Technical Assistance Report

Project Number: 47128
Capacity Development Technical Assistance (CDTA)
April 2014

Republic of the Union of Myanmar:
Off-Grid Renewable Energy Demonstration Project
(Financed by the Japan Fund for Poverty Reduction)

Asian Development Bank

CURRENCY EQUIVALENTS
(as of 26 March 2014)

Currency unit	–	kyat (MK)
MK1.00	=	$0.00104
$1.00	=	MK962.26

ABBREVIATIONS

ADB	–	Asian Development Bank
DRD	–	Department of Rural Development
GIS	–	geographical information system
MLFRD	–	Ministry of Livestock, Fisheries and Rural Development
MOAI	–	Ministry of Agriculture and Irrigation
MOBA	–	Ministry of Border Affairs
MOEP	–	Ministry of Electric Power
MOI	–	Ministry of Industry
MOST	–	Ministry of Science and Technology
MW	–	megawatt
NEMC	–	National Energy Management Committee

TECHNICAL ASSISTANCE CLASSIFICATION

Type	–	Capacity development technical assistance (CDTA)
Targeting classification	–	Targeted intervention (household)
Sector (subsector)	–	Energy (renewable energy)
Theme (subtheme)	–	**Environmental sustainability** (global and regional transboundary environmental concerns), **economic growth** (promoting macroeconomic stability), capacity development (institutional development)
Climate change	–	Climate change mitigation
Location (impact)	–	Rural (high), urban (low), national (medium), regional (low)
Partnership	–	Japan Fund for Poverty Reduction

NOTE

In this report, "$" refers to US dollars.

Vice-President	S. Groff, Operations 2
Director General	J. Nugent, Southeast Asia Department (SERD)
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CONTENTS

I. INTRODUCTION

1. The proposed capacity development technical assistance (TA) will support the Ministry of Livestock, Fisheries and Rural Development (MLFRD) to design and implement an off-grid renewable energy demonstration project that will (i) support the installation of renewable energy-based systems for providing energy access (mostly solar photovoltaic and biomass-based systems) to schools and other public infrastructure in at least 25 villages; (ii) develop geospatial, least-cost energy access plans and an investment plan for select states and regions in the country; and (iii) strengthen the capacity of government institutions to design and implement small-scale renewable energy systems in off-grid areas. The TA will be financed by the Japan Fund for Poverty Reduction (JFPR) and will build on the ongoing pilot activities under the Energy for All (Phase 1) TA project.[1] The proposed TA addresses key medium-term goals elaborated in the interim country partnership strategy, 2012–2014 for Myanmar: (i) assisting the government in promoting sustainable and inclusive economic development and job creation in support of poverty reduction; (ii) enhancing connectivity—domestic and regional, rural and urban—through improved infrastructure; and (iii) helping accelerate economic growth, create income opportunities, and bridge rural–urban gaps in economic opportunities.[2] The scope, expected impact, outcome, outputs, implementation arrangements, costs, financing arrangements, and terms of reference were discussed with the government and finalized during a fact-finding mission in November 2013. The design and monitoring framework is in Appendix 1.[3]

II. ISSUES

2. Myanmar is one of the poorest countries in the world, with a per capita gross domestic product of $857, and a human development index rank of 149 out of 187 countries; 26% of its population lived in poverty in 2010.[4] In response to ongoing major reforms by the Government of Myanmar toward a democratic system and market-based economy, ADB began to reengage with Myanmar, in early 2012.

3. **Energy poverty in Myanmar.** According to the International Energy Agency, Myanmar is an extreme example of energy poverty. Myanmar's per capita electricity consumption was only 140 kilowatt-hours (kWh) per year, which is the lowest among the 10 Association of Southeast Asian Nations (ASEAN) countries. The low national average per capita electricity consumption is due to the low electrification ratio, low industrial development, and lack of investment. The country's average electrification[5] grew from about 16% in 2006 to 28% in 2012. Yangon City has the highest electrification ratio (72%), followed by Nay Pyi Taw (65%), Kayah (42%), and Mandalay (35%).[6] Lack of electricity impedes economic development and achievement of the Millennium Development Goals.[7]

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[1] ADB. 2008. *Technical Assistance for Energy for All Initiative.* Manila. The budget was increased through ADB. 2013. *Major Change in Technical Assistance: Empowering the Poor through Increasing Access to Energy.* Manila. Phase 1 involves development of a geospatial electrification plan for the Mandalay region and piloting off-grid installations in Mandalay region and Chin state.

[2] ADB. 2012. *Interim Country Partnership Strategy: Myanmar, 2012–2014*. Manila.

[3] The TA first appeared in the business opportunities section of ADB's website on 6 December 2013.

[4] Ministry of National Planning and Economic Development, Swedish International Development Cooperation Agency, United Nations Children's Fund, United Nations Development Programme. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010)*; ADB. 2012. *Asian Development Outlook 2012: Update.* Manila.

[5] It is defined as the number of electrified households connected to the grid over the total number of households.

[6] The areas with lowest electrification ratios are Yakhine (6%), Tannintharyi (9%), and Ayeyarwaddy (10%).

[7] ADB. 2012. *Myanmar: Energy Sector Initial Assessment.* Manila.

4. **Renewable energy potential.** Myanmar has abundant renewable energy resources, including solar, hydropower, biomass, and some wind power. Of these, only hydropower has been developed and used on a limited commercial scale, with 2,520 megawatts (MW) of hydropower installed in Myanmar as of 2012; this compares to a total potential of over 100,000 MW. Other renewable energy resources are being researched or in pilot stages of development.

5. **Off-grid energy access programs of the Government of Myanmar.** Until September 2013, the government's Ministry of Industry (MOI) was responsible for providing electricity to off-grid areas in the country. In addition to off-grid micro-hydro, solar, biogas, and biomass installations, about 39 off-grid villages have also been electrified by various government ministries using diesel generators.[8] The Department of Rural Development (DRD), which was formerly within the Ministry of Border Areas (MOBA), has also been carrying out rural infrastructure development activities in the country, including the deployment of small-scale rural energy systems such as pico- and micro-hydro sites, solar photovoltaic mini-grids, solar lanterns, and solar home systems.

6. As of 2013, installations of 38 off-grid micro hydropower plants have been completed by the Ministry of Agriculture and Irrigation (MOAI). The plants are owned and operated by the Ministry of Electric Power (MOEP). The Ministry of Environmental Conservation and Forestry has promoted the use of efficient cooking and heating stoves. The Ministry of Science and Technology (MOST), with support from MOI, has built community-based and family-sized fixed-dome type biogas digester plants in nearly 200 villages, mainly in the central region (Mandalay, Sagaing, and Magway divisions).[9] Solar energy has been provided by MOI in a few off-grid villages to generate electricity for street and home lighting, and other community uses. The government has recently assigned MLFRD the responsibility for providing rural infrastructure, which includes rural energy access; as a consequence the DRD has been moved from MOBA to MLFRD.

7. **Barriers to renewable energy deployment.** Harnessing Myanmar's abundant renewable energy resources to increase energy access is hampered by several factors: (i) lack of a fully transparent institutional and legal framework to support exploration, development, and deployment; (ii) limited financial resources to support research and development, market-based investment programs, and development of physical infrastructure; (iii) lack of trained personnel to install and operate systems; and (iv) subsidized power and petroleum prices, which make it difficult for wind and solar energy to be competitive. Establishment of a supportive environment for development of Myanmar's renewable energy resources should include: (i) more information on the country's renewable energy resource potential; (ii) improved interministerial cooperation and coordination; (iii) promotion of private sector participation; (iv) clarification of the government's policy on renewable energy; and (v) dissemination of technology for family-size biogas digesters, mini-hydropower plants, and other options for increasing rural energy access.

8. During 2010–2013, MOI was given the responsibility for increasing off-grid energy access. MOI presented a project proposal for rural energy development at the Myanmar Development Cooperation Forum, held 19–20 January 2013 in Nay Pyi Taw.[10] This proposal

[8] Energy and renewable energy policies and activities are currently distributed among seven ministries—the Ministry of Energy, MOI, Ministry of Electric Power, the Ministry of Science and Technology, MLFRD, Ministry of Agriculture and Irrigation, and Ministry of Environmental Conservation and Forestry.

[9] Data provided by MOI and MOST. In June 2013, an ADB mission visited four villages with biogas digester plants and solar photovoltaic installations in Mandalay division together with MOI and MOST staff.

[10] Directorate of Industrial Planning, Ministry of Industry. 2013. *Project Proposal for Rural Energy Development Plan in Myanmar.* Nay Pyi Taw.

builds on the ministry's efforts during 2011–2013 to provide access to energy to 591 remote villages in the country using diesel generation sets, biomass gasifiers, micro-hydro, and solar lanterns. In response to MOI's request, ADB initiated pilot off-grid renewable energy activities (Phase 1) using TA grant funds from the Energy for All program (footnote 1). Phase 1 focuses on piloting a limited number of off-grid clean energy installations in 20 villages in Chin State (in eastern Myanmar) and the Mandalay region (in central Myanmar), and developing a geospatial least-cost energy access plan for the Mandalay region. These activities are being implemented from October 2013 to May 2014 with MOI as the executing agency.

9. In September 2013, the President of Myanmar moved the DRD from MOBA to MLFRD and gave the reconfigured ministry responsibility for rural infrastructure provision, including energy access. MLFRD will now chair the national rural electrification and drinking water supply committee, which reports to the vice-president; members include MOI, MOST, MOAI, MOEP, and the Ministry of National Development and Economic Planning. In addition to being the executing agency for community-driven rural energy projects supported by the World Bank and ADB, MLFRD is embarking on an ambitious energy access program and has submitted a supplementary budget request for 2014 to Parliament. This work would constitute phase 2 of ADB's engagement in increasing access to renewable energy in Myanmar's off-grid areas.

III. THE PROPOSED TECHNICAL ASSISTANCE

10. The TA will complement the on-grid focus of the distribution system rehabilitation financed by a recently approved ADB loan on power distribution improvement.[11] This TA will improve the capacity of MLFRD[12] and other agencies to design and implement renewable energy- based energy access projects, develop investment plans for scaling up energy access in the central dry zone (Mandalay, Sagaing, and Magway regions); and cover Chin, Kayah, and Rakhine states[13], and finance pilots installations in these locations.

A. Impact and Outcome

11. The impact will be increased access to energy in rural Myanmar from renewable energy sources. The impact is consistent with ADB's Strategy 2020,[14] which promotes inclusive and environmentally sustainable economic growth. The TA is also consistent with the United Nations' international year of sustainable energy for all, which emphasized the importance of energy access for sustainable development. The TA will lead to the installation of 10 MW of new, small-scale renewable energy capacity by 2022; provide access to modern forms of energy for 0.4 million households and public facilities such as schools by 2022; and result in regional governments making financial provisions and organizational commitments in their annual budgets to expand energy access. The outcome will be improved capacity and commitment within MLFRD and the governments of select regions and states to design and manage rural energy access programs using renewable energy resources.

[11] ADB. 2013. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Republic of the Union of Myanmar for the Power Distribution Improvement Project.* Manila.

[12] The MLFRD is also the executing agency for the grant project for Enhancing Rural Livelihoods and Incomes, which aims to support the creation of rural infrastructure, including energy access projects. ADB. 2013. *Grant Assistance to the Republic of the Union of Myanmar for Enhancing Rural Livelihoods and Incomes.* Manila.

[13] A conflict-sensitive approach will be considered for TA activities in Chin, Kayah, and Rakhine states.

[14] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020*. Manila.

B. Methodology and Key Activities

12. The TA outputs are (i) renewable energy systems designed and installed in 25 villages to power community infrastructure and households; these will be primarily solar photovoltaic and biomass-based systems, targeting the central dry zone (Mandalay, Sagaing, and Magway regions) and Chin, Kayah, and Rakhine states; (ii) geospatial least-cost energy access and investment plans for select regions and states of the country developed; and (iii) skills and abilities of staff in government entities and the private sector strengthened. This will include assessing the potential for and providing assistance for the creation of a separate government agency or entity that would focus on off-grid energy access. The feasibility of alternate financing approaches such as revolving funds and output-based aid will also be evaluated.

C. Cost and Financing

13. The TA is estimated to cost $2,200,000, of which $2,000,000 equivalent will be financed on a grant basis by the Japan Fund for Poverty Reduction and administered by ADB. The government will provide counterpart support in the form of staff time, office space, staff travel costs, and other in-kind contributions; and will be responsible for any civil works and related engineering design that may be required for the pilot installations. The cost estimates and financing plan are in Appendix 2.

D. Implementation Arrangements

14. The MLFRD will be the executing agency. The choice of executing agency was confirmed through consultations with MLFRD, the National Energy Management Committee (NEMC), MOI, and MOEP during an ADB fact-finding mission on November 2013. A steering committee composed of senior officials from the National Rural Development Committee, NEMC, Ministry of Energy, MOEP, MOBA, MOAI, and MOST will oversee TA implementation and provide inputs. The committee will also include a senior representative from a nongovernmental or civil society organization. Within ADB, this project will be managed by the Southeast Asia Energy Division with support from the Energy for All regional TA (footnote 1), and ADB's Extended Mission in Myanmar. The DRD within MLFRD will be the implementing agency. The TA will also work closely with the regional governments of the selected areas for development and implementation of the pilot installations, and the Electricity Supply Enterprise, the power utility, for development of the geospatial plans. Proceeds of the TA will be disbursed in accordance with ADB's *Technical Assistance Disbursement Handbook* (2010, as amended from time to time).

15. A total of approximately 101 person-months of consulting services (36 person-months for international consultants and 65 person-months for national consultants) will be engaged through a firm. The consulting firm will be recruited in accordance with ADB's Guidelines on the Use of Consultants (2013, as amended from time to time) through quality and cost-based selection (with a quality–cost ratio of 80:20) and using full technical proposals. International consultants will include (i) energy access planning and renewable energy technical specialist and team leader, (ii) off-grid solar photovoltaic solution specialist, (iii) biogas or biomass energy specialist, (iv) micro-hydro specialist, (v) renewable energy finance specialist, (vi) capacity development and institutional strengthening specialist, (vii) geospatial planning specialist, (viii) geographical information systems (GIS) specialist, and (ix) procurement specialist. National consultants will have expertise that complements that of the international experts, and will support them in their work. The outline of the terms of reference for consultants is in Appendix 3. The consultants will be responsible for administration of training, seminars and conferences,

and surveys, as reflected in their terms of reference. The consultants will design, procure, and install the pilot off-grid renewable energy facilities under the TA. All goods (equipment) purchased under the TA will be procured in accordance with ADB's Procurement Guidelines (2013, as amended from time to time) and will be turned over to the executing agency upon completion of the TA project.

16. The TA implementation period will be from June 2014 to June 2017. The MLFRD will set up a project management unit and provide an office for the consultants in Nay Pyi Taw along with the requisite utilities, and support the costs of their staff time for project activities and travel to project sites in the region. Local governments in the states and regions for which detailed geospatial maps and energy access plans will be prepared and where the villages selected for renewable energy-based electrification will be located will provide the consultants with access to relevant data and information, and provide office space and travel and logistics support as required. MOEP, MOST, MOAI, MOBA, and other government ministries and agencies will provide access to baseline information and resource surveys that have been conducted.[15]

IV. THE PRESIDENT'S RECOMMENDATION

17. The President recommends that the Board approve ADB administering technical assistance not exceeding the equivalent of $2,000,000 to the Government of Myanmar to be financed on a grant basis by the Japan Fund for Poverty Reduction, for the Off-Grid Renewable Energy Demonstration Project.

[15] Renewable resource surveys will build on resource data—e.g., regarding solar radiation, water flow, and bio-waste generated—currently available from government agencies and international institutions.

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
Impact Increased access to energy in rural Myanmar from renewable energy sources	About 10 MW of new small-scale renewable energy capacity installed and an additional 0.4 million households[a] and 100 public facilities such as schools obtain access to modern forms of energy[b] by 2022	Government statistics Surveys by NGOs and UN agencies Annual budget activity reports for regional governments and MLFRD, MOI, MOEP and NEMC	**Assumption** MLFRD retains its mandate to develop community-oriented energy access programs and is strengthened with time **Risk** Government decides to replace community-driven programs with grid-extension by ESE
Outcome Improved capacity and commitment within MLFRD and the governments of select regions and states to design and manage rural energy access programs using renewable energy resources	By 2017: At least three states or regions endorse least cost electrification plans in the off-grid areas Up to 25 small-scale renewable energy-based mini-grids (totaling 0.25 MW capacity) generation facilities developed and installed[c] At least 10,000 people have increased access to energy	Government statistics MLFRD, MOI, MOEP, and NEMC reports TA reports ADB mission reports	**Assumptions** Government and international development agency financing earmarked for community-driven energy programs Private sector investors and local and regional banks interested in financing rural energy access projects **Risk** Benefits accrue to non-poor segments of society
Outputs 1. Renewable energy systems designed and installed in 25 villages to power community infrastructure and households	Final project designs and implementation plans for 25 mini-grid or stand-alone investments are endorsed by MLFRD and regional governments by mid-2015 Suitable financing models, procurement plans, and community engagement models that involve women, and tariff recovery and revenue management programs are designed by the end of 2015 Identify and train at least 25 local equipment vendors, installers, and service providers (at least 25% of whom are women, or if firms, owned by women) for operations and maintenance by the end of 2015 Install pilot projects by end 2015	Project monitoring, progress, and final assessment reports TA reports Post-installation reports and consumer survey documentation Workshop documentation Training and development feedback forms	**Assumptions** Timely access to data and relevant key personnel in the priority areas Banks remain interested in financing energy access projects **Risks** Change in MOI and ESE priorities result in possible lack of interest Weak and commercially unviable pilot delivery models

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
2. Geospatial least-cost energy access and investment plans for select regions and states of the country developed	Baseline socioeconomic surveys and energy poverty studies implemented by mid-2015 Geospatial maps of resources, communities, and least-cost energy access plans developed by the end of 2015 Comprehensive investment plan for off-grid energy access developed and presented at an international investor forum by mid-2016 In addition to the 25 renewable energy-based rural electrification pilot facilities implemented under this project, at least 25 additional pilot projects for promoting small-scale, community-based, off-grid energy access are designed, including financial analysis, hardware specifications, procurement plans, and community engagement by end the of 2016		
3. Skills and abilities of staff in government entities and the private sector strengthened	At least 50 staff (50% of whom are women) from MLFRD, MOI, MOEP, and NEMC and the state and/or regional governments enhance their capacity in areas relating to procurement, financial management, community development, and safeguards by the end of 2016 Pre- and post-project surveys conducted to evaluate degree of capacity enhancement by the end of 2016 Evaluation of a policy and regulatory structure for off-grid energy access in the country, and review of alternate approaches such as a dedicated agency, fund, and output-based aid by early 2017		

Activities with Milestones	Inputs
1. Renewable energy systems designed and installed in 25 villages to power community infrastructure and households 1.1 Identify 25 locations to be developed, in consultation with MLFRD and regional governments (June–October 2014) 1.2 Determine optimal combination of renewable energy technologies to deliver reliable and low-cost electricity to the project sites (June–November 2014) 1.3 Establish accountability among the local community, promoters, contractors, and suppliers for the operation and maintenance of the plants (October 2014–February 2015) 1.4 Facilitate bidding and procurement of the projects to renewable energy subcontractors and suppliers that are able to construct the plants to specification at the lowest cost (February–May 2015)	**Japan Fund for Poverty Reduction: $2,000,000** Note: The government will provide counterpart support in the form of staff time, office space, staff travel costs, and other in-kind contributions; and pay for detailed engineering design and any civil works that may be required for the pilot projects.

1.5 Construct and commission the renewable energy systems (June–November 2015) 1.6 Post-project user survey and consumer feedback (November 2015–August 2016) **2. Geospatial least-cost energy access plan and investment plan for select regions and states of the country developed** 2.1 Review existing surveys and conduct new physical surveys (as appropriate) of all applicable renewable energy resources (e.g., small wind, solar, micro-hydro and biomass), including power density, availability, total electricity potential, and costs (July 2014–June 2015) 2.2 Assess energy demand, current source of energy, and willingness-to-pay for improved energy services (June–September 2014) 2.3 Evaluate various financing schemes and the role of the private sector, and develop proposals for promoting energy access in the country (September 2014–March 2015) 2.4 Use the maps, plans, data and learning from the TA to create a comprehensive investment plan for the next phase to scale up energy access in Myanmar (July 2015–January 2016) 2.5 Conduct an international workshop to present findings and attract financing from bilateral and multilateral sources and the private sector (April 2016 and March 2017) **3. Skills and abilities of staff in government entities and the private sector strengthened** 3.1 Assess human resources and capability of MLFRD, MOI, MOEP, NEMC, and regional government agencies to facilitate coordination between agencies and the private sector (August–December 2014) 3.2 Evaluate capacity of local renewable energy technology vendors and after-sales service providers, and access to finance and financing schemes (June–September 2014) 3.3 Introduce renewable technologies and delivery models to be implemented on the project sites through seminars and workshops (October 2014–March 2015) 3.4 Design and deliver training and capacity development activities focused on hardware specifications, installation, and operations and maintenance of various renewable energy systems, including alternate financing models and community engagement approaches (October 2014–February 2017)	

ADB = Asian Development Bank; ESE = energy supply enterprise; MLFRD = Ministry of Livestock, Fisheries and Rural Development; MW = megawatt; MOEP = Ministry of Electric Power; MOI = Ministry of Industry; NEMC = National Energy Management Committee; NGO = nongovernment organization; TA = technical assistance.

[a] The computation assumes that households in remote rural areas would consume an average 100 kilowatt-hours per annum. A plant capacity factor of 50% is used for the renewable energy systems.

[b] As of 2013, nearly 74% of the people in Myanmar (about 45 million) lack access to electricity.

[c] Several business models—such as payback of upfront capital expenditure by communities, or tariff payments by communities based on operational expenses—are already in place in Myanmar. These installations will follow business and implementation models that are found to be viable and sustainable during phase 1 of this program.

Source: Asian Development Bank.

COST ESTIMATES AND FINANCING PLAN
($'000)

Item	Amount
Japan Fund for Poverty Reduction[a]	
1. Consultants	
a. Remuneration and per diem	
i. International consultants (36 person-months)	798.1
ii. National consultants (65 person-months)	287.5
b. International and local travel	100.0
c. Reports and communications	15.0
2. Equipment[b]	4.0
3. Training, seminars, and conferences	40.0
4. Surveys[c]	18.0
5. Pilot installations[d]	500.0
6. Vehicle rentals	30.0
7. Representative for contract negotiations	5.0
8. Contingencies	202.4
Total	2,000.0

Note: The technical assistance (TA) is estimated to cost $2,200,000, of which contributions from the Japan Fund for Poverty Reduction are presented in the table above. The government will provide counterpart support in the form of staff time, office space, staff travel costs, and other in-kind contributions; and pay for detailed engineering design and any civil works that may be required for the pilots. The value of government contribution is estimated to account for 9.09% of the total TA cost.

[a] Administered by the Asian Development Bank.

[b] Will include computers, printers, and cameras. All equipment will be handed over to the executing agency following completion of the TA.

[c] May include cost of imagery, maps, photos, and handheld equipment for digitization of information such as scanners.

[d] May include solar photovoltaic-based systems, biomass digesters, and other small-scale renewable energy systems. This line item only covers hardware, transport, and installation charges. Procurement of the installations will be the responsibility of the consulting firm. Any civil works and related engineering design will be financed by the executing agency. Any taxes and duties that may be applicable for the hardware will be financed by the government.

Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

1. The technical assistance (TA) will require 101 person-months of consulting services: 36 person-months of international consultant and 65 person-months of national consultant services. The consultants will be hired through a consulting firm using quality and cost-based selection (80:20) on the basis of a full technical proposal. The inputs may be provided intermittently, based on agreement between the consultants and ADB. The overall terms of reference are subject to change during implementation depending on the circumstances. It is strongly recommended that the international firm consider including: (i) an international research institute or university that has demonstrated qualifications in geospatial least-cost energy access planning, and which would provide the international geospatial planners and geographical information system (GIS) specialists, and community development facilitators; and (ii) a national firm that has strong capabilities with GISs, surveys, and data acquisition, and would provide the national geospatial planners and GIS specialists, and community development facilitators.

2. Overall, the consultants should have extensive experience and knowledge in (i) design, development and deployment of renewable energy-based rural energy access projects, and energy access planning; (ii) institutional, financial, commercial, and social (including gender dimensions) aspects of small-scale renewable energy development in rural and remote areas; (iii) renewable energy development in Myanmar; and (iv) ADB operations, including policies, guidelines, and operational frameworks. The consultants will be expected to have extensive consultations with government representatives at central, regional, and local levels, development partners, civil society, nongovernment organizations, and communities. The consultants are expected to spend a significant portion of their time conducting fieldwork, and are expected to set up and manage a project office in Nay Pyi Taw. The consultants will be responsible for procuring the pilots. They will also be responsible for overseeing the detailed engineering and civil works (to be financed by the government). Office space and basic utilities will be provided by Ministry of Livestock, Fisheries and Rural Development (MLFRD) as part of their contribution to the TA.

3. **Energy access planning and renewable energy technical specialist and team leader** (international, 8 person-months, intermittent). The team leader will be responsible for (i) overall supervision of the consulting team; (ii) timely and successful implementation of the TA, including managing the overall quality of the deliverables and outputs; and (iii) coordination with MLFRD, regional governments, and other counterparts including civil society and nongovernment organizations. The team leader should have demonstrated expertise in energy planning, particularly energy access planning, and a deep knowledge of small-scale renewable energy systems deployment for off-grid rural electrification in various countries in Southeast Asia, preferably in Myanmar. In the capacity of energy access planning specialist, this individual will be responsible for developing detailed energy access plans for all states and regions of the country. This will involve designing and supervising energy demand and supply surveys, reviewing alternate financing models, and developing possible community-led energy access models. The specialist should have demonstrated expertise in off-grid and mini-grid energy planning, energy demand and supply estimation, least-cost and low-carbon energy deployment, and other relevant aspects of energy planning in developing countries, preferably in Myanmar and/or other developing countries in Southeast Asia. An advanced academic qualification in engineering, environmental science, or business administration is preferred.

4. **Off-grid solar photovoltaic solution specialist** (international, 4 person-months). The off-grid solar photovoltaic solution specialist will (i) review available solar irradiance surveys, assess solar availability, and identify a priority list of locations for solar hybrid solution-based

electrification; (ii) review investment plans and engineering cost estimates, and support due diligence on all solar hybrid projects being considered for development under the TA; (iii) where needed, work closely with the national solar photovoltaic solution specialist to upgrade resource analysis and fill in gaps; (iv) validate any engineering designs provided by the government, and complete detailed designs of pilot systems to be deployed under the TA; (v) develop project implementation guidelines and recommendations, including scheduling, contract packaging, and procurement based on competitive bidding procedures; and (vi) support the team leader on solar power-related aspects of the TA's energy access planning task. An advanced academic qualification in mechanical or electrical engineering with regional experience in the design, erection, and commissioning of small-scale photovoltaic systems is preferred.

5. **Biogas or biomass energy specialist** (international, 4 person-months, intermittent). The biogas or biomass energy specialist will (i) review resource availability surveys, assess resource availability for biogas digester and biomass gasifier technologies, and identify a priority list of locations and technology approaches for biogas or biomass technology-based electrification; (ii) develop specifications and standards for equipment and civil works for systems that are being deployed, and suggest improvements as appropriate; (iii) validate any engineering designs provided by the government, and complete detailed designs of pilot systems to be deployed under the TA; (iv) review investment plans and project cost estimates, and support due diligence on all biogas and biomass projects being considered under the TA; (v) where needed, work closely with the national biomass or biogas energy specialist to develop project implementation guidelines and recommendations, including scheduling, contract packaging, and procurement, and conduct training programs and ongoing monitoring of construction; and (vi) support the team leader on biogas and biomass energy-related aspects of the TA's energy access planning task. An advanced academic qualification in mechanical or agricultural engineering with regional experience in the design, erection, and commissioning of small-scale biogas or biomass systems is preferred.

6. **Micro-hydro specialist** (international, 3 person-months, intermittent). The micro-hydro specialist will (i) review available hydrological studies conducted by the Ministry of Agriculture and Irrigation or other entities, conduct due diligence on resource availability, and identify a priority list of locations for the pilots; (ii) review investment plans and engineering cost estimates, and support due diligence on all micro-hydro projects being considered for development under the TA; (iii) where needed, work closely with the national micro-hydro specialist to upgrade hydrological analysis and fill in gaps; and (iv) develop project implementation guidelines and recommendations, including scheduling, contract packaging, and procurement based on competitive bidding procedures. The candidate must have a degree in electrical, mechanical, or civil engineering and at least 12 years of experience with pico and micro-hydro projects.

7. **Renewable energy finance specialist** (international, 4 person-months). The renewable energy finance specialist will (i) conduct financial feasibility analyses (including cash flow and internal rate of return analyses, and due diligence on the project proponents) for various renewable energy generation and distribution systems identified for implementation in 25 of the 103 off-grid villages identified by MLFRD; (ii) liaise with various local and national banks, government agencies, and private sector independent power producers to evaluate the viability of local financing and/or cofinancing of future renewable energy-based rural electrification in Myanmar in collaboration with these agencies; (iii) based on these surveys, propose suitable financing initiatives that can be deployed in future to expand renewable energy-based rural electrification in Myanmar; (iv) work closely with MLFRD, Ministry of Electric Power, and Energy Supply Enterprise to identify barriers and policy, regulatory, and technical support needed for private sector bankable projects for renewable energy-based rural electrification in Myanmar; (v)

explore (a) viable tariff and/or cost-recovery measures, including the use of subsidies to fill financing gaps; and (b) output-based aid programs; and (vi) support the team leader regarding the renewable energy finance-related aspects of the TA's energy access planning task. An advanced academic qualification in engineering, finance, or business administration with regional experience in the financing of renewable energy systems is preferred.

8. **Capacity development and institutional strengthening specialist** (international, 3 person-months, intermittent). The capacity development specialist, in collaboration with the technical experts on the team, will develop capacity-building and training programs for MLFRD and representatives of regional governments and agencies, covering technical and institutional management in the areas of procurement, financial management, community development, and environmental and social safeguards. These programs will be held periodically in Yangon or Nay Pyi Taw or in the select states and regions for which geospatial maps and energy access plans will be developed under the TA. The specialist will help design and supervise the overall capacity development program, and work closely with the national capacity development and institutional strengthening specialist who will be in charge of implementation. Academic qualifications in sociology, anthropology, or political science with regional experience in donor-funded and community-focused development programs are preferred.

9. **Geospatial energy access planning specialist** (international, 2 person-months, intermittent). The specialist will be responsible for the overall design, development, and implementation of a GIS mapping exercise and development of a least-cost electrification plan using an existing decision support system such as Network Planner or GEOSIM. This will include designing a layered GIS mapping and analytical framework for conducting spatial least-cost electrification planning, including listing of key variables, resolution of maps, and choice of analytical approaches. This person will work closely with an international GIS specialist who will be responsible for the day-to-day activities relating to data collection, digitizing, mapping, analysis, and report writing. Academic qualifications in engineering or environmental science, with globally acknowledged credentials in geospatial energy access planning, and prior work in developing countries in Africa and/ or Asia, are strongly preferred.

10. **Geographic information system specialist** (international, 5 person-months, intermittent). The GIS specialist will be responsible for conducting the geo-referenced data collection, preparation, digitization, and analysis needed to arrive at least-cost off-grid energy access deployment plans for select states and regions. The specialist will liaise with the entire consulting team to obtain the necessary household energy demand, supply, renewable energy resource availability and other data; and also with government ministries and agencies to obtain data such as the location and expansion plans of the national grid, location of communities, and geographical terrain. Specific tasks include (i) preparing a structured GIS-layered database to support the spatial analysis, (ii) geospatial identification and characterization of power (cluster) loads from communities and social infrastructure, and (iii) creating geospatial maps for least-cost off-grid energy access planning. The specialist will also be required to organize user training seminars on geospatial planning and least-cost rural electrification planning for participants from relevant government ministries, research institutes, other donors, and the private sector in Myanmar. Advanced training in engineering, geography, environmental sciences, and mapping technologies, including prior experience in collecting data from developing country government agencies for geospatial mapping, is preferred.

11. **Procurement specialist** (international, 3 person-months, intermittent). The procurement specialist will work with the team leader and deputy team leader to develop suitable contract packaging and procurement plans for the proposed renewable energy-based energy access

projects in 25 off-grid villages in line with the requirements of MLFRD and the regional governments, as appropriate. The procurement specialist will also assist the capacity development specialist in preparing procurement capacity-related training program modules and other requirements as appropriate. The procurement specialist will have a degree in engineering, law, or other relevant discipline, and have regional experience with small-scale infrastructure projects and small grants programs, and preferably have strong experience in working with the Procurement Guidelines of ADB or other multilateral development banks.

12. **National consultants** (65 person-months). The national consultants (intermittent except where specified) will include (i) deputy team leader and energy access planning and renewable energy technical specialist (10 person-months); (ii) off-grid solar photovoltaic solution specialist (4 person-months); (iii) biogas or biomass energy systems specialist (4 person-months); (iv) micro-hydro specialist (3 person-months); (v) renewable energy finance specialist (4 person-months); (vi) capacity development and institutional strengthening specialist (4 person-months); (vii) community development facilitators (two positions, 12 person-months each); (viii) geospatial energy access planning specialist (4 person-months); and (ix) GIS specialist (8 person-months).

13. The national consultants will work closely with and support the activities of their international consultant counterparts. The community development facilitators will work with the local communities, project design and implementation teams, and other relevant stakeholders to facilitate the community's mobilization, organization, and engagement in project planning; and to assist in strengthening the community's overall capacity to ensure sustainability of the renewable energy installations. The community development facilitators will also facilitate project planning through group meetings and organized working groups.