

## SECTOR ASSESSMENT (SUMMARY): ENERGY<sup>1</sup>

### Sector Road Map

#### 1. Sector Performance, Problems, and Opportunities

1. Myanmar has abundant energy resources, particularly hydropower and natural gas. The hydropower potential of the country's rivers, which drain the four main basins of Ayeyarwaddy, Chindwin, Thanlwin, and Sittaung, is estimated to be more than 100,000 megawatts (MW). Myanmar has identified 92 potential large hydropower projects with a total installed capacity of 46,101 MW. Proven gas reserves total 20.11 trillion cubic feet with huge potential for discovery. Offshore gas is the country's most important source of export revenue, currently supplying Thailand with a new gas pipeline planned to the People's Republic of China (PRC). A third of the country's \$13.6 billion in foreign direct investment is in oil and gas (as of September 2011). Myanmar is one of the five major energy exporters in the region, particularly of natural gas.

2. **Energy demand and supply.** Despite sitting on huge energy resources, Myanmar's commercial consumption per capita is one of the lowest in Southeast Asia. Low per capita income and insufficient energy infrastructure, as reflected by the country's total electrification rate of only 28% in 2012, are the main causes of the low energy demand. In 2009, according to the International Energy Agency, Myanmar's total primary energy supply was about 15.1 million tons of oil equivalent, with an average annual growth rate of 2.4% from 2000 to 2009. The country's primary energy supply mix comprised coal, oil, gas, hydropower, and biomass. Energy from biomass accounted for 69.9% of the total energy supply, followed by gas at 18.2%, and oil and petroleum at 8.5%. Hydropower accounted for only 2.4% of the total, while coal accounted for just 0.9%. Energy consumption increased at an average of 2.4% per year from 2000 to 2009. The fastest growth was in commercial followed by industrial and transport sector. Residential energy consumption grew the slowest, although it is the largest consumer of energy, mainly using biomass.

3. **Coal.** Coal reserves are estimated at 489 million tons. In 2010–2011, 692,000 tons of coal were produced. Cement and steel companies used 52% of the coal, while 42% was used for power generation, and 6% for others. Since 2010, the private sector has produced all of the country's coal; the price has been set by the market.

4. **Oil and gas.** A total of 104 blocks are demarcated onshore (53) and offshore (51) for oil and gas exploration and development. Proven oil reserves total 160 million barrels (mmbbl). Proven gas reserves total 20.11 trillion cubic feet with huge potential for discovery. Gas production in 2011–2012 was about 1,273 million cubic feet per day (MMCF/D). Onshore oil production is estimated to have reached 7,500 barrels per day in 2011–2012. In addition, offshore gas fields produced 10,853 mmbbl per day of condensates. In 2011–2012, the total demand for petroleum products was 8.15 mmbbl, comprising 3.70 mmbbl of gasoline, 3.38 mmbbl of diesel, 0.60 mmbbl of aviation oil, and 0.47 mmbbl of others. Three refineries with a total capacity of 51,000 barrels per day produced the petroleum products by blending onshore oil and offshore condensate; the shortage, mainly diesel, was imported. Of the total gas production, 95% came from the offshore Yadana and Yetagun fields, while the remaining 5% came from onshore fields. In 2012–2013, domestic gas demand was about 570 MMCF/D; it is expected to increase to 800 MMCF/D. Gas is used for 10 power plants (55%), fertilizer (9%), and compressed natural gas (8%). About 2,775 miles of gas pipeline were constructed in

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<sup>1</sup> This summary is based on ADB. 2012. *Myanmar: Energy Sector Assessment*. Manila. It was subsequently updated in July 2013 to include the latest data where available.

various diameters ranging from 6 to 24 inches. In 1986, a compressed natural gas and natural gas vehicle program was initiated to expand the use of domestically produced natural gas and to respond to climate change concerns. A total of 27,472 vehicles were converted and 44 refuelling stations were constructed throughout the country in 2011.

5. **Renewable energy.** Myanmar has abundant renewable energy resources such as hydro, biomass, wind, and solar. Hydropower is the only renewable energy resource that is being exploited and utilized commercially; the others remain in research and development or the pilot stage. Biomass, such as fuelwood, charcoal, agriculture residue, and animal waste, supplies almost 66% of the primary energy. Bioethanol, produced from sugar cane, molasses, and starchy materials, is used as transportation fuel to substitute for gasoline or to mix with gasoline. In 2005, the government launched the ambitious Jatropha Plantation Project for biodiesel production, aiming for 32,375 square kilometers of plantations (65% of which had been achieved as of September 2011). Because of the low yield from Jatropha seeds, biodiesel production is low. Myanmar has developed 26 micro- and 9 mini-hydropower projects, with installed capacity ranging from 24 kilowatts to 5,000 kilowatts, to reach remote border areas. The country is only starting to use wind and solar energy.

6. **Power.** The power subsector is governed by the Electricity Act 1948 (as amended in 1967), the Myanmar Electricity Law (1984), and the Electricity Rules (1985). Before 1960, the generation system comprised mainly isolated grids supplied by private diesel generators and mini-hydropower plants. In 2010, about 5,661 gigawatt-hours (GWh) were available to the Myanmar grid from all its grid-connected hydropower plants, representing only 68% of the installed capacity. The country's first coal plant, the 120 MW Tigyit facility completed in 2002, is operating at an average of 31% capacity. Off-grid power supply is provided by Electricity Supply Enterprise (ESE) and by community and district authorities; the supply is intermittent and electricity is provided for only 2 hours per day in some remote areas. In 2013, the total installed capacity of the system was 3,495 MW comprising 2,660 MW of hydropower capacity (76%), excluding 31 MW of off-grid mini-hydropower generation; 715 MW of gas-fired capacity (21%); and 120 MW of coal-fired capacity (4%). However, in 2013 the available generation was only 1,560 MW in the dry season and 2,139 MW in the wet season. The available capacity of the gas power plants is low because some are offline for maintenance and the gas pipeline lacks compression. During the dry season, the hydropower plants cannot generate their full capacity because of the lack of water. Hence, Myanmar's power grid experiences load shedding during the dry season of up to 500 MW. The capacity of the transmission lines and transformers is limited. The network also experiences high transmission and distribution losses.

7. **Future power development.** The Ministry of Electric Power (MOEP) will build an additional 11 hydropower plants up to 2020 with a total capacity of 2,132 MW. Local enterprises will develop 5 hydropower plants with a total capacity of 498 MW. Joint ventures with foreign investors are planned for the development of 43 hydropower projects totaling 41,656 MW. MOEP has identified three coal-fired power plants with an installed capacity totalling 876 MW for development in 2012 and 2013. International private sector developers have proposed three gas-fired power plants of 500 MW each (a consortium from the Republic of Korea and two consortia from the PRC) in Yangon and a 1,200 MW ultra-supercritical coal power plant in the Thilawa Special Economic Zone by a consortium led by Toyo Thani. Once these projects are deemed feasible, the government and independent power producer developers will negotiate joint-venture agreements and power purchase agreements.

8. **Transmission and distribution systems.** Myanmar has a unified, interconnected transmission and distribution network covering some parts of the country, as well as some off-

grid distribution systems. Myanmar Electric Power Enterprise (MEPE) is responsible for the transmission network. As power is transmitted over long distances, the 230-kilovolt (kV) transmission system experiences a significant decrease in voltage, in some case exceeding 10%. Therefore, MOEP is planning to build a 500 kV transmission system to facilitate the efficient transmission of power from hydrogeneration in the north to the main load centers in the south. Peak demand in 2012 was 1,790 MW and is expected to reach 2,060 MW in 2013, with a generation shortfall of about 500 MW in the dry season. MEPE has a 5-year expansion plan for the transmission network (2011–2016). The plan envisages building 44 new transmission lines with total investment requirements estimated at \$660 million, and 46 new substations at a cost of about \$320 million. Two distribution companies, ESE and Yangon City Electricity Supply Board (YESB), provide electricity to all grid-connected consumers. Together in their respective areas, they operate the national distribution network, which includes 33 kV (7,269 km), 11 kV (13,974 km), 6.6 kV (1,327 km), and 400 volt (15,500 km) lines; they serve 2.43 million consumers in 13 states and regions. ESE and YESB are currently expanding the 33 kV and 11 kV networks, adding significant new substation capacity, and gradually eliminating the inefficient and redundant 6.6 kV system. In parallel with this expansion, ESE and YESB are carrying out system improvements to reduce losses and enhance the quality of the supply. Technical and nontechnical losses have been reduced from as high as 30% in 2003–2009 to less than 20% in 2012.

9. **Power demand, planning, and tariffs.** With a population of about 60 million, Myanmar's per capita electricity consumption was 140 kWh per year in 2012—the lowest among members of the Association of Southeast Asian Nations (ASEAN). Total electricity consumption in 2012 was 8,434 GWh, nearly 2.5 times the consumption of 3,268 GWh in 2001. The most rapid growth in power consumption was in the industry sector (an average annual growth rate of 6.9% from 2001 to 2012), followed by commerce (4.9%), and transport (2.3%). Yangon City has the highest electrification ratio (72%), followed by Nay Pyi Taw (65%), Kayar (42%), and Mandalay (35%). The remaining rural areas are still poorly electrified as reflected in ESE's average ratio of 21% for these areas. The Department of Electric Planning (DEP) prepared the most recent demand projection in 2001; it has not been systematically revised since then. Power system planning is based on supply availability and the assumption that all power that will be generated will be consumed. Future demand projections, resource availability, technical specifications, and cost parameters are not explicitly linked in this approach. Electricity produced by hydropower and coal-fired power stations is sold to MEPE at a constant price of MK20/kWh, well below the generation cost of MK60/kWh for coal and MK130/kWh for combined-cycle gas turbines. From January 2012, the electricity tariffs was MK35/kWh for general purpose (households), street lighting, and government offices; and MK75/kWh for domestic power, and small and bulk power.<sup>2</sup> The government recently announced the increase in electricity tariff to become effective from 1 April 2014: MK35/kWh for households (until 100 kWh) and MK50/kWh (for 101 kWh and above); MK100/kWh for industry, enterprise, and lumpsum (until 5,000 kWh) and MK150/kWh for industry, enterprise, and lumpsum (for 5,001 kWh and above); MK50/kWh for government offices; and MK100/kWh for industrial use of government departments. Off-grid consumer tariffs vary depending on the cost of generation by diesel or other means (e.g., solar, mini-hydropower) and may range from MK100/kWh to MK300/kWh.<sup>3</sup>

10. **Energy efficiency.** The government's key sector objectives are energy efficiency and conservation. In line with the ASEAN target, the government aims to save 5% of primary energy

<sup>2</sup> The tariff for foreigners is \$0.12/kWh. MOEP requested the electricity tariffs of MK50/kWh for general purpose and MK100/kWh for domestic power in January 2012.

<sup>3</sup> The tariff for foreigners is \$0.12/kWh.

consumption by 2020 and 8% by 2030 compared with the baseline in 2005. The Ministry of Energy (MOE) is the focal point for energy sector coordination. The Ministry of Industry handles energy efficiency activities. Myanmar does not have a legal and regulatory framework for energy efficiency, or a central and dedicated organization for those activities.

11. **Core sector issues and constraints.** The main issues and constraints facing the energy sector, especially the power subsector, include (i) persistent power supply shortages in Yangon; (ii) high technical and nontechnical losses because of poor maintenance of power transmission and distribution systems, and gas pipeline networks; (iii) lack of technical capacity of staff; (iv) lack of a planning function, e.g., no long-term supply and demand projections, and no analysis of alternative supply options; (v) the government-controlled pricing policy; (vi) absence of policies on energy efficiency and climate change; (vii) absence of legal safeguard requirements; and (viii) need to consolidate the responsibilities of seven ministries within the energy sector, with a limited overall planning mandate of MOE.

## 2. Government's Sector Strategy

12. Seven ministries are responsible for energy matters: (i) MOE—overall energy policy and coordination, and the oil and gas subsector; (ii) MOEP—electric power; (iii) Ministry of Mines—coal; (iv) Ministry of Agricultural and Irrigation—biofuels and micro-hydro for irrigation; (v) Ministry of Science and Technology—renewable energy; (vi) Ministry of Environmental Conservation and Forestry—fuelwood, climate change, and environmental safeguard requirements; and (vii) Ministry of Industry—energy efficiency. The Energy Planning Department within MOE is responsible for energy and policy formulation, and for coordinating the energy development programs, particularly for the oil and gas subsector. Myanmar Oil and Gas Enterprise is responsible for the exploration, production, and transportation of oil and gas. Myanmar Petrochemical Enterprise is responsible for the operation of refineries, urea fertilizer plants, methanol, and liquefied petroleum gas plants. Myanmar Petroleum Products Enterprise is responsible for the marketing and distribution of petroleum products. Updated energy policies and strategies will help the country to develop its energy resources. These strategies include (i) inviting foreign technical experts and foreign investment into the oil and gas subsector, (ii) expanding the capacity of liquefied petroleum gas plants and implementing new liquefied natural and petroleum gas production projects, and (iii) substituting the use of liquid fuel in the transport sector with compressed natural gas. Myanmar's energy policy framework includes maintaining independence, promoting the wider use of new and renewable sources of energy, promoting energy efficiency and conservation, and promoting the use of alternative fuels in households.

13. To promote and enhance energy efficiency activities, the government has identified the following needs: (i) strong government commitment, (ii) central and dedicated energy efficiency organization and confirmed roles, (iii) an energy efficiency policy and guidelines, (iv) detailed information on energy use, (v) institutional strengthening and capacity building, (vi) increased awareness of energy conservation through training, (vii) good energy management practices for industry and commerce, (viii) a labeling program for appliances and energy service companies, (ix) greater interest of financial institutions, and (x) energy price with full cost recovery and a reasonable rate of return. Although Myanmar has not issued a specific climate change policy statement, several pertinent policy announcements by senior government officials apply. A climate change policy will be developed under the National Environmental Conservation Committee (formed in April 2011).

### 3. ADB Sector Experience and Way Forward

14. Since joining ADB in 1973, Myanmar has received five energy sector loans from ADB totaling \$31.8 million<sup>4</sup> and three technical assistance (TA) projects totaling \$1.27 million.<sup>5</sup> ADB continues to monitor energy sector activities and economic developments in Myanmar. The country has been a member of ADB's Greater Mekong Subregion working group on energy and regional power trade since 1992. Much of ADB's information and data on Myanmar's energy sector originates from the working group's regional power trade coordinating meetings on the power system, planned generation, and transmission expansion plans. ADB has not undertaken any analytical work on the energy sector to determine sector needs.

15. On the basis of ADB's initial assessments, the following are needed in short term: (i) a detailed energy sector assessment, including long-term demand projections and supply options, and investment requirements for meeting the growing energy demand; (ii) advisory TA for institutional strengthening and coordination in the energy sector and capacity building; (iii) rehabilitation of power generation, transmission, and distribution facilities; and (iv) capacity building in environmental and social safeguards in the Environmental Conservation Department within the Ministry of Environmental Conservation and Forestry. Through policy dialogue with the government, ADB is encouraging the introduction of two to three more tariff categories for consumers, including a lifeline tariff for poor and small consumers, and increasing the current tariff to ensure long-term financial sustainability of the power subsector and attract private sector investments.

16. Medium-term needs include (i) tariff and structural reforms in the sector, (ii) assessment and promotion of renewable energy and energy efficiency, (iii) hydropower development policy and planning, (iv) rural electrification (expansion of transmission and distribution line projects and off-grid renewable energy options), and (v) rehabilitation and expansion of natural gas pipeline networks.

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<sup>4</sup> Five loans include (i) ADB. 1973. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Socialist Republic of the Union of Burma for the Power Transmission Project*. Manila (Loan 0160/0161, \$6.1 million); (ii) ADB. 1975. *Report and Recommendation of the President to the Board of Directors: Proposed Supplementary Loan to the Socialist Republic of the Union of Burma for the Power Transmission Project*. Manila (Loan 0242, \$6.1 million); (iii) ADB. 1979. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Socialist Republic of the Union of Burma for the Sedawgyi Hydropower Project*. Manila (Loan 0395, 14.6 million); and (iv) ADB. 1980. *Report and Recommendation of the President to the Board of Directors and Appraisal Report: Proposed Program Loan to the Socialist Republic of the Union of Burma for the Petroleum Refining Industry*. Manila (Loan 0491, \$5.0 million).

<sup>5</sup> The three TA projects are (i) ADB. 1980. *Technical Assistance to the Socialist Republic of the Union of Burma for the Mini-Hydropower Project*. Manila (TA 0385, \$220,000); (ii) ADB. 1987. *Technical Assistance to the Socialist Republic of the Union of Burma for Institutional Strengthening within the Ministry of Energy*. Manila (TA 0886, \$600,000); and (iii) ADB. 1987. *Technical Assistance to the Socialist Republic of the Union of Burma for the Oil and Gas Development Project*. Manila (TA 0934, \$500,000).

### Problem Tree for Energy

