SECTOR ASSESSMENT (SUMMARY): ENERGY

Sector Road Map

1. Sector Performance, Problems, and Opportunities

1. In 2002, the Bhutan government undertook a major restructuring of the energy sector to separate commercial management and ownership from the government. The Ministry of Economic Affairs, now the policy-making body, includes three departments relevant to the sector: (i) Department of Hydropower and Power Systems, (ii) Department of Renewable Energy, and (iii) Department of Hydromet Services. The state-owned Druk Green Power Corporation (DGPC) looks after power generation while the Bhutan Power Corporation (BPC), also state-owned, has the main responsibility for transmission and distribution.[1] DGPC is the holding company of all existing five hydropower plants.[2] As the power sector regulator, the Bhutan Electricity Authority is responsible for setting tariffs; establishing and enforcing technical, safety, and operating standards; issuing licenses; and monitoring other regulatory functions. While it regulates domestic electricity tariffs using a cost-reflective tariff structure, actual retail prices are cross-subsidized in the power value chain in a transparent regulatory system. Before exporting power, DGPC gives 15% of the power it generates as an energy royalty to the government, which it sells it to BPC at discounted prices. Electricity is supplied to domestic consumers at affordable tariffs that are substantially cross-subsidized by power exports.[3] Both DGPC and BPC are held by the state-owned Druk Holding and Investments, and maintain efficient operations and healthy financial positions.

2. **Demand and supply.** Power generation relies almost exclusively on hydropower. The total installed capacity of existing hydropower plants is 1,614 megawatts (MW), which represents only 6% of the country's technically feasible hydropower potential of 26,760 MW. Since all of the existing plants are run-of-the-river, 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.[4] To deal with the seasonal power shortage, Bhutan has controlled industrial loads during the winter months or imported power from India. During the wet season, existing hydropower plants can generate enough electricity to meet domestic and industry demands, and export surplus power. BPC's annual electricity sales (in gigawatt-hours) are expected to continue growing at about 10% per year on average for the next several years.

3. **Large hydropower development.** After meeting its domestic consumption needs, Bhutan exports about 75% of the total power it generates each year to India. The power industry is the largest source of government revenue and the premier contributor to the country's gross domestic product.[5] Hydropower development and exports have underpinned the economy's rapid growth and generated government resources for social and other investments, making an

[1] 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 hydropower plants are Basochhu (64 MW), Chhukha (336 MW), Dagachhu (126 MW), Kurichhu (60 MW), and Tala (1,020 MW). DGPC has two joint venture companies with private parties: Dagchhu Hydro Power Corporation with Tata Power Company, India, and Bhutan Hydropower Service with Alstom, France.

[3] 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. The royalty is 15% for the existing plants while new plants after 2008 will be based on 12% for the first 12 years of operations and 18% thereafter.

[4] The winter peak demand grew at more than 15% annually during the past 5 years. The winter power shortage will be alleviated in 2017–2018, as some hydropower plants under construction will begin operations.

[5] Since 2008, power exports have contributed 30%–40% of national revenue in the form of taxes and dividends. The power industry accounts for one-fifth of gross domestic product.

acceleration of hydropower development for exports strategically important. In 2006, Bhutan agreed to develop 10,000 MW of capacity for export to India by 2020. Under the bilateral framework with India, three projects are under construction: 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 foster economic cooperation in the region.

4. **Medium-sized and small hydropower development.** Bhutan is considering other financing mechanisms for hydropower development through public–private partnerships (PPPs), 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.[6] 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 for power export, it will also contribute to government revenue though taxes, dividends, and royalties. At present, the government continues to play the role of "provider" rather than "enabler" due to the small and underdeveloped private sector in hydropower development. ADB has played a catalytic role to enable private investment and commercial bank finance. Because of the high up-front cost of hydropower projects, limited local financing potential, and the government's fiscal constraints, foreign private funding will be crucial to bridge funding gaps of the project's equity and debt. As a next step, the Department of Hydropower and Power Systems intends to promote investments by independent power producers (IPPs) as well as PPP, once the necessary IPP rules and guidelines are formulated.[7]

5. **Power trading.** The first power export was from the Chhukha hydropower plant, which was commissioned in 1986, along with the grid system connecting Bhutan and India. Power exports from Bhutan to India are targeted to increase from 2014 levels by three times by 2018. This will provide Bhutan with opportunities to enhance the value of power exports through greater participation in the Indian power market on a short- and medium-term basis, in addition to the long-term power purchase agreements. Since the government's energy royalty size will be increased, any surplus power can be sold through a merchant route in the trading market after meeting domestic demand. Transmission is now interlinked between India and Bangladesh, and is to be extended between India and Nepal. To maximize the value of increasing power exports, Bhutan can strengthen power trading functions and mechanisms, including its bulk power trading, commercial contracts, risk management, and energy accounting.

6. **Transmission.** To facilitate power trading, extensive investments are needed for high-voltage power transmission to evacuate power from new power plants to India and to connect them to BPC's domestic transmission network. A holistic approach to the network's expansion will be crucial to improve control of operations to ensure system reliability as the number of hydropower plants increases.

7. **Rural electrification.** As of 31 March 2014, 98% of households had access to electricity. Completion of ongoing projects supported by ADB and the Japan International Cooperation

[6] 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.

[7] ADB. 2014. *Technical Assistance Report to the Kingdom of Bhutan for Promoting Clean Energy Development in Bhutan* (Financed by the Government of Norway). Manila. The prefeasibility and subsequent bid process is being supported to develop hydropower projects with PPP and/or IPP.

Agency should increase coverage to 100%.[8] 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. Over time, rural households are expected to increase their electricity demand gradually along with the inclusive economic growth. The government wishes to promote hydropower generation development to meet growing domestic demand, while avoiding loss of government revenue from power exports needed for socioeconomic development in rural areas.

8. **Alternative renewable energy.** To improve national energy security, the government issued the Alternative Renewable Energy Policy, 2013. It aims to promote alternative renewable 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 and alleviating seasonal power shortages. Bhutan can also develop the use of biogas as an alternative to wood for cooking fuel in rural areas. Rural households depend heavily on fuelwood for cooking and heating, and suffer from indoor air pollutants and health hazards as a result. To promote renewable energy, the government needs to provide financial and fiscal incentives to help overcome development entry and financial barriers.

2. Government's Sector Strategy

9. The government's development strategy calls for power sector development to enhance (i) inclusive economic development, with geographically balanced growth; (ii) fiscal revenues though power exports; and (iii) industrial investments, based on a reliable supply of electricity.

10. Since the government is about to achieve the national goal of electricity for all, the development priority has shifted to green socioeconomic inclusive development, which will add value to any subsequent hydropower development with inclusiveness. To promote hydropower exports, the Sustainable Hydropower Development Policy was issued in July 2008.[9] This defines the policy and institutional framework for private sector participation, including PPP and IPP arrangements. The government has promoted 10 large hydropower projects for 10,000 MW under bilateral financing from the Government of India and through joint ventures with Indian public sector enterprises. The government and DGPC also plan to develop project opportunities through PPP and/or IPP. These export-oriented projects will sustain Bhutan's economic growth and have thus been given development priority.

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 lays the foundation for 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 of the country's energy consumption.

---

[8] 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.

[9] The key objectives of the policy are to (i) promote public, private, and foreign investments in hydropower development in a competitive manner; (ii) maximize benefits from hydropower generation for the country's socioeconomic development; (iii) assure energy security for domestic demand; (iv) establish a renewable energy fund for sector development and sustainable operations; and (v) protect and sustain the environment.

3. ADB Sector Experience and Assistance Program

12. ADB's current assistance program for the sector takes four parallel, complementary approaches that involve (i) encouraging policy, institutional, and legal reforms to improve the commercial orientation and financial performance of power entities; (ii) expanding the transmission and distribution network of electricity to be supplied inside and outside the country; (iii) mobilizing investments and finance for hydropower development through PPP and/or IPP; and (iv) promoting renewable energy, such as the development of small and mini hydro, wind, solar, and biogas. Efforts to create job opportunities in the energy sector will be supported.

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 households in Bhutan since 1995. Each financing operation was designed to expand the electricity grid 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 from previous operations. The four completed ADB-financed rural electrification projects, together with one ongoing project, will collectively have electrified more than 37,000 households, or 43% of rural households.[10]

15. **Hydropower export development.** Since 2006, ADB has increased its support for hydropower and renewable energy development, aiming to stimulate economic growth and mitigate climate change by increasing hydropower exports. It helped reduce regional greenhouse gas emissions, as clean Bhutan power exports reduce the amount of electricity India needs to generate using fossil fuels. ADB helped formulate policies to attract investments to hydropower in environmentally sustainable energy development. In 2008, the Green Power Development Project supported a PPP transaction using an innovative financing mechanism for the Dagachhu hydropower development. ADB will continue to support subsequent PPP transactions, cross-border power trading, and technical and knowledge transfer.

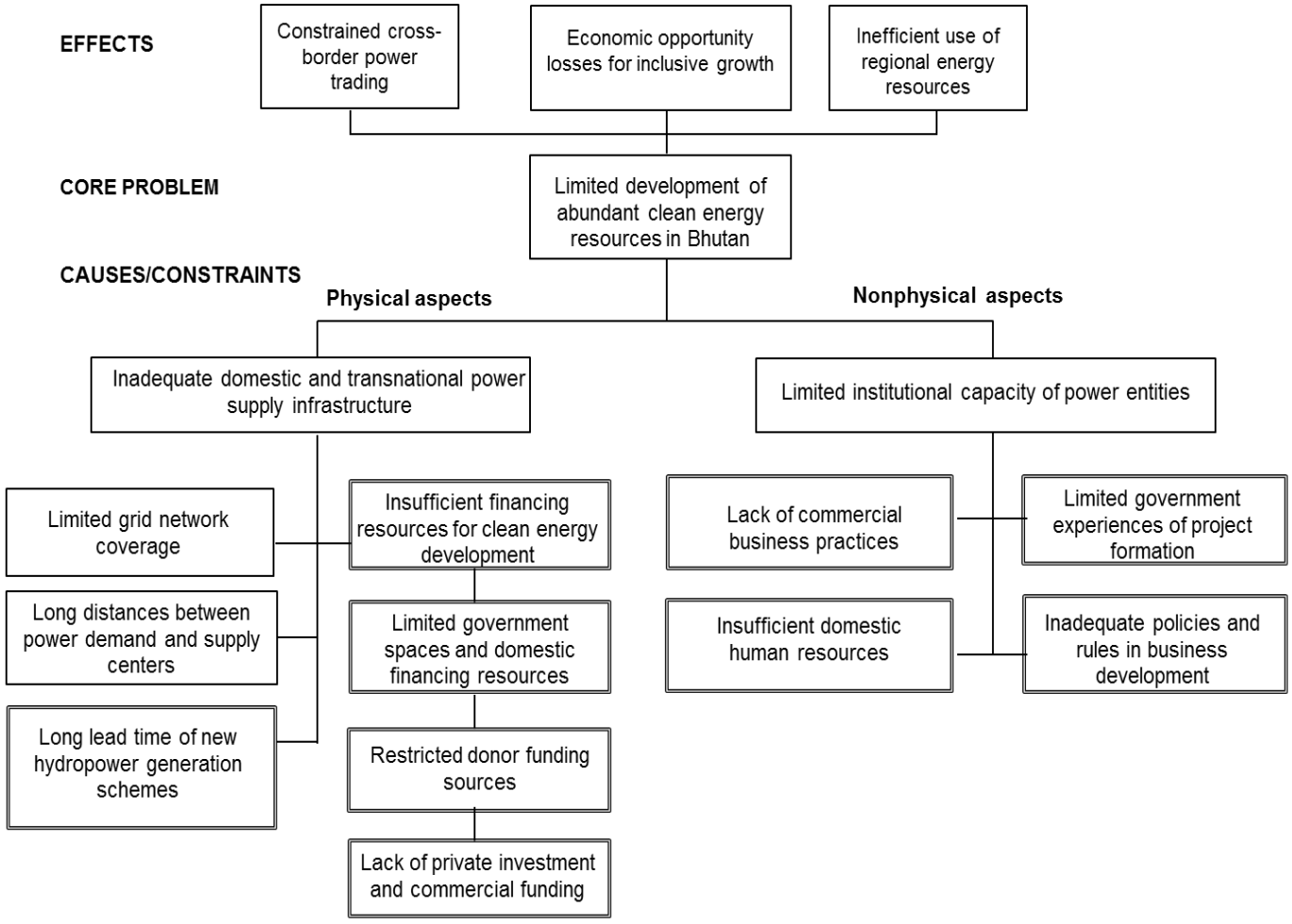
16. **Renewable energy development.** ADB has been supporting the development of solar, wind, biogas, and small and mini hydropower renewable energy; and the deployment of cost-effective technologies and development business models. In 2010, ADB's Rural Renewable Energy Development Project helped initiate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

17. **Way forward.** ADB intends to focus on three development priorities: (i) hydropower generation and trading, (ii) transmission, and (iii) renewable energy and energy efficiency.

[10] 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; 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; 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; and footnotes 6 and 8.

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 be used either domestically or exported through networks. 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.

Problem Tree for the Energy Sector



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	Power exports increased to 3,000 MW by 2018 (2013 baseline: 1,110 MW) 100% rural electrification reached by 2015 and this rate retained through 2018 (2014 baseline: 98%)	Energy systems, including renewable energy, expanded and improved	Additional 3,000 rural households access electricity through grid connections or solar home systems by 2015 10,000 MW of hydropower plant capacity constructed by 2018 (2014 baseline: 1,614 MW) 25 MW of alternative renewable energy generation sourced from wind, solar, mini and/or micro hydro, and biomass facilities by 2018 (2013 baseline: 0.01 MW)	**Planned key activity areas** Large hydropower (PPP energy trade) – 60% Transmission – 30% Solar, small hydro, wind, biogas, and energy efficiency – 10% **Pipeline projects with estimated amounts** Second Green Power Development Project ($120.5 million) Acceleration of Hydropower Trading Development ($1.0 million TA) Preparing the SASEC Green Power Project ($1.5 million TA) Promoting Clean Energy Development (phases 2 and 3, $10.04 million TA) **Ongoing projects with estimated amounts** Rural Renewable Energy Development Project ($ 21.6 million grant): On-grid rural electrification Off-grid solar rural electrification Wind power generation Biogas plants Promoting Clean Energy Development (phase 1, $5.67 million TA) Renewable energy master plan Hydropower prefeasibility Energy efficiency policy Energy registry system	Medium-size hydropower project constructed for power export through PPP Transmission network expanded Renewable energy master plan and energy efficiency policy formulated Medium-size hydropower plant (118 MW) invested for export Large hydropower and/or transmission invested for power export Renewable energy, energy efficiency, climate change promoted On-grid rural electrification of 5,075 households, and rehabilitation of 2,700 solar home systems; 600 kW of wind power plant; 2,800 biogas plants completed Prefeasibility studies for PPP and/or IPP hydropower and solar projects, renewable energy master plan, feed-in tariff systems, energy registry system, and energy efficiency policies and regulations prepared

ADB = Asian Development Bank, IPP = independent power producer, kW = kilowatt, MW = megawatt, PPP = public–private partnership, SASEC = South Asia Subregional Economic Corporation, TA = technical assistance.
Sources: Asian Development Bank and Bhutan government agencies.