

SECTOR ASSESSMENT (SUMMARY): ENERGY

Sector Road Map

1. Sector Performance, Problems, and Opportunities

1. **Overview.** In 2002, Bhutan's energy sector went through a major restructuring to separate commercial management and ownership from the government. Since these reforms, the policy-making body on energy has been the Ministry of Economic Affairs, which includes three departments relevant to the sector: (i) the Department of Hydropower and Power Systems (DHPS), (ii) the Department of Renewable Energy, and (iii) the Department of Hydromet Services (established 1 December 2011). The state-owned Bhutan Power Corporation (BPC) has had the main responsibility for transmitting and distributing of electricity, while the Druk Green Power Corporation (DGPC), also state-owned, looks after power generation.¹ DGPC is the holding company of all existing hydropower companies. As the power sector regulator, the Bhutan Electricity Authority is responsible for setting tariffs; establishing and enforcing technical, safety, and operational standards; issuing licenses; and monitoring other regulatory functions. While the electricity tariffs are regulated by the Bhutan Electricity Authority on a cost-reflective tariff structure, actual retail prices are cross-subsidized in the value chain of the power sector in a transparent manner. Before power exports, DGPC gives 15% of the power it generates as an energy royalty to the government, which sells it to BPC at discount prices. Electricity is supplied to domestic consumers at affordable tariffs that are substantially cross-subsidized by power exports.² Both BPC and DGPC have maintained efficient operations and healthy financial positions.

2. **Demand and supply.** Power generation in Bhutan relies almost exclusively on hydropower. The total installed capacity of existing hydropower plants is 1,488 megawatts (MW). Since all of the existing plants are run-of-the-river types, the total generation drastically drops to about 300 MW during the winter dry season (December–March) due to low water levels. This falls short of meeting peak system demand during winter dry seasons.³ To deal with the seasonal power shortage, Bhutan has curtailed industrial loads during the winter months. Power has been imported from India, especially in the winter, but this will become increasingly difficult to arrange because India has its own power shortage during these months. Bhutan's winter power shortages will therefore worsen until 2016, when the 1,200 MW Punatsangchhu-I hydropower plant is expected to come on line. During the wet season, existing hydropower plants can generate enough electricity to meet the domestic and industry demands and also export power. The BPC's annual electricity sales (in gigawatt-hours) are expected to continue growing at more than 10% per year for the next several years, despite the winter power shortages.

3. **Large hydropower development.** After meeting its domestic consumption needs, Bhutan exports around 70% of the total power it generates each year to India. The power sector is the largest source of the government revenue and the premier contributor to the country's gross domestic product.⁴ Hydropower development and exports have underpinned the

¹ The BPC undertakes the construction and operation of electrical networks for the sale of electricity, the wheeling of electricity for export, and the construction of embedded generation plants.

² The provision of royalty energy to BPC at a discount price results in a loss of export revenues and can be considered a subsidy from the export sector to the domestic sector.

³ The winter peak demand grew at more than 15% annually during the past 5 years.

⁴ Since 2008, the power sector has contributed 30%-40% of national revenue in the form of taxes and dividends. The power industry and relevant construction works account for one-third of gross domestic product.

economy's rapid growth and generated government resources for social and other investments, making an acceleration of hydropower development for exports strategically important. In 2008, Bhutan agreed to develop 10,000 MW of capacity for exports to India by 2020. Under the bilateral framework with India, three projects are under construction at Punatsangchhu-I (1,200 MW), Punatsangchhu-II (1,020 MW), and Mangdechhu (720 MW). Other large hydropower projects being prepared with India's government and its own enterprises are at various stages of development. Clean energy development for power exports will improve energy efficiency and foster economic cooperation in the region.

4. **Medium-sized and small hydropower development.** In addition to these bilateral arrangements, Bhutan is considering several financing mechanisms for hydropower development through public-private partnerships (PPP), particularly for medium-sized and small projects. In 2008, the Asian Development Bank (ADB) provided financing for the Dagachhu hydropower project (126 MW), which was the first PPP infrastructure project in Bhutan.⁵ The project involved a joint venture between DGPC and India's Tata Power Company. It was the first cross-border project registered under the United Nations Clean Development Mechanism. While this type of project is developed on commercial terms under a power purchase agreement, it will also contribute to government revenue through taxes, dividends, and royalties. As a next step in hydropower development, DHPS also intends to promote investments by independent power producers (IPPs) as well as PPP, once it has formulated the necessary IPP rules and guidelines.

5. **Transmission.** Extensive investments will be needed in high-voltage power transmission to evacuate power from new power plants to India and to connect them to BPC's domestic transmission network. While development of these transmission lines will need to be coordinated with the development of individual plants, a holistic approach to the network's expansion will be crucial so that the investment benefits are maximized and any adverse safeguard impacts in the transmission corridors are minimized. As the number of hydropower plants increases, BPC will also need to improve its operational control to ensure system reliability.

6. **Rural electrification.** Despite Bhutan's net power exports, the difficulties of extending grids in the country's mountainous terrain limit access to clean energy in the rural areas where 70% of Bhutan's people live. Traditional fuels such as kerosene and wood that are used instead cause indoor pollution and threaten the health of rural residents, particularly women and children. Providing electricity to these areas has posed significant implementation challenges. To alleviate poverty and stimulate inclusive economic development, the government began large-scale rural electrification projects under the nation's sixth five-year plan for 1988–1992. All subsequent five-year plans have made rural electrification a key development effort. As of 31 August 2013, Bhutan had provided electricity to 95% of its households. This figure is expected to reach 100% marginally on completion of ongoing projects supported by ADB and the Japan International Cooperation Agency, scheduled for 2015.⁶ Households in remote villages where on-grid rural electrification is not technically or economically feasible are provided with electricity from other clean sources, mainly stand-alone home solar systems.

7. **Alternative renewable energy.** To improve national energy security, the government issued the Alternative Renewable Energy Policy, 2013. It aims to promote alternative renewable

⁵ 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.

⁶ ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Grant to the Kingdom of Bhutan for the Rural Renewable Energy Development Project*. Manila.

energy sources other than large hydropower and diversify the energy supply base through the use of wind, solar, biomass, and small and micro hydropower systems. Wind power projects have the potential to generate clean energy in the dry winters, thereby supplementing the diminished hydropower supply during these months and alleviating seasonal power shortages. Bhutan can also develop the use of biogas as an alternative to wood for cooking fuel in the rural areas. Rural households depend heavily on fuel wood for cooking and heating and suffer from the indoor air pollutants and health hazards as a result.⁷ To promote renewable energy, the government needs to provide financial and fiscal incentives that will help overcome the development entry and financial barriers.

2. Government's Sector Strategy

8. The government's development strategy calls for power sector development to play the central role in enhancing (i) inclusive economic development, with geographically balanced growth through electrification of rural communities; (ii) fiscal revenues through power exports; and (iii) industrial investments, based on a reliable supply of electricity.

9. Rural electrification has long been an integral part of Bhutan's national development strategy, since it helps reduce poverty and improve the quality of life for households in rural areas. The governments have made it one of the highest development priorities since 1988. It has also been the government's strategy to use a mix of renewable energy—including large hydropower plants, micro hydro stations, wind power, and solar energy—to electrify rural households. The solar home systems have been used for remote rural households.

10. To promote hydropower exports, the government signed the memorandum of understanding with the Government of India for mutual cooperation in 2006. It includes an agreement to develop 10,000 MW of power generation capacity in 10 large hydropower projects under bilateral financing from the Government of India and through joint ventures with Indian public sector enterprises. These export-oriented projects will sustain Bhutan's economic growth and have been given development priority. To accelerate hydropower development on a sustainable basis, the government has established a policy and institutional framework in Bhutan for private sector participation, including PPP and IPP arrangements. For this purpose, the Sustainable Hydropower Development Policy was issued in July 2008.⁸ It outlines such elements as project structure, fiscal incentives, and the bidding process. To maximize the benefit and efficiency of power export, DHPS plans to improve power trading functions and mechanisms.

11. The government's 2013 Alternative Renewable Energy Policy addresses the facts that the nation's electricity supply is almost exclusively dependent on hydropower and that meeting peak power demand in the dry season continues to be a problem. The policy will lay the foundations for further renewable energy resource development. Its key objectives are to diversify the energy resource mix to enhance long-term energy security, reduce the need for fossil fuel imports, reduce greenhouse gas emissions, and stimulate social and economic development through efficient renewable energy interventions and private sector participation. The government is also considering an energy conservation policy to improve efficiency in the country's energy

⁷ The burning of straw and wood leads to large emissions of carbon dioxide and other toxic gases. With per capita use of about 1.2 tons per year, Bhutan's consumption of fuel wood is the highest in the world and twice that of Nepal.

⁸ 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 the socioeconomic development of the country; (iii) assure energy security for domestic demand and overall development of the sector; (iv) establish a renewable energy fund for the sector development and operational sustainability; and (v) protect and sustain the environment.

consumption.

3. ADB Sector Experience and Assistance Program

12. ADB's current assistance program for Bhutan's energy sector takes three parallel, complementary approaches that involve (i) encouraging policy, institutional, and legal reforms to improve the commercial orientation and financial performance of power sector entities; (ii) providing financial assistance to expand the electricity distribution network to rural communities; and (iii) mobilizing investments for hydropower development through PPPs.

13. **Policy, institutional, and legal reforms.** ADB has supported preparation of the government's energy sector policies and strategies. This support has emphasized sector restructuring, regulatory reforms, and commercial management and cost-recovery in public sector utilities through institutional strengthening and capacity building programs. ADB's technical assistance (TA) has been highly effective in transforming the power sector from a government department into profitable utilities and an independent regulator, as well as in supporting the use of state-of-the-art utility management practices.

14. **Rural electrification.** ADB has consistently supported rural electrification programs through a series of financing operations. Using a program approach, ADB has financed the electrification of a significant proportion of the households in Bhutan since 1995. Each financing operation was designed to expand the electricity grid further into remote areas of the country. This assistance was properly sequenced and maintained continuity in the government's electrification effort but also took into account lessons learned from previous operations along the way. The four completed ADB-financed rural electrification projects, together with one that remains ongoing, will collectively have electrified more than 37,000 households, or 43% of the rural households in Bhutan.⁹ This has been a significant contribution to the government's goal of electricity for all.

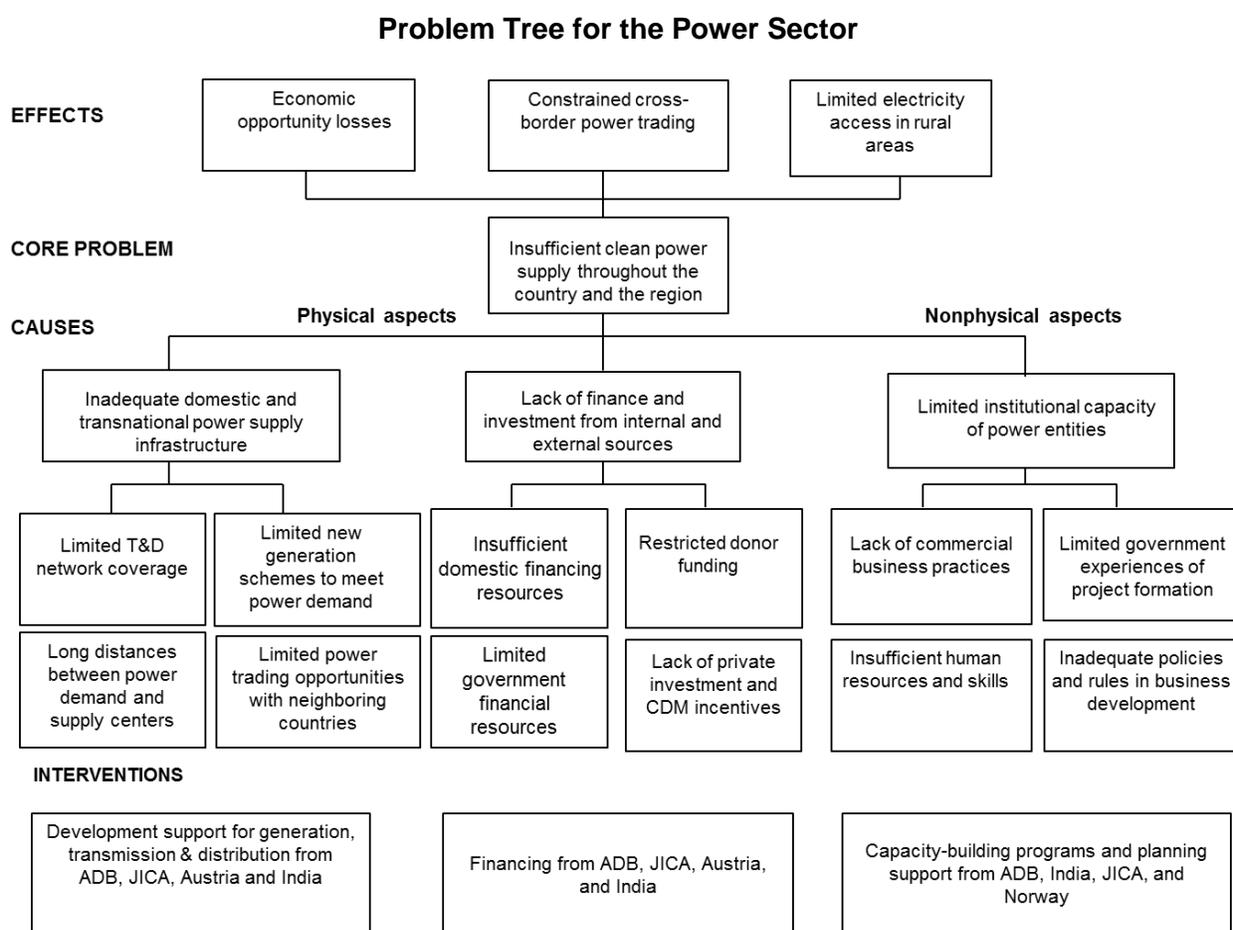
15. **Hydropower export development.** Since 2006, ADB has increased its support for hydropower and renewable energy development. This has been aimed at stimulating economic growth and mitigating climate change by increasing hydropower exports. It has also helped reduce greenhouse gas emissions on a regional basis, since clean Bhutan power exports have reduced the amount of electricity India needs to generate using fossil fuels. ADB has supported the formulation of policies intended to attract investments to the hydropower sector in environmentally sustainable energy development. In 2008, ADB's Green Power Development Project supported a PPP transaction through an innovative financing mechanism for the Dagachhu hydropower development (para. 4). Through ongoing project preparatory TA and other TA programs, ADB will continue to support subsequent PPP transactions, region-wide power trading, and technical and knowledge transfer.¹⁰

⁹ (i) ADB. 1995. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Technical Assistance Grant to the Kingdom of Bhutan for the Rural Electrification Project*. Manila; (ii) ADB. 1999. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Technical Assistance Grant to the Kingdom of Bhutan for the Sustainable Rural Electrification Project*. Manila; (iii) ADB. 2003. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Technical Assistance Grants to the Kingdom of Bhutan for the Rural Electrification and Network Expansion*. Manila; (iv) 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; and (v) ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Grant to the Kingdom of Bhutan for the Rural Renewable Energy Development Project*. Manila.

¹⁰ ADB. 2011. *Concept Paper for Bhutan: Preparing Green Power Development project II*. Manila.

16. **Renewable energy development.** ADB has also been supporting the development of solar, wind, biogas, and small and mini hydropower renewable energy as well as deploying cost-effective technologies and development business models. In 2010, ADB's Rural Renewable Energy Development Project helped initiate pilot projects for wind and biogas schemes and sustainable institutional arrangements for off-grid home solar systems (footnote 6).

17. **Way forward.** ADB intends to focus on three main sector development priorities: (i) hydropower generation and trading, (ii) transmission, and (iii) renewable energy and energy efficiency. Bhutan's hydropower generation and transmission network is strategically positioned for power trading with neighboring countries that will enhance regional cooperation and integration. In addition, such renewable energy as that produced by grid-connected solar, wind, and biomass generation plants developed in the future can also be used either domestically or exported through networks.¹¹ To help reduce poverty domestically, the use of biogas energy by rural farmers can be scaled up after an ongoing pilot biogas program is shown to be successful.



ADB = Asian Development Bank, CDM = Clean Development Mechanism, JICA = Japan International Cooperation Agency, T&D = transmission and distribution

Source: Asian Development Bank.

¹¹ These renewable energy types can be feasible using feed-in tariffs available in India.

Sector Results Framework (Energy, 2014–2018)

Country Sector Outcome		Country Sector Outputs		ADB Sector Operations	
Outcomes with ADB Contributions	Indicators with Targets and Baselines	Outputs with ADB Contributions	Indicators with Incremental Targets	Planned and Ongoing ADB Interventions	Main Outputs Expected from ADB Contributions
Increased cross-border power trade and domestic electricity access	<p>Power exports increased to 3,000 MW by 2018 (2012 baseline: 1,050 MW)</p> <p>100% rural electrification reached by 2015 and this rate retained through 2018 (2013 baseline: 95%)</p>	Energy systems, including renewable energy, expanded and improved	<p>Additional 10,000 rural households get electricity through grid connections or solar home systems by 2015</p> <p>10,000 MW of hydropower plant capacity constructed by 2018 (2012 baseline: 1,488 MW)</p> <p>25 MW of alternative renewable energy generation sourced from wind, solar, mini and/or micro hydro, and biomass facilities by 2018 (2012 baseline: 0.01 MW)</p>	<p>Planned key activity areas</p> <ul style="list-style-type: none"> - Large hydropower (PPP/energy trade) – 60% of funds - Transmission – 30% of funds - Solar, small hydro, wind, biogas/energy efficiency – 10% of funds <p>Pipeline projects with estimated amounts</p> <ul style="list-style-type: none"> - Green Power Development Project-II (\$120 million) - Acceleration of Hydropower Trading Development (\$1 million) - Promoting Clean Energy Development (\$5.6 million) - SASEC Green Power Project (TBD) - Scale up of Renewable Energy Project (TBD) <p>Ongoing projects with estimated amounts</p> <p>(i) Green Power Development Project (\$106.3 million)</p> <ul style="list-style-type: none"> - On-grid rural electrification - Off-grid solar rural electrification - Hydropower generation <p>(ii) Rural Renewable Energy Development Project (\$ 21.6 million):</p> <ul style="list-style-type: none"> - On-grid rural electrification - Off-grid solar rural electrification - Wind power generation - Biogas plants 	<ul style="list-style-type: none"> - Medium-size hydropower project constructed for power export through PPP (118 MW) - Transmission network expanded - Renewable energy master plan formulated - Medium-size hydropower plant invested for export - Pre-feasibility studies for IPP and solar projects, renewable energy master plan, energy efficiency conservation policies and regulations prepared - Large hydropower and transmission invested for power export - Rural electrification of additional 9,000 households, and public facilities (e.g., clinics, schools, and community facilities); and 126 MW Dagachhu hydropower plant for power export completed - Rural electrification of additional 5,075 new households of on-grid extension, and 2,700 new solar home systems; 500 kW of wind power generation plant; 1,600 biogas plants completed

ADB = Asian Development Bank, IPP = independent power producer, MW = megawatt, kW = kilowatt, PPP = public-private partnership, TA = technical assistance
 Sources: Asian Development Bank and Bhutan government agencies.