperation (SASEC)[5] program and actively supported SAARC's South Asia Regional Energy Cooperation program. In 2004, a memorandum of understanding enabled ADB to support SAARC's regional cooperation activities, based on mutually agreed priorities such as energy, transport, trade, and investment. Conducted under various bilateral and multilateral initiatives for more than a decade, many of these steps helped create awareness and emphasized the need for regional cooperation in the power sector of South Asian countries. Three important studies identified the possibility of interventions related to regional energy cooperation including cross-border power transmission interconnections, and quantified the technical and economic benefits.[6] This process helped build consensus on the need for a regional electricity network and the development of electricity markets for optimal investments and utilization of the region's vast and varied energy resources.

In January 2010, a joint communication by the prime ministers of Bangladesh and India declared important breakthroughs in cooperation between the two countries, including India's provision of electricity to Bangladesh through a cross-border grid interconnection. This interconnection was facilitated with the assistance of ADB.

Choosing an optimal location and mode of interconnection. To ensure efficient and effective delivery, the project first had to determine the location and mode of interconnection. Therefore, the Power Grid Company of Bangladesh (PGCB)[7] and the Power Grid Corporation of India (PGCIL)[8] formed a technical team to study and provide recommendations.

The team considered two options: (i) connecting northeastern India with eastern Bangladesh, or (ii) connecting eastern India with western Bangladesh. Ultimately, it favored the second option because it was better able facilitate power exportation to Bangladesh from different generating stations in India and also distribute power to Bangladesh's load centers. Hence, the interconnection would start in Baharampur, West Bengal, India and end in Bheramara, Bangladesh, requiring a 125-kilometer transmission line.

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5 With financial assistance from ADB, the SASEC program was launched in 2001 to support regional cooperation activities between Bangladesh, Bhutan, India, and Nepal. SASEC expanded its energy sector activities to include Sri Lanka in 2010. In 2014, SASEC expanded all of its activities to include both the Maldives and Sri Lanka.

6 ADB. 2012. *Energy Trade in South Asia: Opportunities and Challenges.* Manila; ADB. 2013. *South Asia Regional Power Exchange Study.* Manila; ADB. 2013. *Technical Assistance for South Asia Subregional Economic Cooperation Cross-Border Power Trade Development.* Manila.

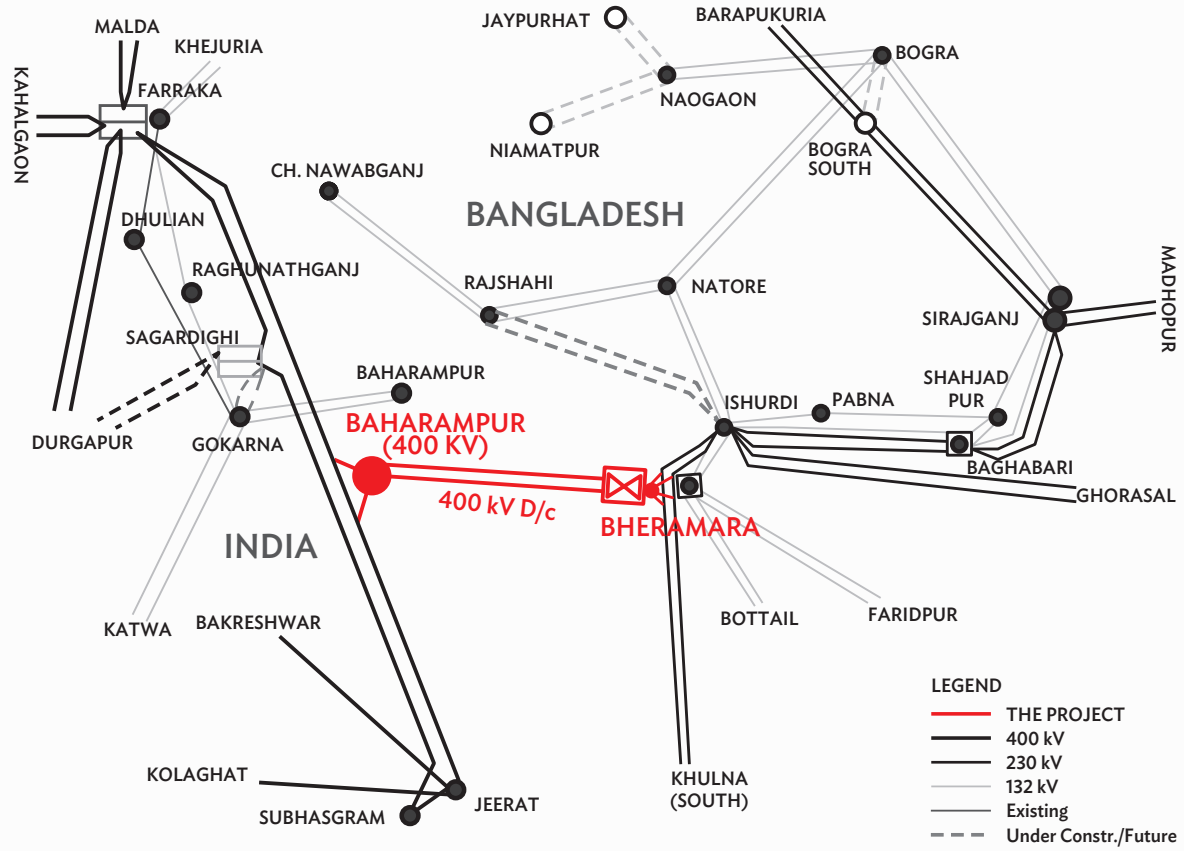
7 PGCB is responsible for operation, maintenance, and development of the transmission system's distribution capacity.

8 PGCIL, which functions under the Ministry of Power, is India's central transmission utility.

To determine the mode of interconnection, the technical team studied the grid characteristics of both countries. Using synchronous interconnection, both grids would operate at the same nominal frequency and voltage, and faults in one grid would affect the other. In contrast, an asynchronous interconnection would facilitate complete control of the power exchange between both grids in either direction, allowing independent operation. Asynchronous interconnection would also negate the need for additional equipment to protect one system against damaging faults and surges from the other system. Therefore, the team selected an asynchronous high-voltage direct current (HVDC) link.

Next, the team had to choose between two general types of asynchronous interconnection: (i) HVDC transmission between two converter stations connected at either end to an alternating current system (HVDC bipole), or (ii) an HVDC back-to-back interconnection to alternating current systems on either side, without intervening transmission. Based on technical, operational, and economic considerations, the team agreed to adopt the back-to-back interconnection. India built a 400-kilovolt (kV) switching station in Baharampur to tap one end of a 400 kV direct current (DC) transmission line. The other end of the line was connected to a 400 kV transmission line at the India–Bangladesh border and ends at the 500 MW HVDC back-to-back substation and 230 kV switching station in Bheramara, Bangladesh (Figure 3.1.1).

Figure 3.1.1: **Bangladesh–India Electric Interconnection Single Line Diagram**

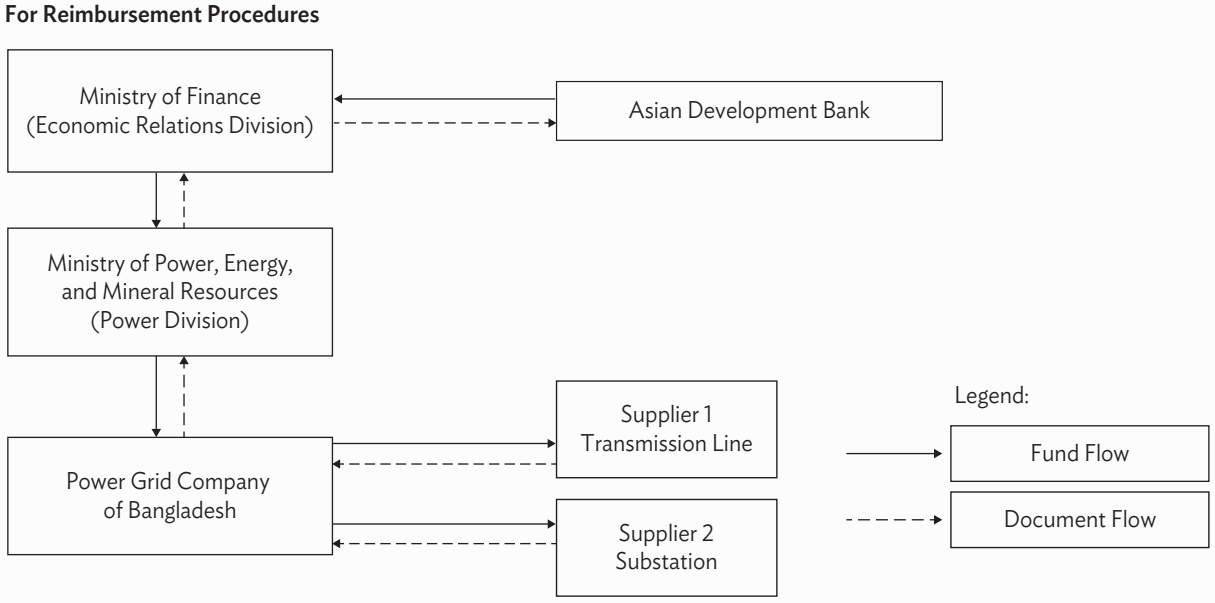


kV = kilovolt.

Source: Asian Development Bank. 2013. An Overview of Energy Cooperation in South Asia. *South Asia Working Paper Series* No. 19. Manila.

Project design and technical implementation. Major physical components of the project include the DC transmission line in Bangladesh, the back-to-back HVDC substation, and a DC interconnection at Bheramara which links with the transmission network in Bangladesh. The project management unit headed by Project Director Kazi Hassan had to address unanticipated challenges (e.g., a large number of *hartals* or labor strikes) and complete the interconnection. Another important project component is the capacity building provided to the PGCB, the executing agency for the project. Under the contract, PGCB officers learned to manage post-installation operation of the HVDC system. Because this project is the first HVDC system in Bangladesh and the first such HVDC interconnection in South Asia, resulting in the first procurement of power from India to Bangladesh, the staff of the Bangladesh Power Development Board (BPDB), Power Division, and other agencies also received training in electricity trading. PGCIL provided technical support for design, monitored implementation, and aligned objectives. Figures 3.1.2 and 3.1.3 illustrate the project fund flow and organization structure.

Figure 3.1.2: Bangladesh–India Electrical Grid Interconnection Project Fund Flow

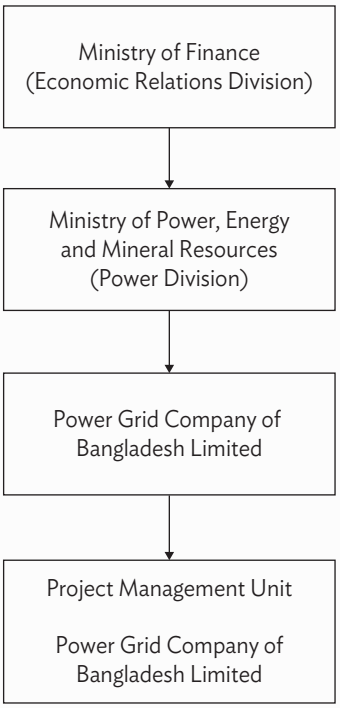


Source: Asian Development Bank. 2013. *Project Administration Manual: SASEC Bangladesh–India Electrical Grid Interconnection Project in the People's Republic of Bangladesh.* August. Manila.

Finalizing power purchase agreements. On 27 July 2010, a Bulk Power Transmission Agreement between PGCIL and BPDB formalized the interconnection of power grids, but the countries also needed to finalize two power purchase agreements (PPAs). Initially, representatives could not agree on terms (e.g., tariff, source, period or duration, etc.) that stipulated 250 MW for each PPA. After lengthy negotiations, both countries agreed on the terms of the first PPA. In March 2012, India's National Thermal Power Corporation (NTPC), through its wholly owned subsidiary, NTPC Vidyut Vyapar Nigam, and BPDB signed a government-to-government PPA for the sale of 250 MW of power from India to Bangladesh for 25 years from the unallocated share of central sector power projects across India. The tariff for this power will be based on regulated tariffs in India, including applicable

transmission and wheeling charges. According to a second PPA, PTC will deliver 250 MW to Bangladesh from December 2013 onward, with tariffs based on a competitive bid. Both tariffs are significantly lower than the marginal cost of power.

Figure 3.1.3: Bangladesh-India Grid Interconnection Project Organization Structure



Source: Asian Development Bank. 2013. *Project Administration Manual: SASEC Bangladesh–India Electrical Grid Interconnection Project in the People's Republic of Bangladesh.* August. Manila.

RESULTS

After completion of the interconnection infrastructure on 5 October 2013, 500 MW of power began flowing from India to Bangladesh. This first-ever interconnection of two national grids in South Asia also includes the region's first cross-border HVDC transmission line. Although the initial power transfer did not entirely solve Bangladesh's energy deficiency problem, it reduced the deficiency by 500 MW. In addition, electricity from the interconnection costs less than that bought from the rental plants.

More importantly, the electrical link laid the groundwork for a regional energy market. Ajay Guha, a former lead energy specialist for ADB, views the Bangladesh–India interconnection as an important step toward achieving a functioning regional electricity network in South Asia that would showcase better utilization of the region's diverse but unevenly distributed energy resources. This project is a key step forward in regional power sharing and cooperation. Using lessons learned from this first project, Bangladesh is now working to attain additional power from India to further reduce its energy deficiency through more complex power transfer arrangements between the two countries.

LESSONS

Potential for economic cooperation. Cooperation between Bangladesh and India overcame barriers to reach a purchase power agreement. India gained revenue by selling its available energy to Bangladesh, and Bangladesh reduced its energy deficiency, thereby supporting economic growth. This mutually beneficial project enabled both countries to maximize other opportunities for dialogue and economic cooperation. This case shows that the energy market can generate quick wins for regional economic cooperation and pave the way for more cooperation in other sectors.

Interagency cooperation. PGCB and PGCIL worked together to determine connection points, possible routes for the proposed transmission line, location of the intermediary substation, and a suitable mode for interconnection. The joint working group and joint steering committee closely monitored project design and implementation, contributing significantly to timely completion of the project.

ADB PHOTO LIBRARY

A high-tension tower along the Bangladesh–India Grid Interconnection

ADB. 2010. *Bangladesh–India Grid Interconnection Project.* May. Manila.

Regional cooperation needs strong champions. Each nation has its own utility technical standards to facilitate interconnection within the country. Since countries were previously dependent on energy generated internally, there was no need to develop a regional utility standard. As economies expanded worldwide, the demand for energy increased and created generating capacity problems. Previously, countries solved power deficiencies with thermal power plants that used expensive imported fuels such as oil, coal, and gas. However, with the diverse natural energy resources within a particular region and an already-established cross-border interconnection, more countries realized that cross-border interconnection of power grids could optimize energy usage for both suppliers and users.

In this project, choosing the mode of cross-border grid interconnection was a significant challenge. In addition to ensuring that disturbances in one system would not affect the other system, asynchronous interconnection allowed adequate operational flexibility for connecting the power systems of different countries.

Keywords

Power grid interconnection, electrical grid, electrical grid interconnection, cross-border grid interconnection, regional cooperation, energy market, asynchronous interconnection, Bangladesh, India

For further reading

- http://www.adb.org/projects/documents/bangladesh-india-electrical-grid-interconnection-project-bangladesh-rrp
- http://www.adb.org/news/india-electricity-flows-bangladesh-first-south-asian-hvdc-cross-border-link

For further information

- Len George, energy specialist, South Asia Department (lgeorge@adb.org)
- Priyantha Wijayatunga, principal energy specialist, South Asia Department (pwijayatunga@adb.org)
- Aiming Zhou, senior energy specialist, Sector Advisory Service Division, Sustainable Development and Climate Change Department (azhou@adb.org)
- Dongxiang Li, advisor, Economic Research and Regional Cooperation Department (dongxiangli@adb.org)