Case Story on
Cross-border Power Export from Dagachhu Hydropower Development

Green Power Development Project
Asian Development Bank

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Executive Summary

1. Issues Addressed

1. Bhutan is the only South Asian country with a surplus of power for export. Almost 100% of power generated in the country is hydropower—the most productive natural resource in Bhutan. The rivers and streams from the Himalayan Mountains provide an abundant source of clean and renewable hydropower with a total installed capacity of about 1,500 megawatts (MW). Because generation is significantly greater than around 300 MW of domestic peak demand, Bhutan is a net power exporter. Of total power generated, 80% is exported to India after meeting domestic consumption. Power exports account for the largest source of the Bhutanese Government (the Government) revenue in the form of taxes and dividends from hydropower companies. It accounts for more than 40% of national revenue and 25% of gross domestic product (GDP). Hydropower infrastructure development contributes another 25% of GDP through the construction sector. The revenue from power exports are also the primary source for the government's socioeconomic development such as health, education, and agriculture.[1] The hydropower development thus forms the backbone of Bhutan's economy and social lives.

2. Despite the net power surplus for export, most rural residents do not have access to electricity due to high costs of investment, operation, and maintenance of rural electrification in the mountainous terrain. Only 40% of rural households use electricity as their main source of lighting and the rest heavily relies on use of kerosene and firewood,[2] which are indoor polluting fuels. To achieve the overarching goal of poverty reduction, the Government aims for 100% rural electrification by 2013.[3] Experiences with rural electrification indicate that overall electricity consumption will increase as rural households acquire new appliances and increase reliance on electricity use, and rural economies develop. In Bhutan, domestic demand for electricity has

[1] For instance, revenues from power exports contributed to all the expenditures for the agriculture and social sectors (e.g., health and education) in 2007. During the ongoing five-year plan (2008-2013), the Government considers that revenues from hydropower development will be the major sources to directly improve social quality of life and reduce poverty.

[2] Consumption of fuelwood in Bhutan is estimated at about 1,200 kg per capita per year, which is the highest consumption in the world (and twice as high as Nepal).

[3] Electricity for all is highly likely to be achieved by 2015 at the latest since all the investment programs have already been committed by donors including ADB.

already been growing by 17% per year with a high pace. This demand growth is expected to escalate in the long run due to rapid expansion of rural electrification and industrialization and is likely to reduce the quantum of electricity exported and resultant export revenue. Therefore, continuous generation addition will be critical for Bhutan to meet the increasing domestic demand while sustaining the export revenue required for the country inclusive growth. In Bhutan, revenue from hydropower export will help provide cross-subsidies to lifeline tariffs to sustain costlier rural electrification operations and access to electricity sourced from hydropower will have significant positive environmental impacts by reducing fossil fuel use and deforestation due to firewood harvesting. Hydropower development will thus enhance energy, social and environmental security of the country, particularly rural areas where more than 90% of poor people live.

3. The most critical challenge facing hydropower development in Bhutan is the lack of available domestic financial resources to high up-front investment and large funding arrangement. The Government's investment is heavily dependent on international aid. Increasing debt burden from external sources would raise the issue of debt sustainability and fiscal capacity constraint, which may adversely limit access to financial resources for the country. The capital needs of high investment for hydropower projects vastly exceed the availability of resources from traditional multilateral and bilateral agencies, and domestic financial resources. Such development finance has become even tighter given the declining worldwide trend in availability of concessionary financing, and the recognition that scarce public resources are needed to develop social sectors. In this context, the strategic use of foreign public and private participation and their investment will be crucial to accelerate the development of hydropower resources in Bhutan. The country has substantial clean and renewable hydropower capacity with theoretical potential hydropower of 26,760 MW—only about 6% is being used. Export of clean power surplus from Bhutan will lower greenhouse gas emissions in the coal-dominated Indian power market, making positive global warming impacts.

2. Objectives Pursued

4. To meet the development priority of Bhutan and promote regional clean power trade in South Asia, the Asian Development Bank (ADB) approved the Green Power Development Project in 2008.[4] The main project component was the Dagachhu hydropower development that aims to export clean hydropower from Bhutan to India. To ensure benefits from power export for poverty reduction, the project also included investment in widening renewable energy access for the poor. It is to provide access to electricity sourced from hydropower to rural households and facilities with grid extensions, and electricity sourced from solar energy to remote public facilities (e.g., schools, health clinics, and other community facilities) on an off-grid basis.

5. The impact of the project is to sustain the country's inclusive economic growth by promoting cross-border power trade and domestic electricity access. As an outcome, the power sector is to improve the coverage of distribution and expand electricity export through clean power development in a sustainable manner. Investment for Dagachhu hydropower will generate a long-term revenue stream for the Government to finance its enormous development needs in social infrastructure, such as health and education, as well as economic infrastructure facilities like roads and electricity supplies. They will form the basis of rural development and poverty reduction in the country. Direct investment for rural electrification will improve access to

[4] ADB. 2008. *Report and Recommendation of the President to the Board of Directors: Proposed Loans, Asian Development Fund Grant, Technical Assistance Grant, and Administration of Grant to the Kingdom of Bhutan for the Green Power Development Project*. Manila.

electricity by rural households and small businesses, and replace more expensive and polluting kerosene and fuelwood with renewable hydropower and solar energy. It will make social interventions to the poor and improve the standard of living and quality of life of people living in rural areas. The Dagachhu development will generate export revenues, which will also be used for cross-subsidies to maintain low-cost power supplies particularly for the rural poor. Thus, rural electrification and hydropower export are strongly interrelated with inclusive economic growth and poverty reduction. Expanding generation capacity for export and rural access to electricity in tandem will improve energy and social security. Clean energy trade will also enhance cross-border cooperation and regional energy efficiency.

3. Design and Implementation

6. The Dagachhu hydropower development is a 126 MW run-of-river type, with minimal adverse environmental and social impacts. Generated power will be sold to India through the existing grid connected to India. As the first undertaking of a commercial nature in Bhutan, the Dagachhu plant decided to be developed through a public private partnership (PPP) to leverage private capital and reduce state debt burden. Druk Green Power Corporation (DGPC, Bhutanese state-owned utility) and Tata Power Company (TPC, Indian private power company) agreed to a joint venture arrangement, and Dagachhu Hydro Power Corporation (DHPC) was incorporated as the project special purpose company. Tata Power Trading Company (TPTC, Indian private power trader) signed a power purchase agreement to supply power generated from the Dagachhu power plant on a long-term. The Dagachhu development is thus expected to showcase private participation for subsequent clean energy projects in Bhutan. Therefore, the Government of Bhutan envisages that the Dagachhu development will be a pilot case to catalyze foreign direct investment to accelerate hydropower development.

7. Clean and renewable power export will be counted as carbon saving in the coal-dominated Indian power market. Under the clean development mechanism (CDM) as defined in the Kyoto Protocol,[5] the clean power generated from the Dagachhu plant will displace power generated by fossil fuel-based thermal power generation in the eastern Indian power grid. The resulting reduction of greenhouse gases equivalent to CO_2 emissions will be quantified as 500,000 tons every year and 15 million tons over 30 years. The additional cash flow from the CDM benefits will make the project bankable and create a proactive investment environment in regional power trading and clean energy development.

8. The total cost of the Dagachhu hydropower development was estimated at arund $200 million and supported from multiple stakeholders including both public and private sectors. ADB has financed $80 million loans to the project, of which is used to support DHPC's debt finance ($51.0 million) and DGPC's equity injection ($29.0 million). Cofinancing ($70.5 million equivalent) has been provided by the National Pension and Provident Fund (NPPF) of Bhutan and the Raiffeisen Zentralbank Österreich AG (RZB) of Austria through export credit of Österreichische Kontrollbank AG (OeKB). The balance of the cost was funded by the DHPC's equity shareholders including DGPC (59% of the total share), TPC (26%) and NPPF (15%), through PPP structure. The project structuring was promoted with technical assistance from the Japan Special Fund, established by the government of Japan and administered by ADB. The

[5] CDM has been established under the United Nations Framework Convention on Climate Change (UNFCCC) to encourage developing nations to invest in greenhouse gas emission reduction projects. Once projects were registered at UNFCCC and reduction of greenhouse gas emission (e.g., $CO_{2)}$ is verified, the certificates of emission reduction can be traded and sold in exchange with cash in the market.

Austrian government has also provided engineering and technical support for the project through the Austrian Development Agency while ADB supports overall policy and institutional capacity development. ADB additionally provided grants of $25.2 million for on-grid rural electrification and $1.0 million for off-grid solar rural electrification from the Asian Clean Energy Fund established by the Japanese government.

4. Problems Encountered

9. While Bhutan signed an umbrella agreement with India to develop 10,000 MW hydropower generation in Bhutan and promote cross-border power trading by 2020, there was not any proper policies that allow Bhutan for foreign direct investment from the private sector in hydropower development. Even though the underlying economic performance for hydropower development is strong, its concomitant policy risks keep private investors away. This is most evident in emerging markets where the most unexploited hydropower potential exists. In neighboring countries such as India, private investment in hydropower sector was miniscule until recently. Hence, one of the challenges for Bhutan was to develop a hydropower development policy framework that can attract private sector participation and create a sustainable and competitive investment climate.

10. Under the situation where Bhutan has lack of domestic capital required for export-oriented hydropower projects, Bhutan had to rely on only bilateral assistance for investment from India; export tariffs were politically negotiated between the two countries under the assistance programs. As a result, there were not any precedent benchmarks to measure Bhutan's hydropower off-take prices that reflect their commercial values. To maximize the comparative advantage of Bhutan's hydropower in the regional power trading market, some power export projects must be demonstrated and promoted on commercial principles, unlike past projects where tariffs were politically decided and revised on bilateral discussions.

5. Factors for Success

11. **Hydropower Development Policy for Private Participation.** To accelerate hydropower development on a sustainable basis, ADB supported the Government of Bhutan in establishing a policy and institutional framework for private participation, such as PPPs and independent power producers. The Sustainable Hydropower Development Policy was issued in July 2008 to provide the development basis for any hydropower projects following the Dagachhu hydropower PPP. The key objectives of the policy are to (i) promote public, private, and foreign investments to accelerate development of hydropower generation in a competitive manner; (ii) maximize benefits from hydropower generation for socioeconomic development of the country; (iii) assure energy security for domestic demand and overall development of the sector; (iv) establish the renewable energy fund to ensure the entire power sector value chain and operational sustainability; and (v) protect and sustain the country's environment. The policy outlines the various elements including the project structure, fiscal incentives, and bidding process.

12. **Institutional Reforms.** In line with the policy initiatives, the Government established DGPC as a holding company to oversee existing hydropower companies and stations to promote new hydropower projects and private sector participation. The amalgamation of the existing corporations enabled DGPC to have larger assets and better financial strength. DGPC is thus expected to promote new hydropower projects by leveraging and structuring public and private capital through various approaches including PPPs. Another challenge is to simplify the process of private investment and provide "single-window" clearances to enhance investor

confidence in Bhutan. The Government approved a setup of the Energy Secretariat as the apex agency for accelerating hydropower projects and ensuring good governance through an impartial and balanced investment framework, and use of competitive practices under the Sustainable Hydropower Development Policy.

13. **Demonstration Project for PPP and CDM.** The first few private investment projects coming to Bhutan will be watched and scrutinized by the investor community. Therefore, it is critical for Bhutan to demonstrate its ability to attract and manage private investments. A pilot hydropower project structured through PPP will evince interest and competition from private developers. Financial structuring on commercial principles is expected to achieve more credibility and provide more confidence to potential foreign public and private investors and lenders. Since the Dagachhu's power purchase agreement (PPA) indicates 40-60% higher off-take tariff prices compared to the past bilateral ones, this commercial benchmark will make significant impacts on subsequent project development and investment. A 25-year long-term arrangement of PPA will also mitigate the project off-take risks. Additional benefits from sales of carbon emission reductions through cross-border CDM are expected to attract private capital in power export projects. While the nature of a post-2012 CDM framework is as yet unknown, the project also demonstrated an agreement for the purchase of the emission reductions to be underwritten by the power trader, TPTC over the 30 year duration at a specific minimum price to mitigate the uncertain risk of the CDM framework. Therefore, the overall project risk to the financial sustainability due to external factors is deemed minimal. The project risk of cost and time overruns is also mitigated by PPP arrangements with TPC—a joint venture partner in the component with extensive experience in implementing and operating hydropower projects worldwide. PPP not only brought additional sources from the private development partner but also strengthened project management ability by mitigating risks and maximizing benefits.

6. Results Achieved

14. Presently, cross-border power trading is limited in South Asia, where most power exchange is available only between Bhutan and India. During the past decades, all cross-border power trading projects in the region have been supported only by the Government of India. The Dagachhu development was the first cross-border power generation project financed by international agencies like ADB in South Asia. It was also the first PPP adopted by Bhutan where Bhutanese public and Indian private enterprises established a joint venture through the sector's institutional reforms and policy formation for private participation. The joint venture made agreements for power trading and CDM benefit underwriting with a private power trader. Since the cross-border power trading market and participants have also been limited, TPTC's private sector participation in the market is expected to create a competitive business climate in future regional power trading in South Asia. In addition to these policy and commercial arrangements, ADB played a role as the lead arranger in financial structuring for the project's debt and equity, with cofinancing from an export credit agency and a local financial institution.

15. In 2010, the Dagachhu hydropower project was registered as the world first cross-border CDM initiative under the United Nations Framework Convention on Climate Change. These many "first" results achieved from the project will help create a competitive investment environment in cross-border power trading and clean energy development in the region through private capital. The investment project for Dagachhu hydropower will also generate (i) a long-term revenue stream for Bhutan to finance its development needs in social and economic infrastructure, and (ii) subsidies for electric supplies to poor rural households, for socioeconomic purposes. Around 9,000 rural households will be electrified under the project to provide access to electricity, which will create new economic and social opportunities for the recipients.

7. Lessons Learned

16. ADB has supported the Bhutan's power sector development since the early stages of the sector development, to promote the sector policies and reforms, improve operating efficiency, and strengthen the capacity of key institutions. Success is most sustainable when the sector development program maintains long-term involvement and combines institutional capacity building with scaling-up investment projects to accelerate subsequent development. The project has provided consistent support to integrate the relevant policy formation and institutional development with project finance for demonstration purposes. In promoting the real project, experience gained by Bhutan in terms of negotiating with off-takers for commercial tariffs and developing shareholders agreements with a strategic partnership with the private sector was incorporated in the relevant policy formation; there were synergy effects to make the policy practical and the project demonstrative. This doing-by-learning approach will be of significant importance to promote and scale up subsequent hydropower projects.

8. Conclusion (applicability to other programs)

17. First, Dagachhu hydropower development demonstrates how low carbon growth can be pursued in cross-border power trading that can be combined to private investment activities through PPP. Second, it sets an unprecedented example by which countries where clean energy sources provide bulk of power, such as Bhutan, Nepal, Laos can still benefit from CDM by promoting more renewable power generation projects for regional use. Currently, such countries face difficulties in undertaking CDM projects particularly in the power sector because their electricity grid is largely based on renewable energy such as hydro and already low greenhouse gas emitting; they are unable to generate any emission reductions that are additional in their own grids by implementing renewable electricity generation projects. However, by exporting clean electricity to neighbouring countries with more carbon intensive grid – they proved to benefit from the CDM. Third, it showcases how PPP structure and CDM benefits can contribute to bringing economic and social benefits on wider fronts for similar least developed countries. Not only will the project help in meeting the ever increasing electricity demand in a sustainable manner but the income from the sale of carbon credits will also result in overall socioeconomic development in Bhutan. Finally, Dagachhu's success also paves avenue for cross border trade in other renewable energy projects such as wind, geothermal etc. Presently, ADB is promoting the Green Power Development Project-II, which aims to expand power trading from the cross-border to regional dimension. It is proposed to export Bhutan's hydropower to both Bangladesh and India through Indian power trader(s) using the transmission interconnection between Bangladesh and India where ADB decided to finance in August 2010.[6] The project has thus been making steps for regional integration toward seamless Asia.

[6] ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to Bangladesh for the Bangladesh–India Electrical Grid Interconnection Project.* Manila.