

# MYANMAR

## ENERGY SECTOR ASSESSMENT, STRATEGY, AND ROAD MAP

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December 2016



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# Weights and Measures

km	kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
MMBtu	million British thermal unit
MMCFD	million cubic feet per day
mtoe	million ton of oil equivalent
MW	megawatt

# Currency Equivalents

(as of 31 October 2016)

Currency unit	=	Myanmar kyat (MK)
MK1.00	=	\$0.00077551
\$1.00	=	MK1,289.47

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# Abbreviations

ADB	Asian Development Bank
EPGE	electricity power generation enterprise
FY	fiscal year
IPP	independent power producer
JICA	Japan International Cooperation Agency
MOEE	Ministry of Electricity and Energy
MOGE	Myanmar Oil and Gas Enterprise
MOU	memorandum of understanding
NEP	National Electrification Plan
PRC	People's Republic of China
TA	technical assistance
TPES	total primary energy supply

# I Sector Assessment: Context and Strategic Issues

## A. Introduction

1. This sector assessment, strategy, and road map documents the Asian Development Bank's (ADB) current assessment and strategic investment priorities of the Government of Myanmar in the energy sector. It highlights sector performance, major development constraints, government plans and strategy, past ADB support and experience, other development partner support, and future ADB support strategy. The assessment, strategy, and road map is linked to and feeds into ADB's country partnership strategy for Myanmar. It will be updated as strategic developments and program changes are needed. It will also help to provide sector background information for investment and technical assistance (TA) operations.

## B. Overall Sector Context

### 1. Overview

2. **Overall context.** Myanmar has been reconnected with the world economy since its major reforms in 2011. As per the 2014 census, its population is 51.48 million. Gross domestic product growth increased from 5.6% in fiscal year (FY) 2011 to an average of over 8% from FY2013 to FY2015, reflecting strong expansion in construction, manufacturing, and services. Growth is expected to further accelerate to 8.3% in FY2015 and remain close to this pace in FY2016. This optimistic projection is based on the country's abundant natural resources; strategic location at the crossroads of Asia; and a large, youthful population. To realize it, however, the country needs to successfully implement extensive reforms and integrated policies, build basic infrastructure, and tackle many bottlenecks.<sup>1</sup> The development of energy sector is key to the country's future.

3. **Energy for socioeconomic growth and development.** Myanmar has abundant energy resources, particularly hydropower and natural gas. The hydropower potential is estimated to be more than 100,000 megawatts (MW) in terms of installed capacity. Natural gas is a major export resource, which generated \$2.1 billion export revenue in the first half of FY2014. Additional revenue of about \$2.7 billion per year is likely from new gas fields. Strategically located between Bangladesh, India, People's Republic of China (PRC), Lao People's Democratic Republic, and Thailand, Myanmar has the advantage of exporting energy resources to these countries to fulfill their high energy needs due to rapid economic growth. Overall, the energy sector accounted for 55% of export earnings and 86% of foreign direct investment in 2013. Energy is also a necessity for socioeconomic development to meet basic human needs and support industrial development.

4. However, the country's energy sector has been underdeveloped due to a lack of financial and technical capacity and global isolation. Furthermore, inadequate power supply has emerged as one of the

<sup>1</sup> ADB. *Myanmar Unlocking The Potential. Country Diagnostic Study*. 2014. Manila.

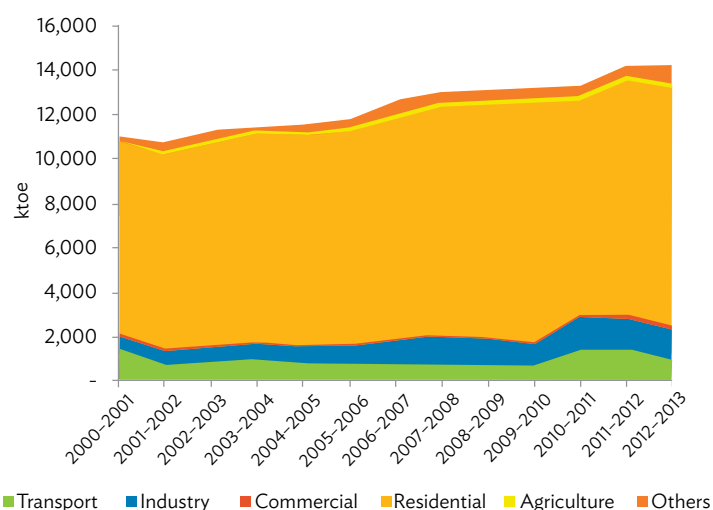


most serious infrastructure constraints for the country's sustainable economic growth. For example, only 34% of the total population had access to electricity in 2014. In terms of per capita electricity consumption, Myanmar is ranked one of the lowest countries in the world, with 110 kilowatt-hours (kWh) per capita in 2011, which is much lower than the world average per capita of 3,000 kWh and even lower than a least developed country average per capita of 174 kWh. In terms of energy intensity, Myanmar was ranked 191 in 2011, making it one of the least energy consuming countries in the world.<sup>2</sup> Traditional biomass (mainly firewood and agricultural wastes) is widely used by most rural people, particularly for cooking and lighting, and access to conventional energy resources is very limited, which impacts the welfare of these people. After the country's opening in 2011, the demand for energy from industry, commerce, and residential sectors is on the rise, placing pressure on the limited energy infrastructure.

5. Compared to its population and economy, the availability and accessibility of modern energy resources are significantly low and hence a bottleneck to improve the living standards and support industrial activities. To tackle such constraints, the government shifted its policy toward increasing domestic energy supply and improving policy frameworks to encourage greater investment in the energy sector. This opens the opportunities for extensive international assistance including public-private partnerships.

6. **Final energy consumption.** Most people use traditional biomass (mainly firewood and agricultural wastes), particularly for cooking and lighting, and this, for example, accounted for 77% of total energy consumption in 2012. Energy consumption grew slowly at an annual average of 2.3% during 2000–2012. The residential sector is the largest consumer of energy, with 75% of total consumption in 2012, mainly in the form of biomass (fuelwood and charcoal), followed by the industry sector (9%), transport sector (8%), and other sectors (6%). The commerce and agriculture sectors make up the remaining 2%. During the period 2000–2012, the commerce sector showed the highest annual energy consumption growth with 5.8%, followed by the residential sector with 1.4% and industry sector with 1.2%. The transport sector, however, had a negative annual average growth (–3.0%) for the same period. Figure 1 shows the historical trends of total final energy consumption.

**Figure 1: Total Final Energy Consumption**



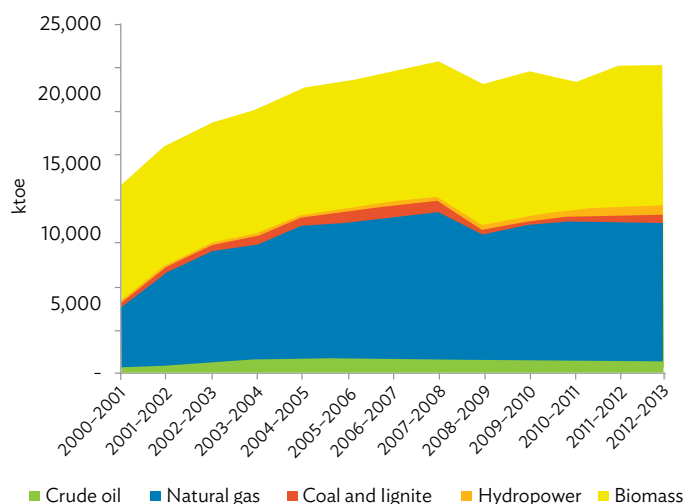
ktoe = kiloton of oil equivalent.

Source: Myanmar Energy Master Plan (Final Report ADB TA No. 8356-MYA). The original data and statistics were collected in physical units from the Ministry of Electricity and Energy and were converted to energy units based on estimates of Myanmar specific calorific values using the methodology documented in the final report chapter B, which may not be identically consistent with alternative sources of energy statistics that are based on standardized calorific value assumptions.

<sup>2</sup> International Energy Statistics by US Energy Information Administration.

7. **Primary energy production.** The total primary energy production was 22.5 million tons of oil equivalent (mtoe) in 2013. Biomass makes up about 46%, followed by gas (43%) and others (11%) consisting of hydropower, oil, and coal. As Figure 2 shows, gas production experienced a rapid growth between 2000 and 2007, with an overall increase of 2.4 times in volume. Biomass production has grown by 26% over the period from 2000 to 2013. Hydropower production, although a relatively minor component, had steady growth with a more than fourfold increase during the same period. Coal production experienced a peak in 2006 but subsequently declined.

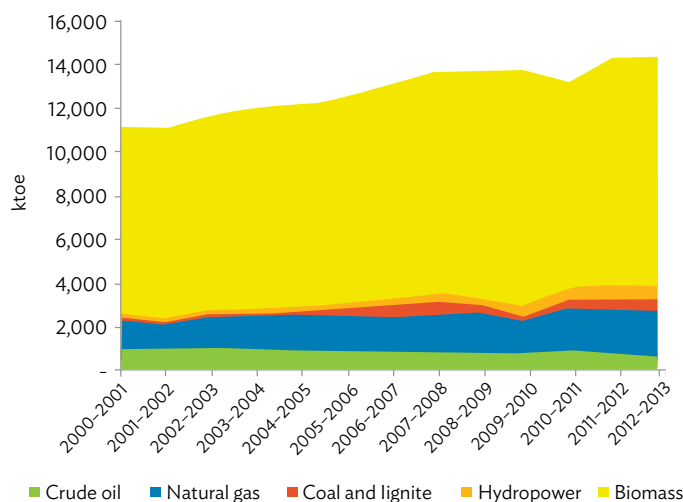
**Figure 2: Total Primary Energy Production**



ktoe = kiloton of oil equivalent

Source: Myanmar Energy Master Plan (Final Report ADB TA No. 8356-MYA). The original data and statistics were collected in physical units from the Ministry of Electricity and Energy and were converted to energy units based on estimates of Myanmar specific calorific values using the methodology documented in the final report chapter B, which may not be identically consistent with alternative sources of energy statistics that are based on standardized calorific value assumptions.

**Figure 3: Total Primary Energy Supply**



ktoe = kiloton of oil equivalent.

Source: Myanmar Energy Master Plan (Final Report ADB TA No. 8356-MYA). The original data and statistics were collected in physical units from the Ministry of Electricity and Energy and were converted to energy units based on estimates of Myanmar specific calorific values using the methodology documented in the final report chapter B, which may not be identically consistent with alternative sources of energy statistics that are based on standardized calorific value assumptions.

8. **Primary energy supply.** Myanmar exports a large fraction of the total primary energy produced and, therefore, the total primary energy supply (TPES) is lower than total primary energy production. Most of the produced gas is intended for export, which accounted for 78.8% in 2012, while the remaining 21.2% is utilized for domestic use. The largest part of domestically utilized gas is for power generation, accounting for 65% of the domestically allocated gas. Figure 3 shows the TPES for the period 2000–2013.

9. In 2000, the country's TPES was about 11.8 mtoe. About two-thirds (7.8 mtoe) of energy supply was from biomass, followed by 16.8% (2.0 mtoe) from oil, and 10.2% (1.2 mtoe) from gas. In 2001, hydropower and coal accounted only for a small share (6.2% from hydropower and 0.7% from coal). However, these proportions are changing: in 2015, the TPES increased to 20.1 mtoe by 35% compared with that in 2000, amounting at about 18.0 mtoe. In 2015, the biomass share dropped to 50.0% (10.0 mtoe), followed by 16.8% (3.4 mtoe) for hydro and 12.0% (2.4 mtoe) for gas. Coal accounted for 1.65% (0.33 mtoe). The influence of natural gas exports increased significantly in the latter part of the period.

## 2. Oil and Gas Subsector

10. **Oil production.** Myanmar was one of the earlier countries to have a national oil and gas industry in the Southeast Asia region. No new oil reservoirs were discovered in the last 20 years, and the production caliber per well is limited because of the natural depletion of reservoirs. The monthly oil production fell from about 1 million barrels in 1984 to about 0.2 million barrels in 2014. Furthermore, improvements from petroleum recovery contracts in some producing fields are not significant, resulting in a decrease in crude oil supply for the domestic market.

11. **Gas production.** The discovery of large offshore gas deposits in the early 1990s led the government to export the gas partly due to low domestic usage at the time. Myanmar's production of offshore gas started in 1998 from the Yadana gas field, followed by the Yetagun gas field in 2000, the Shwe gas field in 2013, and the Zawtika field in mid-2014. The gas fields are explored and developed by private operators as shown in Table 1, and depending on the arrangement with operators, the allocation for domestic supply has been determined.

**Table 1: Status of Key Operating Offshore Gas Fields in Myanmar**

Phase	Gas Field	2P Reserves (TCF)	Block	Main Developer	Export	Domestic Supply (%)
Existing	Yadana	6.9	M-5, M-6	Total	Thailand	20
	Yetagun	4.2	M-12, M-13, M-14	Petronas	Thailand	0
Ongoing	Shwe	5.4	A-1, A-3	Daewoo	PRC	20
	Zawtika	1.8	M-9	PTTEPI	Thailand	20

PRC = People's Republic of China, PTTEPI = A unit of Thailand's PTT Exploration and Production Public Co.

Source: Myanmar Oil and Gas Enterprise. 2013.

12. There are two gas export markets: the PRC and Thailand. The export to the PRC is from the Shwe gas field, which started in 2013 for 4.5 trillion cubic feet of gas over 30 years via an 870-kilometer (km) 40-inch gas pipeline financed and operated by the PRC. Export to Thailand started from the Yadana field in 1998. The total volume of gas export to the PRC and Thailand was 1,300 million cubic feet per day (MMCFD) in 2013.

13. **Gas price.** The gas prices of Yadana are \$7/million British thermal units (MMBtu) (wellhead) and \$12–\$13/MMBtu (borderline). The gas prices of Shwe are \$7.73/MMBtu (wellhead) and \$15–\$16/MMBtu (borderline). In 2013, the export price to Thailand was \$10.30/MMBtu on average. Gas for power generation charged to Electricity Power Generation Enterprise (EPGE) increased from \$5/MMBtu to \$7.50/MMBtu in 2013. Nevertheless, power sector users avail of subsidized gas prices while nonpower sector users pay \$11.20/MMBtu.

14. **Domestic gas supply.** Myanmar Oil and Gas Enterprise (MOGE) supplies 250–300 MMCFD of natural gas to domestic consumers. Of this, about 60 MMCFD is from MOGE's onshore production. The remaining amount is from the Yadana gas field, operated by Total E&P; the Shwe gas field, by Daewoo International; and the Zawtika gas field, by PTT International. Yadana gas is priced at the same level as the export price to Thailand; Shwe and Zawtika gas is priced at the level set for the domestic market obligation. The domestic market obligation price is at a 10% discount of the contract price to foreign buyers. Consumers include EPGE for its power plants (run by both independent power producers [IPPs] and EPGE), other government industries, private industries, and compressed natural gas vehicles.

15. **Gas pipeline.** MOGE constructs and operates domestic oil and gas pipelines and the overall network is 4,100 km. MOGE has been laying the pipes throughout Myanmar to expand its national pipeline network and gas is distributed via an onshore pipeline system (6–24 inch diameter) and offshore from Yadana to Yangon via a 410-km, 24-inch pipeline. This pipeline is currently transporting 200 MMCFD and it could be increased up to 250 MMCFD by compression if the domestic market absorbs more gas supply.

16. **Petroleum retail sector.** Since June 2010, the private sector has been permitted to import and operate gasoline retail outlets. Reflecting an increase in demand, the number of outlets in 4 years has quadrupled and the import of petroleum products (gasoline and diesel) has doubled. As of July 2014, there were as many as 1,281 retail outlets countrywide compared with 269 outlets before June 2010 when it was opened to the private sector. The government operates only 1% of the total outlets compared with 100% before 2010 when it was the sole operator. After the new policies of 2010, there was an exponential growth in diesel sales, from 150 million gallons in 2009 to more than 450 million gallons in 2010.

### 3. Coal Subsector

17. **Coal resources.** It is known that coal existed in 565 places with estimated resources of 540 million tons. The coal is generally low-quality lignite and subbituminous. Coal extraction and use so far has been at a slow pace and there is little application of technology because of low investment and the remoteness of the deposits. Earlier, there were only three active coal mines—in the Sagaing Region and in the north of the Shan state—but now as many as 57 private and government mines are operating. Because all mines are opencast, special attention is required to address the environmental and social issues. Coal production reached its highest level of about 1,400 thousand tons per year in 2007 but decreased since then to less than 700 thousand tons per year in 2013.

18. About half of the coal produced is used for power generation at the 120-MW coal-fired power plant in Tigyt, and a similar amount is used by cement and steel companies. Only a small proportion is used for cooking and heating in households. With the increasing demand for coal in the industry sector and thermal power plants, its production is expected to increase up to 5 million tons a year by 2030 by using technology and funding from foreign investors. Domestic coal prices are set by the market and, depending on the calorific value, vary from about MK9,000–MK25,000 per ton in Shan State to about MK40,000 per ton in the Kalewa Region.

#### 4. Renewable Energy

19. **Large hydropower.** Myanmar has rich hydropower potential that drains the four main basins of the Ayeyarwady, Chindwin, Thanlwin, and Sittaung rivers. It is estimated that there is more than 100,000 MW of installed capacity potential. Myanmar has identified 92 large hydropower potential projects with a total installed capacity of 46,000 MW, while the current installed capacity of hydropower plants is 3,033 MW.

20. **Micro- and minihydro energy.** A total of 26 microhydro and 9 minihydro projects have been implemented with installed capacity ranging from 24 kilowatts (kW) to 5,000 kW to reach remote border areas. An additional five microhydropower projects are planned for eastern Shan State (3), Kachin State (1), and northeastern Shan State (1). A study by the Ministry of Electricity and Energy (MOEE) concluded that there are as many as 210 potential sites of small- and medium-size hydropower projects, each of which have a capacity of less than 10 MW, for a total potential installed capacity of approximately 230 MW. The regional government is permitted to approve small-scale hydro plants (up to 30 MW according to the new Electricity Law [2014]). Through this strategy, small-scale hydropower plants of approximately 40 MW will be developed until 2030.

21. **Solar energy.** Myanmar has a strong solar radiation level, reaching more than 6.5 kWh/square meter and collecting up to 1.9 megawatt-hours annually on a square meter, and 60% of the land area appears suitable for photovoltaics. Due to its mountainous terrain and protected areas, Myanmar's maximum solar power potential is estimated at about 40 terawatt-hours per year. The solar energy potential drops during the rainy season but compensates for the decline of power production from hydropower and wind sources during the dry season. However, the development of solar energy is still in the beginning stages. Solar energy has been introduced in some rural areas in the last decade through photovoltaic cells for charging batteries and pumping water for irrigation. The MOEE is conducting a preliminary investigation to construct solar power plants with foreign direct investment in Minbu, Magway Region, Myingyan, and Mandalay Region.<sup>3</sup> Solar power in Myanmar has an estimated levelized cost of electricity between \$0.16/kWh and \$0.19/kWh.<sup>4</sup>

22. **Wind energy.** Considering that an average wind speed required for modern wind turbines is at least 6 meters/second, most of Myanmar is considered unattractive as average wind speeds are below 4 meters/second, except for coastline and mountain ranges (such as Shan and Chin states). The theoretical wind resource potential in Myanmar is shown as about 80 terawatt-hours per year but site-specific wind data is limited to a few; therefore, an in-depth assessment is needed. Foreign investment

<sup>3</sup> In August 2014, the Ministry of Electric Power, currently the Ministry of Electricity and Energy, signed the first agreement with the US firm ACO Investment for an investment of \$480 million under a build–operate–transfer scheme for the construction of a 300-MW photovoltaic (2 × 150 MW) grid-connected solar power plant in two locations in the Mandalay Region.

<sup>4</sup> ADB. 2014. *Promoting Renewable Energy, Clean Fuels, and Energy Efficiency in the Greater Mekong Subregion*. Consultant's report. Manila (RETA 7679).

proposals for a total of 4,032 MW have been received but none of them has yet to begin any activities.<sup>5</sup> In addition, there are small-scale experimental projects.<sup>6</sup>

23. **Bioenergy.** For biogas, the potential annual yield of wood fuel is up to 19.12 million cubic tons, and 18.56 million acres of land could generate residues, by-products, or direct feedstock for biomass energy.<sup>7</sup> Agricultural by-products, such as sugarcane bagasse, rice straw, rice husks, sesame stalks, and palm leaves, offer limited sources of energy. In addition, there is approximately 103 million heads of livestock generating animal waste that could be used for biogas. Around 190 biogas digesters of varying capacities (5, 15, and 25 kW) have been installed all over the country for lighting and cooking purposes.

24. **Biofuels (biodiesel and bioethanol).** Five biofuel plants have been constructed by various agencies between 2003 and 2010, with a total annual production of 19.5 million gallons. However, these five facilities are not currently in operation due to lack of support (such as subsidies for production), presence of pest and diseases in *Jatropha*-type cultivation, as well as outstanding legal issues. Bioethanol is a convenient fuel acceptable in remote locations and could provide self-sufficiency supply on a community level. In 2009, the government issued a notification permitting the production, transport, storage, and sale of biofuel in Myanmar to encourage the use of biofuel in place of gasoline.

25. **Geothermal, tidal, and waste energy.** For geothermal energy, there are a total of 93 potential locations for commercial geothermal-generated electricity throughout the country. Around 43 of these sites are being assessed and tested. For tidal energy, there are no studies to assess its potential in Myanmar despite a coastal line of 2,832 km. The first tidal power plant (3 kW) was installed in 2007 in Kanbalar village, providing electricity to about 220 households (approximately 1,200 persons).<sup>8</sup> A similar project was being implemented at a salt production site. For waste-to-energy, there is a significant opportunity to develop waste-to-energy projects in urban areas as there is a potential for at least 20 MW of waste-to-energy installed capacity.

## 5. Power Subsector

26. **Consumption.** Total electricity consumption was 11,252 gigawatt-hours in 2015, of which Yangon accounted for 44%. Electricity consumption has grown by 9.8% per year during 2000–2012. The peak load reached 2,500 MW in February 2016.

27. **Generation.** The total installed capacity at mid-2016 is 4,764 MW, with 2,820 MW (59.2%) from hydropower, 1,824 MW (38.3%) from gas, and 120 MW (2.5%) from coal. The MOEE owns about 75% of total installed capacity and the rest owned by private sector. The available capacity is approximately 50% of the installed capacity. Gas and coal power plants are not fully operated due to poor maintenance, and during the dry season hydropower is curtailed. Of the hydropower capacity, 520 MW is reserved for export to the PRC. Nine new projects are forecast to be added by the end of 2016, with the MOEE adding 220 MW and the private sector adding 300 MW. Various other projects of about 1,500 MW are under development for completion by 2020.

<sup>5</sup> There are memorandums of understanding (MOUs) to develop wind power projects. The MOU with the Thailand-based Gunkul Engineering Public Company includes plans to develop 2,930 MW wind power plants in Mon State, Kayin State, Thaninthayi Region, Shan State, and Kaya State; and the MOU with the PRC-based Three Gorges Company includes plans for 1,102 MW wind power plants in Chin State, Rakhine State, Ayeyawady Region, and Yangon Region.

<sup>6</sup> Three microwind power projects (smaller than 3 kW) are currently operating between Yangon University and the MOEE.

<sup>7</sup> ADB. *Status and Potential for the Development of Biofuels and Rural Renewable Energy: Myanmar*. 2011. Manila.

<sup>8</sup> Ibid.



28. There are 10 MOEE-owned gas-fired power plants for a total capacity of 943 MW and one MOEE-owned coal-fired power plant with a capacity of 120 MW. Nine privately owned gas-fired power plants for a total capacity of 661 MW have been added since 2012. Availability of the non-IPP plants is approximately 31%. Replacement of the Thaton 51 MW open-cycle gas turbine power plant with a 106 MW combined cycle gas turbine power plant financed by the World Bank is under implementation. The award of an IPP contract to construct the Myingyan 250 MW combined cycle gas turbine was done in 2015. Various other government and IPP projects are under development.

29. **Transmission and distribution.** The country's transmission system comprises a network of 230-kilovolt (kV), 132-kV, and 66-kV transmission lines and substations. Most of these lines lead from the northern part of the country, where most hydropower plants are, to the southern load centers, particularly the Yangon area. A 454-km long 500-kV transmission line is under implementation from north to south through bilateral assistance. The first section of 146 km from Meiktila (in Mandalay) to Taungoo (Phase I), which is financed by the Government of Serbia, is almost complete. The middle section of 188 km from Taungoo to Karmarnat (near Bago) (Phase II) was confirmed for financing by the Government of the Republic of Korea (\$100 million) in 2014. The Government of Japan will finance the last section of 120 km from Karmarnat (near Bago) to Hlaingtharyar in Yangon (Phase III). The current transmission lines are mostly single circuit, with relatively few double-circuit connections. Structure designs are mostly lattice steel towers, with a variety of portal and conventional freestanding towers, some with overhead lightning protection earth wires. Lines are generally in good condition. The distribution system comprises a network of 33-, 11-, and 6.6-kV lines and substations. Technical and nontechnical losses of the combined transmission and distribution system were as high as 30% in 2003 and fell to 20% in 2013. To improve efficiency, it is planned to phase out the 6.6-kV systems in favor of an 11-kV network, and to expand the 33-kV systems.

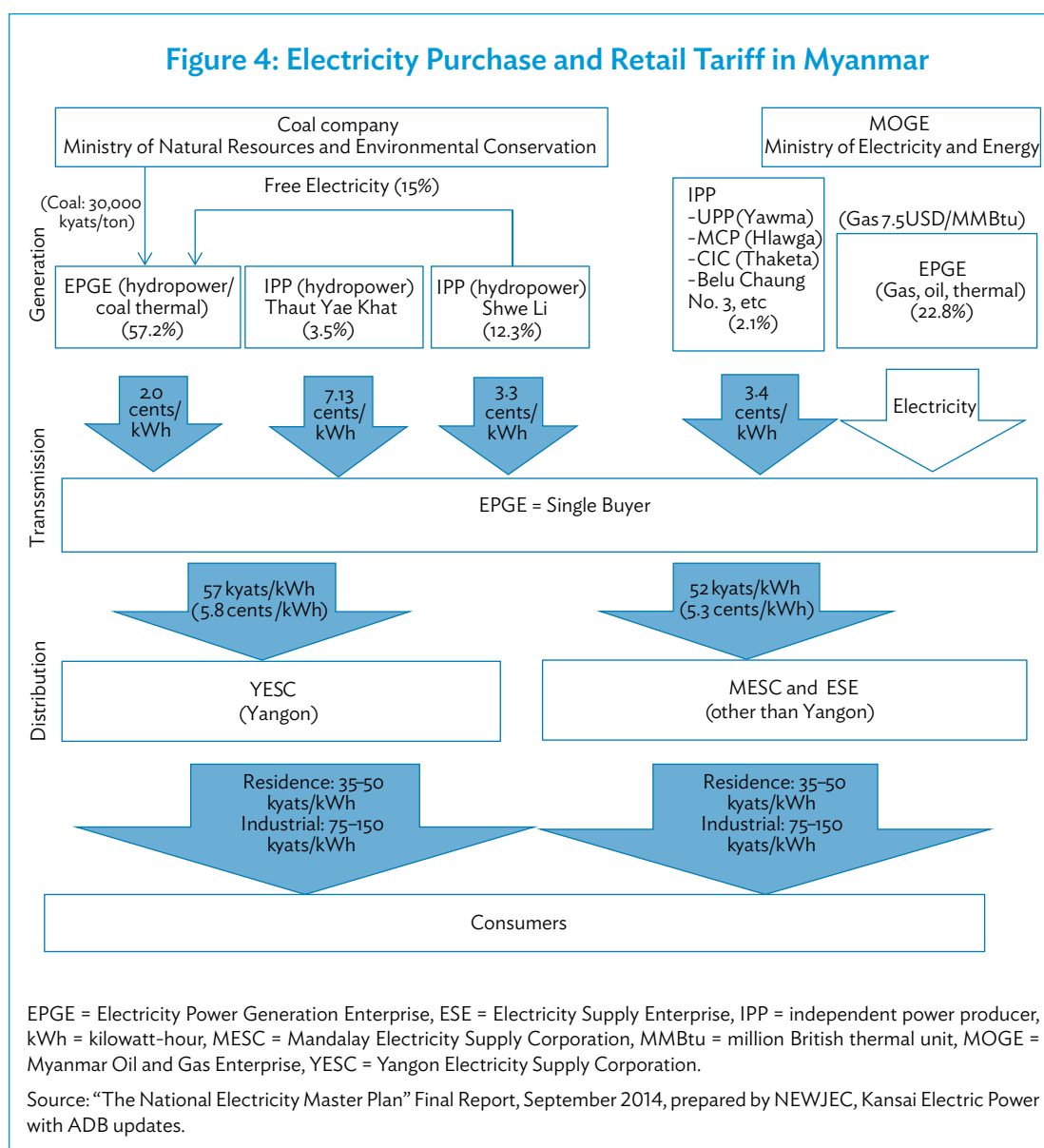
30. **Electrification.** The country's average electrification ratio has grown from about 16% in 2006 to 26% in 2011 to 34% in 2015. Yangon City has the highest electrification ratio of approximately 78%, followed by Kayar (46%), Mandalay (40%), and Nay Pyi Taw (39%). The remaining rural areas are still poorly electrified, averaging less than 20%. In Kayin and Tanintharyi states, it still remains under 10%. Under the national target of universal access by 2030, the government approved the National Electrification Plan (NEP) in September 2014, which proposes an aggressive grid electrification rollout program and an ambitious off-grid program. For this, the state and regional governments are permitted to approve small-scale hydropower plants up to 30 MW according to the new Electricity Law of 2014.

31. **Electricity tariff.** The retail tariff is set at MK35–MK50/kWh for households and MK75–MK150/kWh for industry, depending on their consumption level. It was raised in April 2014 by an average of 40% from the previous tariff; however, it is still lower than the actual cost of supply and one of the lowest tariffs in Southeast Asia, consequently causing losses to the government. Figure 5 shows electricity purchase and tariff arrangements.

32. **Single buyer.** The Myanmar Electric Power Enterprise, the entity then responsible for gas-fired electricity generation and transmission, was the single buyer having the authority to purchase electricity from different operators including IPPs through individual power purchase agreements and sell it to state-owned distributors. In 2016, Myanmar Electric Power Enterprise's functions were split between the Power Transmission and System Control Department and EPGE. Single buyer responsibility is now allocated to EPGE.

33. **Government institutions.** In April 2016, the government restructured its organization and reduced the number of ministries from 36 to 21. This included the merging of the Ministry of Energy and Ministry of Electric Power into the new MOEE, which is responsible for oil and gas and electricity operations. Other ministries related to the energy sector include (i) Ministry of Agriculture, Livestock, and Irrigation with responsibility for off-grid rural electrification, (ii) Ministry of Natural Resources and Environmental Conservation with responsibility for coal mining, and (iii) Ministry of Industry with

Figure 4: Electricity Purchase and Retail Tariff in Myanmar

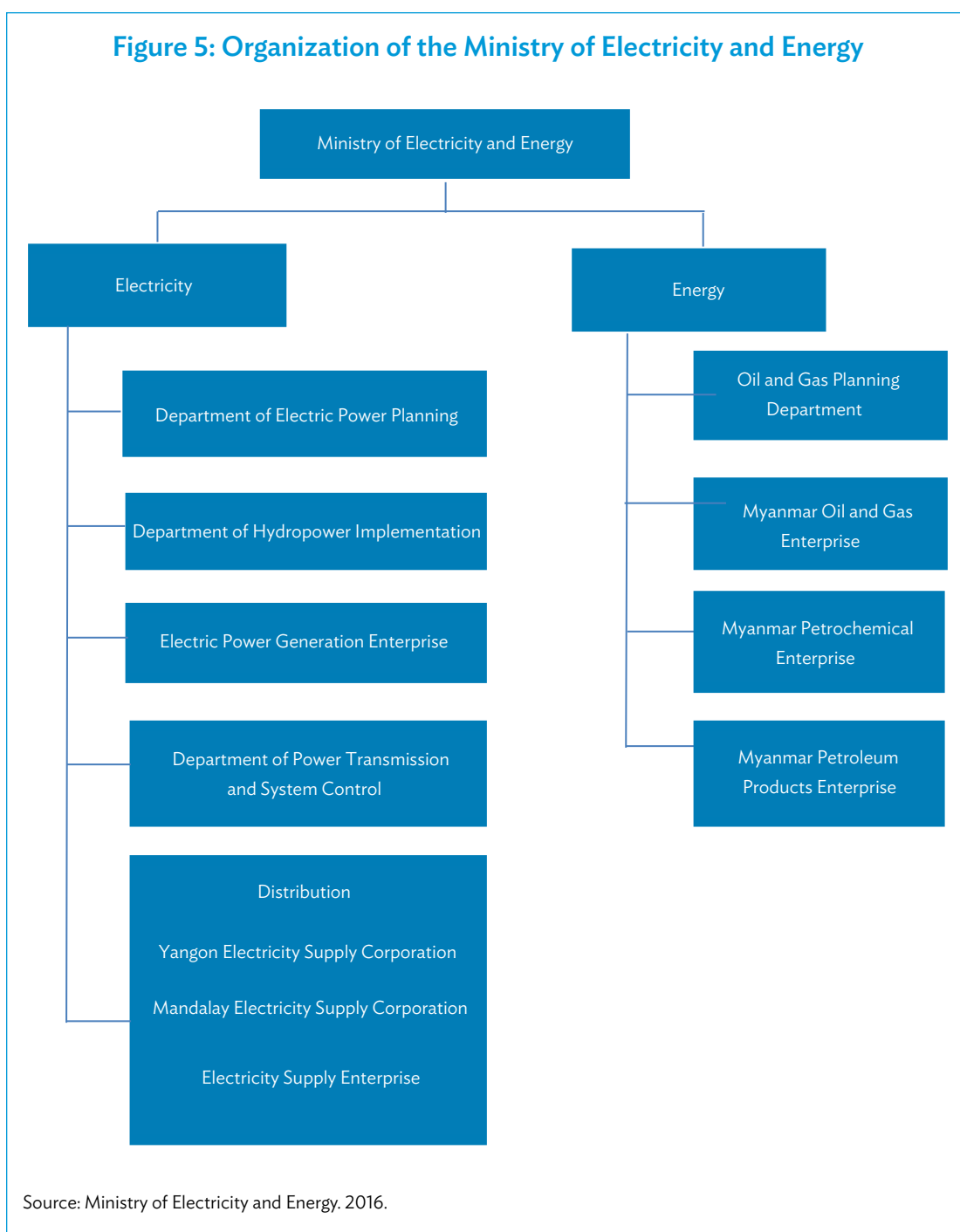


responsibility for energy efficiency. The organization chart of MOEE, based on then structures of the Ministry of Energy and Ministry of Electric Power, is shown in Figure 5.

34. **Private sector participation.** The private sector has demonstrated strong interest in developing commercially operated power plants. The government signed memorandums of understanding (MOUs) with developers promoting 44 hydroplants, 11 gas-fired power plants, and various solar power plants. These projects are at various stages of development. Since 2013, 620 MW of gas-fired IPP projects have been added, representing 40% of the total gas fleet. The Myingyan 225 MW gas IPP is at an advanced stage of development.

35. To strengthen the coordination and cooperation between line ministries for the energy sector, the government established the National Energy Management Committee in January 2013 by the President Office Notification No. 12/2013 and the National Electrification Executive Committee in September 2014. In light of the ministerial reorganization in April 2016, the government abolished



**Figure 5: Organization of the Ministry of Electricity and Energy**

more than 100 committees including the National Energy Management Committee and National Electrification Executive Committee. The government is reviewing the need to establish new coordinating committees in the energy sector.

## 6. Energy Efficiency

36. Myanmar has significant potential in its industrial and commercial activities for substantial savings in energy consumption. The potential savings estimated are 45% for the iron and steel industry, 65% for pulp and paper, and 35% for sugar mills due to their high electrical and thermal demands. In the commerce sector, office buildings and hotels continue using inefficient incandescent lighting and electric hot water systems. Significant energy savings could be achieved through the use of high-efficiency fluorescent and light-emitting diode lighting and solar hot water systems. In addition, there is no official energy efficiency certification that can be applied to new commercial buildings or those that have been refurbished to meet such standards.

37. Biomass, which accounted for 77% of the total energy consumption in 2012, is primarily consumed by the rural population, which comprises 70% of the total population. Hence, the adoption of efficient technologies, especially in cooking, would make a significant contribution to improve the quality of life of rural households by enabling affordable and reliable energy supply. The current market penetration of energy-efficient products such as lights, air conditioners, refrigerators, and other home appliances is low. Most of the electrical products are imported mainly from the PRC and India and have no labeling on energy performance. Energy rated products from Thailand are available in some stores but with an extremely low market share due to the cost differential. There is potential for significant energy savings through the introduction of Minimum Energy Performance Standards and Energy Labeling schemes.

38. The initial target for energy efficiency set by the Ministry of Energy in 2008 was 5% reduction in total energy consumption by 2015 and 8% by 2020 from the 2005 level. The basis for these targets is in line with targets set by the Association of Southeast Asian Nations. To strengthen the institutional setup, an energy efficiency and conservation division under the Directorate of Planning at Ministry of Industry was established in April 2014.

## 6. Climate Change

39. Consistent with its predominantly hydro-based power production and low industrial development, Myanmar has one of the lowest levels of absolute and per capita greenhouse gas emission rates in the world. This is unlikely to change significantly in the medium-term future. However, climate change is expected to have a major impact in Myanmar with forecasts of increased flooding, sea levels rises, and increased temperature variations. Climate change adaptation is therefore the priority concern for Myanmar.

## C. Core Sector Issues, Causes, and Effects

40. Core sector issues are (i) uncertainty over sector planning and introduction of new policy frameworks impeding private sector investment and mobilization of finance; (ii) outmoded sector structure with state-owned enterprises being under the direct control of the MOEE and with the transmission function being a department within the MOEE while the MOEE has conflicting responsibilities for investment, policy, regulation, and commercial performance; (iii) outdated or absent legal rules and regulations; and (iv) concerns about sector sustainability with below-cost tariffs and cross-subsidization, and weak capacity of government and institutions. Although progress is being made on all these issues, ongoing and expedited progress is needed to ensure the required scale of investments is met and sector performance is improved such that government targets are met of an efficient and sustainable sector providing energy to the entire population.

41. **Oil and gas subsector.** Local refineries are operating well below capacity and the growing demand for energy has led to an increase in the importation of petroleum products and improvement of domestic refinery operation and capacity. Considering existing plans for expansion of gas production as well as demand forecasts, there are possible shortages of natural gas supply for domestic use. There are an increasing number of leakages in the gas pipeline system and it is estimated that more than 100 leaks were detected, accounting for 1.5% of the total production and causing \$1 million in losses in 2013. The out-of-date gas pipelines and refineries and urea fertilizer plants are inefficiently operating at government-set budget levels. All the operations of the oil and gas subsectors are handled and governed by the government (MOGE, Myanmar Petrochemical Enterprise, and Myanmar Petroleum Products Enterprise) under the MOEE and their technical, managerial, and negotiation skills are much lower than the competing international companies. In response to all these challenges, the oil and gas subsector needs to (i) improve domestic refinery operation; (ii) determine the optimal allocation of natural gas for maximum benefit of the country; (iii) encourage more private sector participation; (iv) expedite the process for the corporatization of MOGE, Myanmar Petrochemical Enterprise, and Myanmar Petroleum Products Enterprise; (v) gradually reduce subsidies and use market-based pricing mechanism; and (vi) improve human resources development in oil and gas subsector operation and management.<sup>9</sup>

42. **Power subsector.** The core subsector issues are summarized as follows:

- (i) **Funding:** Under a medium-growth scenario identified in the draft Energy Master Plan, the 2030 forecast demand of 58 gigawatt-hours will require increasing installed capacity to 16 gigawatts (from 4.3 gigawatts in 2015). A least cost investment plan in the draft Energy Master Plan identifies required generation investments of \$28 billion. Under a high-growth scenario, and depending on fuel mix, required generation investment rises to approximately \$45 billion as identified in a Japan International Cooperation Agency (JICA)-financed Power Sector Master Plan. Required investments are \$5 billion–\$7 billion in transmission and \$6 billion in distribution. In a medium-growth scenario with a least cost expansion plan, \$40 billion is required. Mobilizing such investments will require both private sector investment and ongoing development partner support.
- (ii) **Private sector investments:** The private sector has strongly responded to the needs for generation investment by proposing unsolicited hydropower, thermal, and solar projects, resulting in approximately 60 MOUs signed between various developers and the government. One competition for thermal generation, conducted with support from ADB and World Bank, has resulted in the Myingyan 225-MW gas-fired power plant. An analysis under an ADB TA compared Myingyan with similar MOU projects and identified that competitive procurement results in superior commercial terms for the government in all cases.<sup>10</sup> The analysis also noted that MOU projects may not optimally meet the government's needs in technology and schedule. A series of competitive procurements based on approved investment plans will better meet the government's needs.
- (iii) **Generation fuel mix:** The government is studying the optimum fuel mix for 2030 with assistance from development partners. Earlier but dated studies recommended a gas, hydropower, coal, and renewable energy mix to maximize the security and reliability of supply with minimum social and environmental impact and cost. The government is now examining options with no coal and using imported liquefied natural gas and

<sup>9</sup> MOGE is inviting foreign private companies for (i) gas pipeline construction and maintenance works, (ii) seismic data acquisition services for onshore fields, and (iii) drilling services onshore using MOGE's drilling rigs.

<sup>10</sup> ADB. 2014. *Technical Assistance to the Republic of the Union of Myanmar for Support for Public-Private Partnership Framework Development*. Manila. Ongoing.

- imported electricity. An approved plan will assist the government and private sector in implementing optimum investments at an appropriate time.
- (iv) **Energy efficiency:** There is a large financing gap for energy efficiency and conservation investments in the industry sector. Although the majority of industrial energy efficiency investments are financially viable, most enterprises with low energy costs would rather invest in business expansion than promoting energy efficiency measures. The same is also true for the commercial sector. In addition, there is an urgent need for improved and comprehensive data quality, improved capacity of stakeholders, and supporting institutions and resources.
  - (v) **Subsector commercialization:** While the government is encouraging private sector participation, the electricity sector remains a largely state-owned vertically integrated utility. Plans to restructure and corporatize the power subsector are in hand and must be implemented to ensure a commercial and efficient industry.
  - (vi) **Policy reforms:** Although the new Electricity Law was passed in 2014 allowing private sector participation, the associated Rules and Regulations, which is to be finalized, must address details on implementation of the law and establishment of the Energy Regulatory Commission and its duties and powers.
  - (vii) **Tariffs:** Below-cost tariffs result in insufficient investment for proper maintenance and expansion of infrastructure required for universal national electrification and system growth. New generation projects proceeded by IPPs will increase the power purchase prices and, therefore, will continue to deteriorate government financial standing unless electricity tariffs are increased.
  - (viii) **Electrification rate:** Government policy is to increase electrification from 34% to 100% by 2030. Such a pace of electrification will be challenging given the geographical and institutional constraints.
  - (ix) **Capacity development:** Significant capacity gaps exist in terms of technical and engineering skills as well as planning capabilities, such as supply and demand projections and least cost and alternative supply analysis. Capacity gaps also exist in environmental and safeguard assessment and economic and financial analysis.

## II Strategy

### A. Government Sector Strategy, Policy, and Plans

43. **Development plan and reform program.** The government has prepared a set of reform programs aiming to transform the country to a modern, democratic, and developed nation by 2030. The framework for these reforms was laid down in the 2011–2031 “National Comprehensive Development Plan.” The 2012 “Framework for Economic and Social Reforms” aimed to achieve poverty alleviation, improved infrastructure, and capacity building through many plans, such as (i) rural development and poverty alleviation; (ii) human resources development, investment, and trade sector development; (iii) industrial development; (iv) finance sector development; and (v) regional and sector-wise development.

44. **National energy policy.** To ensure development of the energy and electricity sectors, the NEMC prepared the National Energy Policy paper which was approved by the President in January 2014. The paper summarized the national energy sector policies as follows:

- (i) To implement short-term and long-term comprehensive energy development plans based on systematically investigated data on the potential energy resources that are feasible and can be practically exploited, considering minimum impact on natural environment and social environment.
- (ii) To institute laws and rules and regulations to promote private sector participation and privatize state energy organizations in line with State Economic Reform Policy.
- (iii) To compile systematic statistics on domestic demand and supply of various different kinds of energy resources of Myanmar.
- (iv) To implement programs through which local population could proportionally enjoy the benefit of energy reserve discovered in the areas.
- (v) To implement programs on a wider scale, utilizing renewable energy resources such as wind, solar, hydropower, geothermal, and bioenergy for the sustainable energy development in Myanmar.
- (vi) To promote energy efficiency and energy conservation.
- (vii) To establish a research, development, design, and dissemination institution to keep abreast with international practices in energy resources exploration and development works, and to produce international quality products and conduct energy resources exploration works in accordance with international standards.
- (viii) To promote international collaboration in energy matters.
- (ix) To formulate appropriate policy for energy product pricing, meeting economic security of energy producers and energy consumers.

45. Government plans as set out in the National Energy Policy paper include sector restructuring, investment planning, pricing and fuel subsidy review, renewable energy and energy efficiency development, promotion of private sector, increased international trade, and a national electrification program to achieve 100% electrification by 2030. These plans are at various stages of development and implementation with (i) a new electricity law approved in 2014 allowing for corporatization,

private sector participation, and establishment of an independent electricity regulatory commission; (ii) energy sector and power subsector plans to be completed identifying required investments; and (iii) commencement of a national electrification program.

## B. ADB's Sector Support Program and Experience

46. **ADB's sector experience.** Since 2012, ADB has been a lead development partner in the energy sector. ADB's initial assessment of Myanmar's energy sector (2012) outlined the need for (i) preparation of a detailed energy sector assessment including demand projections, supply options, and investment plan; (ii) an 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.<sup>11</sup> Separate from project preparatory TA projects, a summary of capacity development and policy and advisory TA projects is as follows:

**Table 2: ADB's Capacity Development and Policy and Advisory TA Projects to Myanmar**

	Description	TA Number	Status
1.	Capacity development and institution support	TA 8244-MYA	Completed
2.	Policy, strategy, and energy master plan development	CDTA 8356-MYA	Ongoing
3.	Legal and regulatory framework development	PATA 8469-MYA	Completed
4.	Off-grid renewable energy demonstration	CDTA 8657-MYA	Ongoing
5.	Investment project identification and feasibility study	TA 8251-MYA	Completed
6.	Financial management assessment of energy sector	S-CDTA 8216-MYA	Completed
7.	Country safeguard system strengthening	RETA 7566 and CDTA 8786-MYA	Completed
8.	Public-private partnership framework development	CDTA 8624-MYA	Ongoing

CDTA = capacity development technical assistance, MYA = Myanmar, PATA = policy advisory technical assistance, RETA = regional technical assistance, TA = technical assistance.

Source: Asian Development Bank.

47. In 2013, ADB provided a \$60 million loan to rehabilitate the distribution network in five townships in Yangon, four districts in Mandalay, five districts in Sagaing, and two townships in Magway. ADB also approved an \$80 million loan focusing on strengthening the 230-kV transmission lines and substations in the Yangon area. ADB also approved a loan and political risk guarantee of \$260 million to the project company of the Myingyan gas power plant.

## C. Other Development Partner Support

48. **World Bank Group.** Since May 2013, the World Bank Group has been assisting MOEE and the Ministry of Agriculture, Livestock and Irrigation in preparing the NEP focusing on power distribution extension and off-grid applications. In line with the NEP, the World Bank Group has approved a \$400 million International Development Association credit to support the first phase of its implementation in parallel with an International Finance Corporation Lighting Myanmar Program. In 2013, the World Bank approved the \$140 million International Development Association credit to support replacement

<sup>11</sup> ADB. 2012. *Myanmar: Energy Sector Initial Assessment*. Manila.

of the existing gas turbine station in Thaton with a new combined cycle gas turbine power plant. This credit also provides TA for the energy sector, including transaction advisory services provided by the International Finance Corporation for the corporatization of Yangon Electricity Supply Board (Yangon Electricity Corporation since April 2015) and procurement of Myingyan IPP.

49. **Japan International Cooperation Agency.** Since June 2013, JICA has been assisting the MOEE in preparing the National Electricity Master Plan focusing on power sector generation and transmission sector planning. The report was submitted in September 2014 and JICA is now assisting in its update and revision. Ongoing and planned JICA loans and grants, totaling more than \$1 billion, cover all power subsectors. These include the following:

- Power Generation: (i) Urgent Rehabilitation and Upgrade in Yangon (\$40 million), (ii) Infrastructure Development in Thilawa (\$100 million), (iii) Rehabilitation of Baluchaung No. 2 Hydropower (\$70 million);
- Power Transmission: (i) National Power Network Development 500 kV Phase I (\$250 million) and (ii) National Power Network Development 500 kV Phase II (\$400 million); and
- Power Distribution and Electrification: (i) Power Distribution Improvement in Yangon (\$60 million), (ii) Power Distribution Improvement in Major Cities (study completed), (iii) Rural Power Infrastructure Development Phase I (\$40 million loan), (iv) Rural Power Infrastructure Development Phase II (\$40 million loan under study).

50. **KfW and GIZ.** The German development bank on behalf of the German government supports rural electrification in off-grid areas and by grid expansion under the NEP. A grant fund of €7 million (€2 million for TA and €5 million for investment) for a solar home system program in southern Shan State has been allocated. In addition, a program for extending the grid to rural areas in Shan State, which amounts to a €30 million (€24 loan and €6 million grant) under the MOEE, is under preparation. The federal agency for international cooperation for development on behalf of the German government is providing €2 million for TA in rural electrification policy.

51. **Department for International Development.** It has provided financial support to the International Finance Corporation for the Myingyan 250 MW IPP Transaction Advisory Services and ADB for public-private partnership framework development with the MOEE. It has also established Infracore Asia in Myanmar, a not-for-profit infrastructure project development institution, which is looking to develop off-grid power projects, as well as other rural infrastructures. It has plans for a new private sector development program in Myanmar.

52. **Thailand.** The Government of Thailand will provide grant funding for two 120-MW gas-fired power plants in Yangon, and a grant of \$20 million to rehabilitate distribution networks in three townships in Yangon (North Dagon, Okkakarpa, and Shwe Pauk Kan), since 2013.

53. **Norway.** The Government of Norway provided assistance, through ADB, for revising the electricity law. In 2015, Norway approved \$10 million of TA to MOEE for planning and implementation of hydropower plants, electricity law and regulations, and capacity building and for resident advisory group in MOEE.

## D. ADB's Sector Strategy

54. ADB will support the government policy to achieve full electrification by 2030 to be delivered by a commercially operated electricity industry using private and public sector resources. As the private sector has demonstrated strong interest in the oil and gas industry and with successful



projects in operation and under development, ADB will focus on the power subsector. ADB will provide investment and program loans and TA from its sovereign lending resources to state-owned power institutions and will provide assistance from its nonsovereign resources to support private sector investments.

55. Estimates of investment requirements vary depending on demand forecast. Assuming a medium case demand forecast for 2030 (peak load of 9,500 MW), investments of approximately \$40 billion are required, with \$28 billion in generation, \$5 billion–\$7 billion in transmission, and \$6 billion in distribution. Considering active support from development partners and the private sector in the power generation subsector, ADB will focus its sovereign operations on network strengthening, increasing electrification, energy efficiency, and renewable energy.

56. A programmatic approach will be adopted whereby ADB will coordinate with development partners and private sector for investments, in line with sector development plans, and will follow a long-term and strategic arrangement of individual yet interlinked projects that aim at achieving large-scale impacts. ADB will leverage its assistance, envisaged at approximately \$1.2 billion for the energy sector until 2030, by cofinancing with development partners as appropriate.

57. ADB's nonsovereign operations will explore opportunities in supporting the private sector in all power subsectors but with an expected focus on power generation initiatives.

58. The first phase of a Power Network Development Program is planned for 2018. The program will build on ADB's existing portfolio and initially focus on expanding and strengthening the transmission infrastructure while also addressing policy reforms. Responding to the strong needs of rural communities, the ADB program will also address rural electrification by both grid expansion and off-grid supply where renewable energy sources will be developed. Cross-border electricity trade projects will be supported under the coordination of the Greater Mekong Subregion initiative and Association of Southeast Asian Nations. Assistance will be aligned with priorities identified in the energy-related master plans and policies being prepared by the government. ADB will ensure that new projects are designed to be climate proofed and greenhouse gas emission rates are minimized in line with international practice.

59. ADB will assist the government in corporatizing energy enterprises and improving their efficiencies and operational capacity. ADB will provide assistance for capacity development and institutional support for (i) development and implementation of policies, plans, and laws; (ii) research, statistical, technical, and engineering skills development; (iii) financial management and economic evaluation; (iv) public-private partnership management and development; and (v) preparation of environmental impact assessments and socioeconomic impact assessments for sustainable and inclusive development of energy resources.



# III Plans and Supporting Analysis

## A. Sector Road Map and Results Framework

**Table 3: Sector Results Framework (Energy Sector, 2014–2020)**

Country Sector Outcomes		Country Sector Outputs		ADB Sector Operations	
Outcomes with ADB Contribution	Indicators with Targets and Baselines	Outputs with ADB Contribution	Indicators with Incremental Targets	Planned and Ongoing ADB Interventions	Main Outputs Expected from ADB Interventions
Increased reliability and accessibility of electricity services for industrial, commercial, and residential consumers	Electrification rate will be increased to 47% by 2020 (2014 baseline: 34%)	Energy system expanded, improved, and well managed	(i) Targeted operational capacity for domestic consumption to exceed 9,000 MW by 2020 (2013 baseline: 4,085 MW) (ii) 230 kV substation transformer capacity will be increased to 8,800 MVA by 2020 (2014 baseline: 5,000 MVA) (iii) Power transmission and distribution loss will be reduced to 18% by 2020 (2014 baseline: 22%)	<b>Planned key activity areas</b> (i) Electric power transmission, electric power distribution, rural electrification, and distribution loss reduction (ii) Solar, small hydropower, biomass, and other renewables (iii) Policy and regulation, public-private partnership, sector-wide approaches, and market promotions  <b>Planned projects</b> (i) Power Network Development Program (\$420 million, 2018) (ii) Project preparatory TA (\$2.0 million, 2016)  <b>Ongoing projects</b> (i) Power Distribution Improvement Project (\$60 million) (ii) Power Transmission Improvement Project (\$80 million)	<b>Planned key activity areas and projects in the pipeline</b> (i) Transmission and distribution and rural electrification (ii) Three 230-kV/132-kV SS and 16.8 km of transmission lines in Yangon constructed (iii) 230kV Transmission lines and substations, and 66kV-33kV distribution network in Yangon area.  <b>Ongoing projects</b> (i) Seven 66-kV SS, 27 33-kV SS, 7 km of 33 kV line, 160 km of 11 kV line, 667 km of ABC LV line constructed (ii) Renewable energy-based mini-grid system (12 solar PV mini-grid systems) developed

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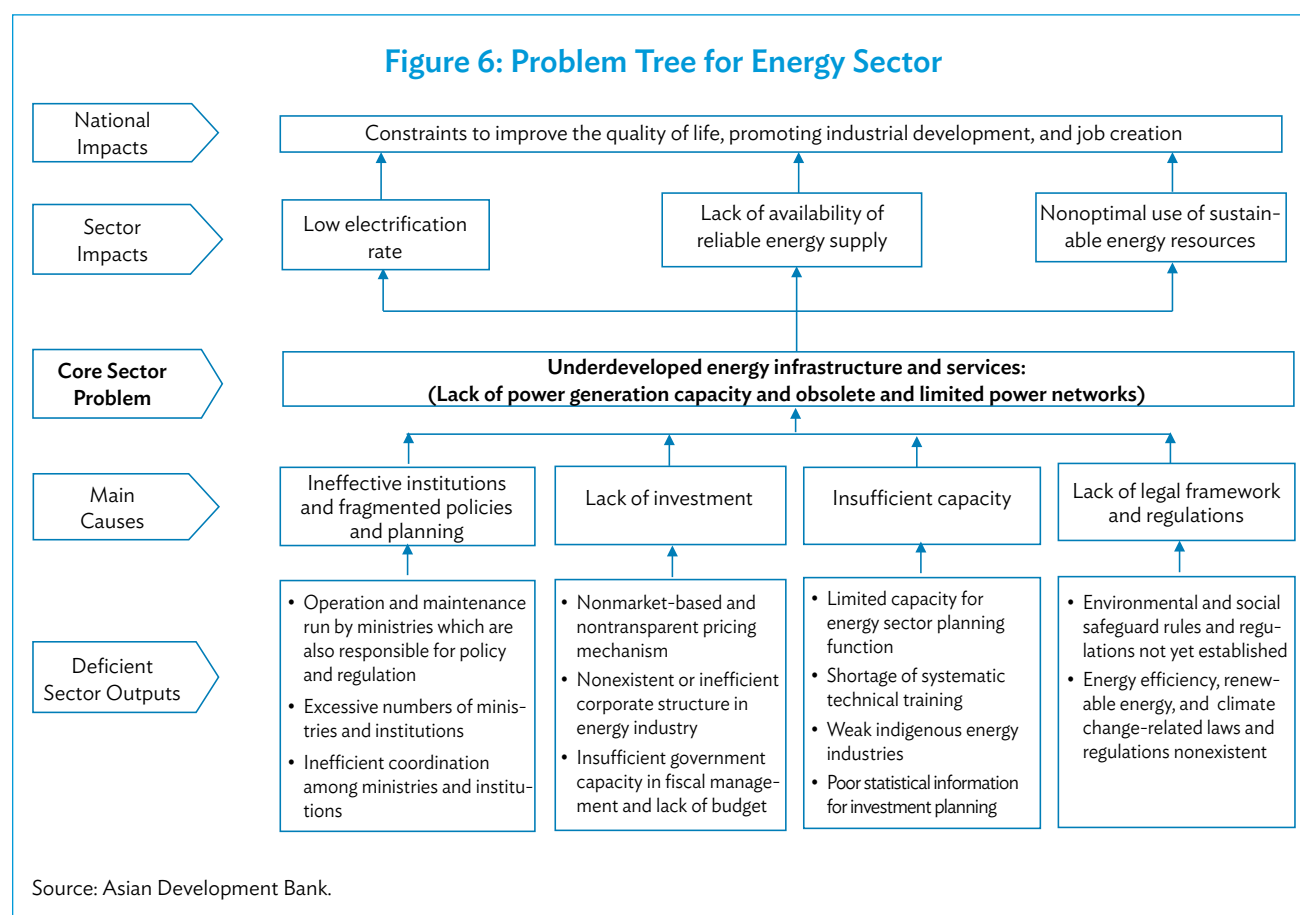
Table continued

Country Sector Outcomes		Country Sector Outputs		ADB Sector Operations	
Outcomes with ADB Contribution	Indicators with Targets and Baselines	Outputs with ADB Contribution	Indicators with Incremental Targets	Planned and Ongoing ADB Interventions	Main Outputs Expected from ADB Interventions
				(iii) Off-Grid Renewable Energy Demonstration Project (capacity development TA, \$2 million) (iv) Policy advisory, capacity development, and regional TA projects	

ADB = Asian Development Bank, km = kilometer, kV = kilovolt, LV = low voltage, MVA = megavolt-ampere, MW = megawatt, PV = photovoltaic, SS = substations, TA = technical assistance.

Source: ADB estimates.

## B. Sector Problem Analysis



## C. Sector Issues, Government Actions, and ADB Support

Table 4: Links between Sector Issues, Government Plan, Gaps, and ADB Summary Assessment of Plan Feasibility

Core Sector/Subsector Issues (Constraints and Problems)	Government Plan	Policy, Institutional, Investment Action, and Resource Gap Needs	Remarks (On Plan Relevance and Feasibility, Implications)
Need for policy reforms to: 1. Commercialize the power sector 2. Introduce legal and regulatory reforms 3. Introduce cost reflective tariffs	1. Restructuring and corporatization of power sector planned and partly under implementation 2. New Electricity Law passed in 2014. Associated Rules and Regulations under preparation. Establishment of ERC planned. 3. Gradual introduction of cost reflective tariffs planned	TA provided by donors appropriate to absorption capacity of institutions	<ul style="list-style-type: none"> <li>Government may delay introduction of cost reflective tariffs due to population resistance.</li> <li>Rules associated with electricity law may discourage private sector investment.</li> <li>ERC may not be granted sufficient powers.</li> </ul>
Mobilize adequate funding	Mobilize investments from private sector and donor	\$40 billion funding required in power sector for 2030	Private sector investments will require commercial tariffs, clear legal framework, and ERC with adequate powers.
Need for major rural electrification program	To connect 7 million households by 2030 using public and private sector funding by grid and off-grid electrification projects	\$6 billion required. World Bank \$400 million project to be approved in 2015. Funding gap to be filled	Donor funding of \$0.4 billion per year will be a challenge while private sector is unlikely to fill gap. Low-cost off-grid solutions are needed.
Energy efficiency	Introduce energy efficiency program	Donors to provide TA	Not applicable
Sector institutions require capacity development	To seek donor assistance to provide capacity development in planning, project, management procurement, environment, safeguards, economic and financial assessment	All investment projects to include capacity development components	Donors, including ADB, have been active in providing capacity development support. Ongoing support will be required.
Domestic energy resource utilization and fuel mix for power sector	Split of domestic resources for domestic needs and export, and fuel mix for power sector under study	Donors providing appropriate TA	Assessment ongoing.

ADB = Asian Development Bank, ERC = Energy Regulatory Commission, TA = technical assistance.

Source: Asian Development Bank.

## D. Government Actions, Development Partner Support, and Key Lessons

**Table 5: Summary of Key Issues, Government Actions, Development Partner Support and Lessons Learned**

Core Issue	Government Action	Development Partner and ADB Support	Key Lessons
Need for policy reforms	Government appreciates the issues and has taken significant actions, such as introducing electricity law in 2014, actively encouraging private sector investment, and planning to introduce tariff increases	Policy reforms are supported by bilateral and multilateral donors and NGOs.	<ul style="list-style-type: none"> <li>• Good progress has been made</li> <li>• Donors and NGOs have successfully coordinated in activities</li> </ul>
Mobilize adequate funding	Government has sought private sector support and donor support	Donors are supporting reforms to attract private sector investment while investing in targeted projects.	Ongoing and increased investment from donors and private sector will be required to bridge the funding gap.
Need for major RE program	Government has: <ul style="list-style-type: none"> <li>• Introduced free solar home systems for off-grid households</li> <li>• Prioritized RE program to achieve full electrification by 2030</li> <li>• Established a cross-ministerial rural electrification implementation board</li> </ul>	<ul style="list-style-type: none"> <li>• World Bank \$400 million national electrification project</li> <li>• RE included in ADB strategy</li> </ul>	Introduction of large RE program to 70% of the population over a 15-year timeframe will require management of community expectations as some communities will receive low-cost reliable grid supply in short term while others must wait for a long term.
Sector institutions require capacity development	Needs assessment and support requested	A wide range of technical assistance projects are being implemented by donor support.	Institutions will require ongoing capacity development support.
Domestic energy resource utilization and fuel mix for power sector	Being addressed by the National Energy Management Committee	<ul style="list-style-type: none"> <li>• Energy, power, and electrification planning projects have been completed or are under implementation</li> <li>• ADB is assisting in establishment of an integrated energy policy and planning unit</li> </ul>	Need to establish a government energy planning unit with capacity to produce and publish regular and credible analysis.

ADB = Asian Development Bank, NGO = nongovernment organization, RE = rural electrification.

Source: Asian Development Bank.

## E. Data Tables

### 1. Onshore Blocks and Operators

No.	Blocks/Area	Awarded Company
<b>PSC Blocks</b>		
1	B-2 (Zebyutaung-Nandaw)	ONGC Videsh Limited, India
2	K (Yamethin)	Eni, Italy
3	O (Pathein)	Petroleum Exploration (PVT), Pakistan
4	EP-1 (Kyaukkyi-Mindon)	Brunei National Petroleum Co., Sdn.Bhd., Brunei
5	EP-3 (Thegon-Shwegu)	ONGC Videsh Limited, India
6	IOR-5 (Htantabin)	Petronas Carigali, Malaysia
7	C-1 (Indaw-Yenan)	Pacific Hunt Energy Corp., Canada
8	H (Taungoo-Pyinmana)	Pacific Hunt Energy Corp., Canada
9	J (Mawlamyine)	Petroleum Exploration (PVT), Pakistan
10	MOGE-4 (Myintha)	CAOG S.a r.l., Luxembourg
11	EP-4 (Mayaman)	JSOC Bashneft, Russian Federation
12	RSF-5 (Ondwe)	Eni, Italy
13	MOGE-3 (Padaukpin-Natmi)	PTTEP South Asia + Palang Sophon Offshore, Thailand
<b>IPR Blocks</b>		
14	IOR -4 (Pyay)	MPRL E&P Pte., British Virgin Islands
15	IOR -6 (Myanaung)	MPRL E&P Pte., British Virgin Islands
16	IOR -7 (Shwepyitha)	Petronas Carigali, Malaysia

IPR = improved petroleum recovery, MOGE = Myanmar Oil and Gas Enterprise, PSC = production sharing contract.

Source: Ministry of Oil and Gas Enterprise. September 2014.

### 2. Offshore Blocks and Operators

No.	Blocks/Area	Awarded Company
<b>Shallow Water Blocks</b>		
1	A-4	BG Asia Pacific Pte + Woodside Energy Myanmar + Myanmar Petroleum E&P
2	A-5	Chevron (Unocal Myanmar Offshore Co.) + Royal Marine Engineering
3	A-7	Woodside Energy Myanmar + BG Asia Pacific Pte + Myanmar Petroleum E&P
4	M-4	Oil India Limited + Mercator Petroleum Limited + Oilmax Energy Pvt + Oil Star Management Services
5	M-7	Roc Oil Co. + Tap Oil + Smart E&P
6	M-8	Berlang Holding B.V. + A-1 Mining Co.
7	M-15	Transcontinental Group (TRG) + Lin Win
8	M-17	Reliance Industries + United National Resources Development.
9	M-18	Reliance Industries + United National Resources Development.

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Table continued

No.	Blocks/Area	Awarded Company
10	YEB	Oil India Limited + Mercator Petroleum Limited + Oilmax Energy Pvt + Oil Star Management Services
<b>Deep Water Blocks</b>		
11	AD-2	BG Exploration and Production Myanmar Limited + Woodside Energy Myanmar + Myanmar Petroleum E&P
12	AD-3	Ophir Energy Plc + Parami Energy Development
13	AD-5	Woodside Energy Myanmar + BG Asia Pacific Pte + Myanmar Petroleum E&P
14	AD-9	Shell Myanmar Energy + MOECO
15	AD-10	Statoil + ConocoPhillips
16	AD-11	Shell Myanmar Energy + MOECO
17	MD-2	Eni Myanmar
18	MD-4	En Myanmar
19	MD-5	Shell Myanmar Energy + MOECO
20	YWB	Total E&P Myanmar

MOECO = Mitsui Oil Exploration Corporation.

Source: Ministry of Oil and Gas Enterprise. November 2014.

### 3. Myanmar Oil and Gas Enterprise's Participation in Offshore Gas Fields and Pipeline Companies

MOGE Share (%)	Business	Lead Operator
15	Yadana Gas Production	Total E&P, Myanmar
15	Yadana Gas Production Transportation	Total E&P, Myanmar
20.45	Yetagun Gas Production	Petronas Carigali
20.45	Yetagun Gas Transportation	Petronas Carigali
20	Zawtika Gas Production	PTT E&P Int
20	Zawtika Gas Transportation	PTT E&P Int
15	Shwe Gas Production	Daewoo E&P Int
15	Shwe Gas Transportation (to Landfall) Domestic	Daewoo E&P Int
7.365	Myanmar-China Gas Line	CNPC
49.1	Myanmar-China Oil Line	CNPC

CNPC = China National Petroleum Corporation.

Source: Ministry of Electricity and Energy. 2014.

## 4. Coal, Gas, and Diesel-Fired Power Plants (2016)

Coal-Fired Power Plant						
No.	Plant	No. of Machines	Installed Capacity (MW)	COD	No. of Operation Machines	Available Capacity (MW)
1	Tygit	2	120	2005		30
Gas-Fired Power Plant						
No	Plant	No of Machines	Installed Capacity (MW)	COD	No. of Operation Machines	Present Generation (MW)
MOEE-Owned Power Plant						
1	Kyung Chaung	3	54	1974	1	12
2	Myan Aung	2	35	1975	1	12
3	Ywama (CCPP)	3(GT)+1(ST)	70	1980	2(GT)	26
4	Mann	2	37	1980	0	–
5	Shwe Taung	3	55	1982	1	12
6	Thahton	3	51	1975	2	26
7	Thaketa (CCPP)	3(GT)+1(ST)	92	1990	2(GT)	24
8	Ahlone (CCPP)	3(GT)+1(ST)	154	1995	2(GT)+1(ST)	50
9	Hlawga (CCPP)	3(GT)+1(ST)	154	1996	2(GT)	40
10	Ywama (240)	2	240	2014	1	100
	Subtotal		942			302
IPP-Owned Power Plant						
1	Toyo Thai	2(GT)+1(ST)	121	2013	2(GT)+1(ST)	115
2	MCP	29(GE)	54	2013	27	48
3	Max Power	16(GE)	50	2013	14	45
4	UPP	13(GE)	52	2014	13	48
5	Myanmar Lighting	4(GT)+2(ST)	230	2014	4(GT), 2(ST) Future	120
6	Kanbauk	6(GE)	6	2015	6(GE)	5
7	Thaketa CIC	1 (GE)	54	2015		
	Subtotal		452			381
Rental						
8	APR	75(GE)	110.6	2014	71	101
9	V-Power	32(GE)	100	2015	31	45
10	Aggreko	92(GE)	103	2015	87	95
	Subtotal		314			241
	<b>Total Gas</b>		<b>1,824</b>			<b>924</b>

COD = commercial operation date, GE = gas engine, GT = gas turbine, ST = steam turbine, IPP = independent power producer, MOEE = Ministry of Electricity and Energy, MW = megawatt.

Source: Ministry of Electricity and Energy. 2016.

## 5. Hydropower Plants (2016)

Name of Hydropower Station	Installed capacity [MW]	Category	Storage capacity [Value]	Storage capacity [Unit]
Ba Luchang No.1	28	Run of River	/	
Ba Luchang No.2	168	Run of River	/	
Ba Luchaung No.3	52	Run of River	/	
Kinda	56	Irrigation	1078	Mm3
Sedawgyi	25	Irrigation	/	
Zawgyi No1	18	Run of River	/	
Zawgyi No2	12	Irrigation	639	
Zaung Tu	20	Storage	620	Mm3
Thapanzeik	30	Irrigation	/	
Mone	75	Storage	53	GWh
Yenwe	25	Storage	67	GWh
Kabaung	30	Storage	1084	Mm3
Shweli No.1	400	Run of River	/	
Keng Taung	54	Run of River	/	
Yeywa	790	Storage	322	GWh
Shwegyin	75	Storage	114	GWh
Dapein No.1	19	Run of River	/	
Kun	60	Storage	205	GWh
Kyeeon Kyeewa	74	Irrigation	571	Mm3
Upper Paunglaung	140	Storage	1300	Mm3
Nancho	40	Run of River	/	
Lower Paunglaung	280	Storage	71	GWh
Phyuu Chaung	40	Storage	780	Mm3
Chipwi Nge	99	Storage	1.23	Mm3
Thaukyegat II	120	Storage	51	GWh
Mong Wa	60	Storage	65	Mm3
Myogyi	30	Storage	593	Mm3
<b>Total</b>	<b>2,820</b>			

/ = not applicable, GWh = gigawatt-hour, Mm3 = mega cubic meter, MW = megawatt.

Note: 5 MW installed smaller rural electrification is not included in the table.

\* Figure in bracket is power supply to the People's Republic of China and not included in the total.

Source: Ministry of Electricity and Energy, 2016.



## Myanmar: Energy Sector Assessment, Strategy, and Road Map

Myanmar has abundant energy resources, particularly hydropower and natural gas. However, the country's energy sector has been underdeveloped due to global isolation and lack of financial and technical capacity. This is the first energy sector assessment, strategy, and road map for Myanmar prepared by the Southeast Asia Energy Division of the Asian Development Bank (ADB). It highlights energy sector performance, major development constraints, government plans and strategy, past ADB support and experience, other development partner support, and future ADB support strategy. This document is linked to and feeds into ADB's country partnership strategy for Myanmar and will be updated as strategic developments and program changes are needed.

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