Technical Assistance Report

Project Number: 49412-001
Regional Capacity Development Technical Assistance (R-CDTA)
September 2016

Access to Electricity with New Off-Grid Solar Technology in Central Asia

(Financed by the Clean Energy Fund under the Clean Energy Financing Partnership Facility)

Asian Development Bank

ABBREVIATIONS

AC	–	alternating current
ADB	–	Asian Development Bank
CAREC	–	Central Asia Regional Economic Cooperation
DC	–	direct current
TA	–	technical assistance
TEP	–	technical expert panel

NOTE

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

Vice-President	W. Zhang, Operations 1
Director General	S. O'Sullivan, Central and West Asia Department (CWRD)
Director	F.C. Kawawaki, Energy Division, CWRD
Team leader	S. Hasnie, Principal Energy Specialist, CWRD
Team members	C. Peralta, Operations Assistant, CWRD
	M. Soriano, Associate Project Analyst, CWRD
	C. Tiangco, Energy Specialist, CWRD
	E. Webb, Senior Operations Assistant, CWRD

CONTENTS

CAPACITY DEVELOPMENT TECHNICAL ASSISTANCE AT A GLANCE

1. Basic Data — **Project Number:** 49412-001

Project Name	Access to Electricity with New Off-Grid Solar Technology in Central Asia	**Department /Division**	CWRD/CWEN
Country	REG	**Executing Agency**	Asian Development Bank

2. Sector	**Subsector(s)**	**Financing ($ million)**
✓ Energy	Renewable energy generation - solar	2.00
	Total	**2.00**

3. Strategic Agenda	**Subcomponents**	**Climate Change Information**	
Inclusive economic growth (IEG)	Pillar 1: Economic opportunities, including jobs, created and expanded	Climate Change impact on the Project	Medium

4. Drivers of Change	**Components**	**Gender Equity and Mainstreaming**	
Partnerships (PAR)	Civil society organizations Implementation Private Sector	Some gender elements (SGE)	✓

5. Poverty and SDG Targeting		**Location Impact**
Project directly targets poverty and SDGs	No	Not Applicable

6. TA Category: A

7. Safeguard Categorization Not Applicable

8. Financing

Modality and Sources	**Amount ($ million)**
ADB	**0.00**
None	0.00
Cofinancing	**2.00**
Clean Energy Fund under the Clean Energy Financing Partnership Facility	2.00
Counterpart	**0.00**
None	0.00
Total	**2.00**

9. Effective Development Cooperation

Use of country procurement systems	No
Use of country public financial management systems	No

I. INTRODUCTION

1. The Central Asia Regional Economic Cooperation (CAREC) Program member countries are committed to a shared vision for the region's energy sector to ensure (i) energy security through the balanced development of the region's energy resources, infrastructure, and institutions; (ii) stronger integration of the region's energy markets to enable all Central Asians to have access to adequate volumes of reliable, affordable, financially sustainable, and environmentally sound commercial energy; and (iii) economic growth through energy trade.

2. The Strategy and Work Plan (2016–2020) for Regional Cooperation in the Energy Sector of CAREC Countries aims to promote new technologies and remove market barriers in the region.[1] As a first step, the Asian Development Bank (ADB) organized technology-training programs in 2015 to increase the awareness of global energy trends and recent energy innovations among key decision makers and opinion leaders from CAREC countries. With the awareness of recent innovations, senior officials representing CAREC's Energy Sector Coordinating Committee agreed on a new technology vision for pilot projects using readily available equipment in developed countries, especially lithium-ion batteries and solar power. Five Energy Sector Coordinating Committee member countries—Afghanistan, Kyrgyz Republic, Mongolia, Pakistan, and Tajikistan—were convinced on the use of new technology in an off-grid solar setting to increase or maintain reliable electricity access in their countries, and requested ADB to finance regional technical assistance (TA) to demonstrate a direct current (DC) solar electrification kit. The plug-and-play solar kit will include solar panels, lithium-ion batteries, energy-efficient lights, fans, a small refrigerator, a mobile phone charger, and a television, with some form of universal connectors and pre-cut cables for easy connection and setup. This solar kit is not readily available in the global market.

3. The TA will develop a technology adoption road map for off-grid areas in the CAREC countries. The Renewable Energy Development TA[2] for Afghanistan will pilot test and support the proof of concept (allocation of $30,000) to demonstrate the technical feasibility of a 12-volt DC solar kit, which can be easily assembled with little training. The design and complete technical specifications of the kit will be developed for the proof of concept, which will also identify the appliances that can be used with the kit.

II. ISSUES

4. More than 700 million people in Asia and the Pacific have no access to electricity, and a large number of them are in two CAREC member countries: Afghanistan and Pakistan. People in the remote mountainous areas of other CAREC countries also have poor access to reliable electricity. People rely on kerosene lamps for lights, when they have no access to electricity. An International Finance Corporation study notes that about 144 million people have no access to reliable electricity in Pakistan alone and that people spend about $2.3 billion annually on candles, kerosene lamps, and battery-powered flashlights. Kerosene lamps cost up to 30 times more than the inefficient incandescent bulb and 100 times more than compact fluorescent and light-emitting diode (LED) lamps. In some poor households, kerosene costs may account for up to 25% of their family's monthly income, and people in off-grid areas often travel to electrified towns to charge their phones for a fee. Further, kerosene lamps release black carbon into the environment, pollute the air inside homes, and cause lung and eye diseases. They produce insufficient light for work or study and their naked flame causes many accidents and injuries.

---

[1] CAREC. 2015. *Strategy and Work Plan (2016–2020) for Regional Cooperation in the Energy Sector of CAREC Countries.* Ulaanbaatar.

[2] ADB. 2014. Afghanistan: Renewable Energy Development. http://www.adb.org/projects/47266-001/main.

5. Small (30–50 watt) off-grid solar lighting systems are a popular alternative to kerosene lamps. About 4.5 million households and 25.0 million people in Bangladesh[3] have replaced kerosene lamps with small solar home lighting systems, and about 35.0 million people in Africa have basic lighting under the Lighting Africa Program of the World Bank. In Pakistan, the Buksh Foundation initiated the Lighting a Million Lives Project[4] to provide solar energy access to rural, unelectrified villages in the country and plans to bring electric lights to 4,000 villages and about 1 million people by 2017. The small systems only provide lighting.

6. Beyond lighting, modern life requires the use of mobile phone chargers, a mechanical fan, a television, and a small refrigerator. In off-grid areas, these appliances can only be operated with either electricity generated by diesel generators or a larger off-grid solar system with lead acid batteries. Both of these options are expensive and are beyond the reach of the average household in rural areas. Diesel generation is an electrocution risk and requires expert knowledge, a large fuel inventory for reliable supply, and technical knowledge to manage the generation set; a lead acid battery-based system requires battery replacement every 1–3 years.

7. Recent technological advances and price reductions in three areas—lithium-ion batteries, solar power, and energy-efficient appliances—have made larger off-grid solar systems economically more viable than extending the main transmission and distribution networks, especially in the case of expensive diesel generation-supplied grids. With this new technology, millions of people may be able to stop using kerosene lamps and start producing their own electricity, leapfrogging the long wait for connection to the electricity grid. As larger solar panels have become cheaper and suppliers of lithium-ion batteries are ready to provide more than 5 years of guarantee, it is possible to design a system that can power lights, a television, and a small refrigerator; and charge mobile phones for off-grid communities.

8. Off-grid solar approach may soon be the preferred choice over grid-connected electricity, even in countries with 100% electrification. For example, a typical new connection in rural Afghanistan is estimated to cost about $1,200[5] (plus regular payments for energy consumed), compared with a $1,500 kit that includes power generation and basic appliances with no additional payment other than basic maintenance for 5 years. According to a recent World Bank report,[6] the market for off-grid electricity will be about $3.1 billion by 2020, reaching about 100 million households. This is leading to a huge paradigm shift: off-grid electrification and micro-grids may no longer be a stopgap measure and may even be the least-cost option in many developing countries.

9. The TA aims to demonstrate the technical and financial viability of this new technology combination in the CAREC region, and enable the off-grid community to move from basic lighting to a range of basic battery-operated appliances using larger solar panels and long-life lithium-ion batteries. This is consistent with other ADB investments that allow off-grid solutions as a long-term technology option on the least-cost optimization plan.

10. The development challenge is to create a market for low-voltage DC appliances, quality batteries, and reliable solar panels in CAREC countries at reasonable prices. Solar panels

---

[3] Z. Shahan. 2016. ~25 Million People Benefit from Home Solar in Bangladesh. *Clean Technica*. 6 April. http://cleantechnica.com/2016/04/06/25-million-people-benefit-from-home-solar-in-bangladesh/.

[4] Buksh Foundation. 2015. *Concept Paper: Lighting A Million Lives Project.* Lahore. https://www.globalgiving.org/pfil/22398/projdoc.pdf.

[5] Based on a consultant's cost estimates for a distribution project in the south of Kabul in Afghanistan.

[6] *Lighting Global*. 2016. Launch of 2016 World Bank Group/Bloomberg Off-Grid Solar Market Trends Report. 3 March. https://www.lightingglobal.org/launch-of-off-grid-solar-market-trends-report-2016/.

produce DC electricity, and most off-grid systems convert DC to alternating current (AC), for which everyday appliances are designed. While DC appliances are affordable and easily available in developing countries and online stores, mainly for use during camping and other recreational activities, they are not readily available in CAREC countries. In some cases, high-priced but low-quality products are on the market—a key barrier to mainstreaming off-grid electrification to be viable for scale-up. In addition, other universal barriers, such as high up-front costs, lack of financing and awareness, institutional barriers, and perceived risks, will be assessed during implementation and scale-up.

11. The project will promote DC off-grid solar kits and equipment by demonstrating the viability of this technology, developing knowledge materials, and building capacities for mainstreaming this initiative. By establishing a market and creating new demand, ultimately through retail competition, the overall price of the kit will be lower. Off-grid electrification will mitigate climate change by reducing black carbon, and bring significant health and development benefits by replacing kerosene lamps. By using lithium-ion batteries, the system will be safer and healthier than kerosene, produce brighter lights, extend product lives, and lower life cycle costs.

III. THE CAPACITY DEVELOPMENT TECHNICAL ASSISTANCE

A. Impact and Outcome

12. The project impact will be increased access to reliable, affordable, financially sustainable, and environmentally sound energy using new technology. This is aligned with the CAREC Energy Strategy and Work Plan, 2016–2020 (footnote 1). The outcome will be off-grid electrification in CAREC countries mainstreamed, with at least one off-grid electrification project included in the country operations business plan pipeline for CAREC countries by 2018.

B. Methodology and Key Activities

13. The TA will deliver three outputs through the following key activities:

(i) **Viability of large-scale off-grid direct current solar kits adoption demonstrated in selected Central Asia Regional Economic Cooperation countries.** Participants of a focus group discussion and pilot users accept off-grid solutions as a permanent alternative to grid-connected electricity, both in terms of price and service levels. The project will install 100 operational off-grid solar kits in five CAREC member countries. A technical expert panel (TEP) will complete the design of the solar kit, finalize the technical specifications of the kit components, and establish acceptable warranty levels. With a consulting firm, the TEP will also identify the main equipment suppliers, procure components, establish the implementation arrangements, distribute the solar kits, and develop a technology adoption road map.

(ii) **Open-source design available for developing new business by private sector.** A communications coordinator will be engaged to help the TEP and the consulting firm develop a website for open-source design where off-grid electrification project designs can be published. Together, they will test the social acceptability of off-grid and DC technology, organize an open-source design community, and prepare and launch social media plans.

(iii) **Off-grid electrification capacity developed.** The consulting firm will develop a data collection framework to assess the financial and technical viability of the

solar kits. It will also provide training on the framework and on managing the installation of the solar kits.

14. The TA will take the proof of concept to the pilot phase and will (i) test for technical, financial, and economic viability; (ii) develop financial models and plans for scale-up; (iii) design cash flow models and policy needs plans for local industry development; (iv) establish acceptable warranty levels and detailed technical specifications of kit components; (v) develop a branding and communication strategy; and (vi) analyze the target beneficiaries' willingness to pay and the social acceptability through consumer surveys and focus group studies.

15. After the pilot phase, and based on consumer acceptability and technical results, the project will identify areas within Afghanistan and Pakistan that may use this technology to increase access to electricity by 30,000 to 50,000 households for a scale-up project and local market development. Once technical viability is demonstrated and a market price for the kit is established, an option to develop a basic kit (lighting only) and a full kit (lighting plus other appliances) will be market-tested with consumer focus groups.

C. Cost and Financing

16. The TA is estimated to cost $2,000,000, which will be financed on a grant basis by the Clean Energy Fund[7] under the Clean Energy Financing Partnership Facility and administered by ADB. The participating governments will provide counterpart support in the form of counterpart staff, office, secretarial assistance, and other in-kind contributions.

D. Implementation Arrangements

17. ADB will be the executing agency for the TA and will work closely with the Department of Energy (or its equivalent), power utilities, and interested civil society organizations in each of the pilot countries: Afghanistan, Kyrgyz Republic, Mongolia, Pakistan, and Tajikistan. Details of this arrangement will be developed during the inception mission. The TA will be implemented over 24 months starting from September 2016 to October 2018.

18. ADB will oversee and lead the implementation of the TA, and will work closely with CAREC coordinators in ADB resident missions in the pilot countries. The Energy Division of ADB's Central and West Asia Department and its team of consultants will organize internal seminars and workshops that will include other ADB staff members as resource persons. ADB will engage all consulting services following its Guidelines on the Use of Consultants (2013, as amended from time to time).

19. ADB will recruit up to four individual technical experts (one as the consultant team leader) and an international consulting firm to manage the design and implementation of the off-grid solar kits. ADB will recruit 12 person-months of international individual experts to design the technical specifications of the off-grid kit, its packaging, and component selection criteria based on the preliminary proof-of-concept work. Once the technical and innovative specification of the design is complete, the consulting firm will distribute, monitor, and report the performance of the pilot project in the five selected countries. The firm will deliver 24 person-months of international and 60 person-months of national consulting services, and will be selected through ADB's quality- and cost-based selection method with a 90:10 ratio and using a simplified technical proposal.

[7] Financing partners: the governments of Australia, Norway, Spain, Sweden, and the United Kingdom.

20. **Technical expert panel.** The four key technology elements—solar power, DC supply, storage, and DC appliances—have seen dramatic technological development in the past 24 months, requiring technical experts to have fresh perspectives and recent research or academic achievements. Recent technical experience gained from technical institutions with established credentials in the four technology elements will have more bearing in selecting the individual experts that will be recruited under this TA.

21. ADB may establish partnerships with renowned technology service providers or universities. The guiding principles for any partnership will include the following:

(i) TA proceeds will not finance the staff costs, capitalization, or ordinary operating expenses of partner(s), and will only finance the eligible individual's transportation and daily subsistence allowance.

(ii) Partner(s) will not engage consultant(s) or resource person(s) using the TA proceeds. All consultants and/or resource persons to be financed by ADB using the proceeds for the assignments envisaged and/or proposed in the partnership agreement will be engaged directly by ADB.

(iii) The off-grid training will be conducted in partnership with Hydro Tasmania, a utility-owned by the Government of Australia. This will cover visits to solar installations that are wind and fly-wheel installations (as energy storage) in the King Island Renewable Energy Integration Project and Flinders Island Hybrid Energy Hub.[8]

(iv) The project team will continue its work to establish partnerships with large battery providers and companies like Tesla, which makes the AC-based Powerwall.

22. ADB's Procurement and Contracts Administration Unit will purchase batteries, solar panels, controllers, DC appliances, and other types of equipment.

IV. THE PRESIDENT'S DECISION

23. The President, acting under the authority delegated by the Board, has approved ADB administering technical assistance not exceeding the equivalent of $2,000,000 to be financed on a grant basis by the Clean Energy Fund under the Clean Energy Financing Partnership Facility for Access to Electricity with New Off-Grid Solar Technology in Central Asia, and hereby reports this action to the Board.

[8] These projects are financed by the Australian Renewable Energy Agency. Hydro Tasmania. Hybrid off-grid solutions. http://www.hydro.com.au/energy/hybrid-off-grid-solutions.

DESIGN AND MONITORING FRAMEWORK

Impact the TA is Aligned with
Increased access to reliable, affordable, financially sustainable, and environmentally sound energy using new technology[a]

Results Chain	Performance Indicators with Targets and Baselines	Data Sources and Reporting	Risks
Outcome Off-grid electrification mainstreamed in CAREC countries	At least 1 off-grid solar electrification project in the country operations business plan pipeline for CAREC countries by 2018 (2016 baseline: 0)	National energy plan for CAREC countries	Pilot tests may not produce financially viable results that governments will accept as a solution for scale-up. Imitation products with poor quality may undermine the kits to be developed under the project. The kits may face negative publicity from suppliers of kerosene and diesel in remote areas. Extremely low-priced diesel or kerosene and the risk of solar panel theft may undermine the kit-based approach.
Outputs 1. Viability of large-scale off-grid DC solar kits adoption demonstrated in selected CAREC countries 2. Open-source design available for developing new business by private sector 3. Off-grid electrification capacity developed	1. 100 off-grid solar kits installed and operating in 5 CAREC member countries by July 2018 (2016 baseline: 0) 2. A website for open-source design established and design material for at least 1 off-grid electrification project published by May 2017 (2016 baseline: 0) 3. At least 30 people (in each country) trained on managing the installation of the off-grid kit;	1–3. Actual field data from the project's report that will be presented twice a year at the Energy Sector Coordinating Committee meeting of CAREC; data and report released on the CAREC website[b]	Actual cost may be higher than assumptions because of procurement constraints. Suppliers of small-scale diesel generators may oppose off-grid solar.

Results Chain	Performance Indicators with Targets and Baselines	Data Sources and Reporting	Risks
	awareness-building materials (website, videos, and brochures) disseminated; and videos developed and produced by June 2017 (2016 baseline: 0)		

Key Activities with Milestones

1 Viability of large-scale off-grid DC solar kits adoption demonstrated in selected CAREC countries

1.1 Design completed, technical specifications of kit components finalized, key components developed, and acceptable warranty levels established (Q4 2016–2018)
1.2 Key suppliers identified through a road show, and components procured through advance action and international shopping (Q1 2017)
1.3 Implementation arrangements established in participating CAREC countries, and at least 500 kits distributed and installed with support from local counterparts (Q1 2017)
1.4 Social acceptability of off-grid and DC technology tested and market research prepared for potential scale-up (Q3 2017)
1.5 Open-source design community organized and social media plan prepared and launched (Q2 2017)
1.6 Regional road shows for awareness building completed (Q4 2017)
1.7 Off-grid section and display of miniature house electrified by kit installed at Asian Development Bank premises for demonstration to other developing member countries (Q1 2018)

2 Open-source design available for developing new business by private sector

2.1 Social acceptability of off-grid and DC technology tested (Q3 2017)
2.2 Open-source design community organized and social media plan prepared and launched (Q2 2017)
2.3 Regional road shows for awareness building completed (Q4 2017)

3 Off-grid electrification capacity developed

3.1 Training completed and option to add a SIM card to each kit for automatic generation and consumption of data to evaluate financial and technical viability assessed (Q2 2017)

Inputs

Clean Energy Fund under the Clean Energy Financing Partnership Facility: $2,000,000

Note: The governments will provide counterpart support in the form of counterpart staff, office, secretarial assistance, and other in-kind contributions.

Assumptions for Partner Financing

Not applicable

CAREC = Central Asia Regional Economic Cooperation, DC = direct current, Q = quarter, SIM = subscriber identity module, TA = technical assistance.

[a] CAREC. 2015. *Strategy and Work Plan (2016–2020) for Regional Cooperation in the Energy Sector of CAREC Countries.* Ulaanbaatar.

[b] Central Asia Regional Economic Cooperation (CAREC) Program. http://www.carecprogram.org.

Source: Asian Development Bank.

COST ESTIMATES AND FINANCING PLAN

($'000)

Item	Amount
Clean Energy Fund[a] under the Clean Energy Financing Partnership Facility	
1. Consultants	
a. Remuneration and per diem	
i. International consultants	500.0
ii. National consultants	200.0
b. International and local travel	45.0
c. Reports	5.0
2. Equipment	
a. Batteries	250.0
b. Solar panels	55.0
c. Charge controllers	25.0
d. DC (direct current) equipment	250.0
e. Cables and other accessories	20.0
3. Training, seminars, and conferences	
a. Facilitators	100.0
b. Seminars	100.0
c. Off-grid training[b]	100.0
4. Communication	200.0
5. Miscellaneous administration and support costs	100.0
6. Contingencies	50.0
Total	**2,000.0**

Note: The technical assistance (TA) is estimated to cost $2 million, of which contributions from the Clean Energy Fund under the Clean Energy Financing Partnership Facility are presented in the table above. The participating governments will provide counterpart support in the form of counterpart staff, office, secretarial assistance, and other in-kind contributions. The value of government contribution is estimated to account for 33.3% of the total TA cost.

[a] Financing partners: the governments of Australia, Norway, Spain, Sweden, and the United Kingdom. Administered by the Asian Development Bank.

[b] Off-grid training will be conducted in partnership with Hydro Tasmania, a utility owned by the Government of Australia.

Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

1. The capacity development technical assistance will engage 36 person-months of international and 72 person-months of national consulting services.

1. International Consultants (independent, 4 experts, 12 person-months total)

2. The four international consultants (one as the team leader) that will comprise the technical expert panel (TEP) will have a bachelor's degree and cutting-edge technical expertise gained from reputable academic institutions or industry. The TEP will design the off-grid solar kit and each expert will be responsible for one of the key equipment specifications for the kit. The four key types of equipment are (i) solar power, (ii) DC supply, (iii) battery-based storage, and (iv) DC appliances. The TEP will be responsible for the following:

(i) identifying suitable components and developing the complete technical specifications for each type of key equipment;
(ii) designing the electrical assembly, and recommending packaging and handling procedures;
(iii) developing procurement strategy options and identifying a pool of suppliers and technology providers;
(iv) developing the testing procedure and acceptance criteria based on the technical specifications of the key equipment, including acceptable warranty levels;
(v) benchmarking the cost of the proposed design against similar kits that may be commercially available (not available in 2016) in other markets; and
(vi) organizing an open-source design community and launching a social media platform to increase awareness of off-grid and DC technology.

2. National Consultants (independent, 2 experts, 12 person-months total)

3. **RETA coordinator.** The consultant will undertake the following tasks:

(i) assist with project implementation and the preparation of project documents and reports;
(ii) keep records of all key references and documents used and developed by the technical experts, including managing communication with all stakeholders;
(iii) coordinate with the consulting firm on the distribution of the kits, feedback results, and other coordination requirements; and
(iv) design project feedback monitoring and reporting mechanisms, and process and analyze feedback results from consultants and pilot sites.

4. **Communications coordinator.** The consultant will undertake the following tasks:

(i) coordinate with the TEP and the consulting firm in developing the open-source design community and social media platforms;
(ii) generate and disseminate project briefs and updates to project stakeholders;
(iii) maintain and monitor communication platforms; and
(iv) develop branding and a marketing and communication strategy.

3. Consulting Firm

5. A consulting firm will be recruited following the Asian Development Bank's Guidelines on the Use of Consultants (2013, as amended from time to time) through quality- and cost-based selection with a 90:10 ratio and using a simplified technical proposal.

6. The consulting firm will coordinate the distribution, and monitor and evaluate the performance of the kits in partnership with the local universities and local utility providers in each country. The team of international and national consultants will be responsible for developing and implementing the project. The international technology team will consist of (i) an off-grid solar expert and team leader, (ii) a finance expert, (iii) a civil society expert, (iv) a procurement expert, and (v) a communication and media specialist. The national technology consultants, one from each of the five countries covered by the project, will be in charge of project implementation and coordination at the country level.

7. **Off-grid solar expert and team leader** (international, 6 person-months). The consultant will have a minimum of 5 years' experience in the engineering and design of off-grid solar technology, preferably in low-voltage systems. The consultant will be responsible for leading the team and coordinating with other experts. The activities to be undertaken include the following:

(i) develop a detailed project implementation plan for at least 500 kits;
(ii) recommend modifications to the design of the kit based on feedback;
(iii) develop and implement procedures required to ensure adequate control of the delivery, acceptance, and storage of equipment from suppliers;
(iv) prepare and assess the complete logistics chain from shipment to on-site delivery for all goods and services to be procured and installed under the project;
(v) supervise the assembly of the kits as the different components are delivered by the suppliers;
(vi) design and implement procedures to test the social acceptability of the kits;
(vii) provide technical support to the national technology consultants, and interface with suppliers on technical issues of the equipment supplied;
(viii) develop a capacity building program and activities to raise awareness of off-grid solar and DC technology;
(ix) develop a data collection and reporting framework to assess the financial and technical viability of the project and to test the social acceptability of off-grid and DC technology;
(x) develop and design policy needs plans for local industry development; and
(xi) develop the project implementation plan for the scale-up program.

8. **Finance expert** (international, 6 person-months). The consultant will have a degree in finance or business, with at least 5 years' experience in designing cash flow models. The consultant will undertake the following tasks:

(i) collect data and assess the financial viability of the kits;
(ii) design cash flow models and pricing plan options for the pilot test and for the possible scale-up program;
(iii) quantify project benefits by reporting energy produced versus avoided costs; and
(iv) develop leasing options and rent-to-own schemes for the scale-up program.

9. **Civil society expert** (international, 6 person-months). The consultant will have a degree in social science and at least 10 years' experience in developing countries. The consultant will undertake the following tasks:

(i) provide inputs in developing the training and data collection framework to test the social acceptability of off-grid and DC technology;
(ii) consult non-government organizations, focus group study participants, and other stakeholders on maintenance, sustainability, and delivery;
(iii) design and implement procedures to test the social acceptability of off-grid and DC technology;

(iv) recommend necessary inputs, if needed, for other project implementation documents; and
(v) coordinate with other similar activities in the country, identify negative aspects, and suggest improvements.

10. **Procurement expert** (international, 3 person-months). The consultant will have at least 10 years' experience working in international procurement and contract administration of infrastructure projects. The consultant will undertake the following tasks:

(i) develop bid documents and manage the procurement process, bid evaluation, and approvals;
(ii) interface with suppliers regarding warranty agreements, and advise the project coordinator on executing warranty redemptions for faulty equipment;
(iii) manage the logistics chain from shipment to on-site delivery for kit components to be procured and installed under the project;
(iv) manage warranty claims of kit users; and
(v) identify new supplies in the market and provide feedback on local market development.

11. **Communication and media expert** (international, 3 person-months). The consultant will have at least 5 years' experience working with various communication platforms. The consultant will undertake the following tasks:

(i) develop communication platforms to encourage user feedback and increase awareness of off-grid and DC technology; and
(ii) monitor and maintain social media platforms (i.e., Facebook, LinkedIn, and YouTube).

12. **National technology consultant** (national, one from each country, 12 person-months each). The consultant will have an engineering science background with at least 5 years' experience in the energy sector, including renewable energy projects. Working with the local utility provider and university, the consultant will undertake the following activities:

(i) take part in developing the list of workshop and training participants based on the criteria developed by the team leader;
(ii) organize workshops and training logistics for households;
(iii) conduct field visits of the project sites, collect all necessary data from the users, and transmit the data back to the international technology team at the project headquarters;
(iv) develop and implement procedures required to ensure adequate control of the delivery, acceptance, and storage of kits from project headquarters;
(v) design systems for the delivery and distribution of kits;
(vi) collect and monitor feedback data from households, process and analyze the data, and prepare regular reports;
(vii) provide solar kit maintenance support to the participating households, report to the team leader on systemic issues, and prepare monthly reports on the performance of installed units;
(viii) work with utility representatives and coordinate the replacement of faulty equipment;
(ix) be the first contact point of users for basic queries on the operation and maintenance of the kits; and
(x) participate in conferences and workshops related to off-grid electrification in the country.