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| **Note for Project TTLs:**The following TOR is for the rapid installation of electric power systems for key facilities which are expected to be on the front lines of supporting the country’s COVID-19 response and which have inadequate or non-existent electricity supply. It is a template that can be tailored to the specific needs of a World Bank project that is being restructured to support a country’s emergency response to COVID-19. A separate, companion TOR covers the consulting activities to help with the preparation and oversight of the activities related to this TOR. ESMAP remains available to support project teams with the design and implementation of energy-related activities in response to COVID-19. The key contact for activities related to this TOR is Dana Rysankova, Senior Energy Specialist and Global Lead for Energy Access (drysankova@worldbank.org). |

**Terms of Reference for the Installation of Electric Power Systems for Facilities at the Front Lines of COUNTRY’s COVID-19 Response**

# Summary

This Terms of Reference (TOR) is for a single company or consortium of companies to electric power systems for facilities that are on the front lines of COUNTRY’s response to the COVID-19 pandemic. This activity is funded through the World Bank-supported PROJECT NAME (P NUMBER), which is being restructured to aid in the Government of COUNTRY’s emergency COVID-19 response.

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| **Note for Project TTLs:**This TOR could be split into two separate TORs – one for procurement and installation of the works, and one for operations and maintenance. However, given the need to move quickly to implement these projects before cases of COVID-19 overwhelm healthcare facilities, it is recommended to have a single firm manage all of the activities. That said, the lead firm could engage subcontractors for different activities of the TOR.  |

For the purposes of this TOR, the types of facilities targeted for urgent intervention are:

* Type 1 Facility: Hospitals in urban and peri-urban areas that are connected to the main grid, but which receive unreliable power
* Type 2 Facility: Primary health clinics and smaller hospitals in rural and peri-urban areas that are (a) not connected to the main grid and either depend on diesel generator sets or lack access to electricity

 or (b) which are connected to the main grid but receive unreliable power

* Type 3 Facility: Temporary emergency facilities that are being established to process and treat overflow patients
* Type 4 Facility: Other buildings that are critical to the country’s COVID-19 response including testing laboratories, cold-storage warehouses, local factories making personal protective equipment, and government offices (both in the capital and elsewhere) coordinating and implementing COVID-19 activities.

The firm or consortium will be responsible for the following activities, divided into three Work Programs:

* Work Program 1: Procure and install modular electric power systems for facilities in COUNTRY, which have been identified by the Government of COUNTRY with World Bank support.
* Work Program 2: Ensure continuous 24/7 operation of the facility’s electric power system, including any necessary maintenance plans and technology upgrades, for a period of 24 months after the date of commissioning or until a long-term operator is identified, whichever occurs first.
* Work Program 3: Hand-over of the system to the relevant owner-operator at the conclusion of Work Program 2.

The activities described in this TOR will be competitively tendered under emergency fast-tracked World Bank procurement policies to firms or consortia of firms. The successful applicants will sign a contractual agreement with GOVERNMENT IMPLEMENTING AGENCY and will receive payments upon successful completion of the agreed milestones.

# Background

An outbreak of the coronavirus disease (COVID-19) caused by the 2019 novel coronavirus (SARS-CoV-2) has been spreading rapidly across the world since December 2019, following the diagnosis of the initial cases in Wuhan, Hubei Province, China. Since the beginning of March 2020, the number of cases outside China has increased thirteenfold and the number of affected countries has tripled. On March 11, 2020, the World Health Organization (WHO) declared a global pandemic as the coronavirus rapidly spreads across the world. As of April 4, 2020, the outbreak has resulted in approximately 1 million cases and more than 50,000 deaths across nearly every country around the world.

COVID-19 is one of several emerging infectious disease outbreaks in recent decades resulting in major outbreaks with significant public health and economic impacts. The last moderately severe influenza pandemics were in 1957 and 1968; each killed more than a million people around the world. Although countries are now far more prepared than in the past, the world is also far more interconnected, and many more people today have behavior risk factors such as tobacco use and pre-existing chronic health problems that make viral respiratory infections like COVID-19 particularly dangerous.

Scientists are still trying to understand the full picture of COVID-19’s symptoms and severity. Approximately 20 percent of all confirmed cases require hospitalization, and 5 percent of all confirmed cases require intensive care typically consisting of mechanically powered respiration through the use of respirators or the surgical procedure of intubation. Patients admitted to hospitals and clinics with moderate to severe symptoms can expect to remain there for an average of about two weeks. While around 5 percent of the people worldwide confirmed as having been infected have died (the so-called “case fatality rate”), the World Health Organization has been careful not to describe this as the mortality rate or death rate of COVID-19. This is because in an unfolding epidemic it can be misleading to look simply at the estimate of deaths divided by cases so far.

COVID-19 is highly contagious: each infected person is expected to infect an additional 2-3 people, and asymptomatic people are infectious. To date, there is no cure or vaccine for COVID-19. There have been no clinically proven efficacious treatments for COVID-19, but a handful of drugs appear to increase the life expectancy in patients with severe symptoms. Most of these drugs are currently in early stage clinical trials to prove or disprove their efficacy as COVID-19 treatments. Meanwhile, experts agree that a vaccine is still more than a year away even if several companies and laboratories are actively developing vaccine candidates for clinical trials.

As a result of the characteristics of COVID-19 as a disease and the limited healthcare options available to support moderately and critically ill patients, the best option available to governments today is to enact and enforce strict “social distancing” measures that drastically reduce the contact that individuals have with each other. One consequence of these measures is the dramatic slowdown of the national economy and the disruption to most supply chains.

It is in this context that the World Bank is supporting COUNTRY’s response to COVID-19 through a restructuring of PROJECT NAME. A core component of this restructuring is to urgently provide reliable electric power to facilities that will be on the front lines of caring for COVID-19 patients.

COVID19 presents unique and severe challenges to health care systems in World Bank client countries and around the world. The World Bank and UN are making [billions of dollars](https://www.google.com/url?q=https://www.worldbank.org/en/news/press-release/2020/04/02/world-bank-group-launches-first-operations-for-covid-19-coronavirus-emergency-health-support-strengthening-developing-country-responses&sa=D&ust=1586149432273000&usg=AFQjCNFiQjIJ0gPLHd8RcLXNxdGZM146QA) in emergency loans available to governments to prepare for the ongoing spread of the pandemic, including the purchase of ventilators and oxygen supplies, and ramping up staff where possible, and to manage the economic impact of the crisis. A reliable electricity supply is among one of the many requirements that must be in place for a country’s health care system to address the crisis.

The World Bank can play a critical role in addressing the urgent electricity needs for hospitals and clinics during the COVID-19 crisis. Solutions can be distinguished according to the site's power demands and supply options, considering unique needs for COVID-19 response. Power demands range from large urban hospitals with unreliable grids to unelectrified rural clinics with few resources. Supply options include some combination of diesel generators (subject to fuel supply), batteries and inverters, and solar PV.

# Types of Facilities Targeted for Support

The four types of facilities expected to be supported by activities covered under this TOR are the following:

**Type 1 Facility: Hospitals (on-grid, but often with intermittent supply)**

It is expected that hospitals (especially larger ones with at least 200 beds) in urban areas will be designated to treat COVID19 patients. In many cases these will have electricity supplies from the national grid and already have diesel backup generators.

**Type 2 Facility: Rural Clinics, Primary Health Centers, Small Rural Hospitals (off-grid or on-grid with unreliable supply)**

Rural clinics, primary health centers and small rural hospitals that are not assigned treating COVID19 patients should be included in the emergency response where possible. Even if not as urgent as COVID19 centers, these clinics and health centers are still in the frontline of the fight against the pandemic as they are often the only place that sick patients can access in rural areas. As major hospitals focus on COVID19, these facilities will also need to treat other patients, including those that would typically be referred to hospitals. They are likely to provide palliative care, and possibly serve as referral clinics for more severe cases. Moreover, these clinics and health centers will gain more prominence if the pandemic spreads to rural communities; hence it is essential that they are also well equipped.

These facilities are more likely to be located in areas with no national grid, or if grid electricity is available it is likely to be less reliable than in more urban areas. Many have no electricity of any kind. At these sites it is more likely there will be adequate space for solar arrays. Diesel fuel supply chains will likely be more fragile and grid extension would be unviable. For all of these reasons, solar electric systems will likely be an appropriate solution, if they can be installed relatively quickly. It should be noted that even though diesel based solutions could help mitigate immediate concerns, solar systems (solar PV + Battery) or a hybrid of solar and diesel solutions could be more affordable, sustainable, and resilient in the medium (6 months and beyond) to long term. This is primarily due to two reasons: Diesel fuel supply will be a significant risk in many client countries particularly during a global crisis such as COVID which could last over a year. Moreover, the high cost of diesel may permit health institutions to use it only for a few hours, thus compromising health care that is needed 24/7 amid the coronavirus pandemic.

**Type 3 Facility: Temporary Emergency COVID19 Facilities**

Temporary emergency facilities for processing and treating COVID19 patients are expected to be set up in a number of countries. These will serve as isolation wards for suspected cases and for confirmed cases, with facilities for treatment of acute cases. These will often be built adjacent to existing hospitals, with screening facilities to separate COVID-suspected patients from non-COVID cases.

**Type 4 Facility: Non-clinic Facilities: cold chain, testing labs, and other critical facilities**

Certain promising drugs for COVID19 treatment and any eventual vaccine will need cold-chain facilities that keep them chilled in all stages from production to final delivery in village clinics. This will require reliable 24/7 electricity to power cooled warehouses and refrigeration down to the level of clinics and dispensaries. Where the grid is not available, cooled warehouses will be most cost-effectively served by 24/7 electricity from hybrid solar/diesel systems. Where grid electricity is available but not reliable, battery/inverter systems or backup generators will be needed. At the level of clinics and dispensaries, highly reliable direct-drive solar vaccine refrigerators can keep vaccines and medicines cool without the need for batteries. Testing is proving to be essential in the fight against COVID19, and laboratories will require electricity to process test samples and communicate results. Masks and other personal protective equipment – essential for healthcare workers encountering COVID19 patients – is in limited supply worldwide. As a result, local workshops and factories will need to produce additional supplies. These factories will need electricity to operate sewing machines and other equipment. Finally, government buildings coordinating COVID-19 response (including facilities outside the capital coordinating sub-nationally) would also be candidates for priority support in terms of guaranteeing 24/7 electricity.

# Description of Activities

The activities of this TOR are expected to be carried out in three Work Programs. Detailed requirements for the installation, operations, maintenance, and handover are provided in Appendix B.

## Work Program 1: Procurement and installation of modular electric power systems for targeted facilities.

An audit conducted by the Government of COUNTRY with support from the World Bank has identified the following facilities that urgently require new or improved electric power systems:

* NUMBER Type 1 facilities
* NUMBER Type 2 facilities
* NUMBER Type 3 facilities
* NUMBER Type 4 facilities

A list of sites and the technical characteristics of their electric power system needs is attached as Appendix A.

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| **Note for Project TTLs:**Activities 2 and 3 in the companion TOR for consultancy services to assist with the implementation of this TOR cover the demand assessment of the electric power system needs of targeted facilities around the country. Results from this assessment would be reported in Appendix A of this TOR. As noted in the companion TOR for TA consultancy, if the project team does not already have a consultant under contract who could carry out a demand assessment, or foresees challenges in rapidly onboarding a consultant with sufficient technical capabilities to do this, then Activities 2 and 3 from the TA consultancy TOR could be added to this TOR, in which case, it would be the installation firms that conduct the audit and prepare the technical requirements package for each site.  |

[Optional: These sites have been grouped into lots of roughly equal number of sites in the same geographic area.] The firm will be responsible for procuring and installing electric power systems at each site under very tight timelines: installations are expected to be completed in less than a week at each site, and for firms installing systems at multiple sites, all installations are expected to be completed within 30 days of signing the contract with GOVERNMENT IMPLEMENTING AGENCY.

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| **Note for Project TTLs:**The larger the number of sites, the more attractive the project will likely be to the private sector, but the more difficult it will be for a single firm to manage the rapid deployment that will be required. As a result, project teams should carefully assess the capacity and experience of the firms submitting offers,and should be prepared to evaluate and award contracts for individual sites to smaller companies as well as groups of sites to larger companies.  |

The works are carried out under the strict supervision and quality control practices of GOVERNMENT IMPLEMENTING AGENCY personnel or its authorized representatives. Upon completion of the facilities, there will be a further 12-month defects liability period.

The systems should be

* modular in design such that additional generation and storage capacity can be easily and quickly added.
* of sufficient capacity to run critical equipment – for example, lights, vaccine refrigeration, oxygen concentrators, bed side monitors, and other critical loads autonomously for three days.
* fully automatic with the lowest possible maintenance requirements, and should integrate remote monitoring capabilities.

Additionally, for Type 2 facilities in sites that are not connected to the main grid and rely on diesel generators or lack electricity access altogether, the proposed system should be a standalone PV-diesel hybrid. If economically and physically feasible, the system should be capable of being integrated into a mini grid that would serve the surrounding community (e.g. a PV-diesel hybrid mini-grid).

Systems for Types 1, 2, and 4 facilities that rely exclusively on a diesel generator are not recommended since the maintenance and fuel supply requirements would make the system vulnerable to the supply chain risks inherent to the COVID-19 pandemic and also prohibitively increase cost in the medium to long term. However, given the need for an immediate response, system designs may include an initial installation of diesel gensets (which are faster to procure and install) followed by the addition of solar PV (where possible) and battery storage to reduce or eliminate medium to long term reliance on diesel generation.

Systems should also accommodate, or if appropriate, replace, any existing electric power infrastructure at the facility.

All activities under Work Program 1 should be completed within 30 days of signing the contract with GOVERNMENT IMPLEMENTING AGENCY.

## Work Program 2: Ensure continuous 24/7 operation of the system, including any necessary maintenance and technology upgrade, for the full duration of the operations and maintenance period.

The operations and maintenance period commences on the date of commissioning and ends 24 months after the date of commissioning or until a long-term operator is identified, whichever occurs first.

The contracted firm shall be expected to provide continuous on-site operations and maintenance support and training to health personnel for a period of two weeks after successful commissioning. Thereafter, and for the entire duration of the operations and maintenance period, the contracted firm will be expected to provide continuous remote monitoring of the entire system and to respond to faults within six hours. Furthermore, the contracted firm will remain available for remote troubleshooting support for health facility staff for matters related to the facility’s electricity system.

The contracted firm shall also update the system software and interface when needed and keep records and activity logs.

The contracted firm will be required to provide training to key health facility staff on the safe and proper use of the electricity system, as well as on simple and routine maintenance procedures such as cleaning the solar panels, replacing blown fuses, or cycling the batteries. To complement the training, the contracted firm will be required to prepare an operations and maintenance manual, which should include a section on troubleshooting.

## Work Program 3: Hand-over of the system to the relevant owner-operator at the conclusion of Work Program 2.

At the conclusion of the operations and maintenance period or when a long-term operator is identified (whichever occurs first), the contracted firm will be expected to hand over the system to the relevant owner-operator in good working order. This includes training on system operations and maintenance and participation in inspections of the works. The contracted firm will be expected to remain available remotely to answer questions about the system and to support the owner-operator during a two-month transition period that begins on the last day of the operations and maintenance period.

In some sites, the health facility’s electricity system will become the basis for the generation system of a mini grid that serves the surrounding community. In these cases, the contracted firm will be expected to cooperate with GOVERNMENT IMPLEMENTING AGENCY in its preparations for developing the mini grid. This requirement holds for the entire duration of the operations and maintenance period, and includes but is not limited to sharing detailed technical and demand data and facilitating site access to GOVERNMENT IMPLEMENTING AGENCY employees or other individuals that it authorizes.

# Special Health and Safety Conditions

Given the nature of this assignment, the contracted firm should indicate the measures it will take to avoid person-to-person transmission of COVID-19 as it carries out all activities under this TOR. This should include personal protective equipment for all employees working in and around the health clinic, remote video-enabled trainings and other meetings whenever possible, and on-site social distancing and personal hygiene rules.

# Expected Role of the Recipient Facility

The GOVERNMENT IMPLEMENTING AGENCY will sign an agreement with each facility laying out the roles and responsibilities of the parties. In general, facilities will provide: (i) suitable land for the power system (with GOVERNMENT IMPLEMENTING AGENCY responsible for any resettlement and/or livelihood restoration planning and implementation processes and associated costs in accordance with World Bank safeguards requirements, including a suitable Grievance Redress Mechanism (GRM)); and (ii) access and security for the firm carrying out the activities under this TOR. The facilities will also be responsible for the maintenance and proper usage of any electrical appliance receiving power from the solar-battery system. The facilities will be encouraged to identify an on-site manager to be the lead point of contact for all parties related to the activities of this TOR.

# Timeline

* Date TBD: Signing of contracts with firms
* Date TBD: Installation and commissioning of electric power systems, including identification of defects to correct
* One year after commissioning: Identification and rectification of any defects in the electric power system
* 24 months of the commissioning date or when a long-term operator has been identified, whichever occurs first: Conclusion of the operations and maintenance period

# Disbursement Schedule

* 20% of the contract amount paid upon signing the contract
* 10% of the contract amount paid when materials arrive on site
* 20% of the contract amount paid when the power system is successfully commissioned
* 20% of the contract amount paid at the end of the defects liability period if all known defects have been rectified
* 30% of the contract amount paid at the end of the operations and maintenance period.

# Appendix A: List of Facilities and their Technical Requirements

The Government of COUNTRY has identified the following facilities as urgently requiring new or improved electric power systems.

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| **Note to Project TTLs:** Appendix A should report out the prioritized list of sites identified for urgent intervention and their technical characteristics and requirements, ideally divided into those facilities that require immediate intervention (within 2 weeks), intermediate intervention (within 1-2 months), and other critical interventions (within 3-6 months). If firms are being awarded fixed-price contracts, each site should also have the associated contract price. This list would be prepared by the consultant according to the TOR for TA consultancy services that accompanies this TOR.  |

# Appendix B: Detailed Conditions for Installation, Commissioning, Operations and Maintenance, and Handover

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| **Note for Project TTLs:** Colleagues at Humboldt State University are working on a quality assurance framework for electric power systems for healthcare facilities that is tailored to the COVID-19 context in our client countries. This framework will be shared as soon as it is available, and can then be added to Appendix B.  |

**Structure Excision**

* The contractor shall submit data sheets/ catalogues for all of the proposed material including but not limited to PV modules, battery inverter, charge controller, DC cables, AC cables, DC junction box, AC coupling panel, Main Distribution Board (MDB), LED lights and air conditions;
* Contractor shall make all measurements and check all dimensions necessary for the proper construction of the Work called for by the Drawings and Specifications. During the execution of the Work, the Contractor shall make all necessary measurements to prevent errors in the Work.
* When it is customary to do so, when the dimensions are of particular importance, or when so specified, the drawings shall be certified by the manufacturer or fabricator as corrected for the Contract. All submittals shall be checked and approved by GOVERNMENT IMPLEMENTING AGENCY.
* All materials should be supplied as specified and subject to GOVERNMENT IMPLEMENTING AGENCY approval prior to commencement of work.

**Installation**

* The contractor is responsible to safely construct any mounting structures taking in consideration all the precautions to keep the integrity of the buildings,
* The contractor is responsible to investigate the buildings’ integrity prior to any work and make sure the safe installation on the buildings and consider required precaution for roof integrity with-out any extra cost.
* The contractor is responsible for set up a protection system against lightning, any equipment fails due to lightening will be replaced by the contractor and on his own cost;
* Installation of PV systems components shall be done in accordance with manufacturer operation manual;
* The contractor will be responsible for setting up a battery management plan in line with Environmental Point of Practice;
* The contractor should take into account the site condition in terms of obstacles and shadings;
* Outdoor above-ground cables shall be housed inside perforated galvanized steel cable trays with covers, underground cables laid in 40cm depth trench inside PVC pipe, while indoor cables shall be laid in cable tray or high quality trunk;
* The contractor shall supply all the required components required for data logging and monitoring;
* All electrical works shall comply with the manufacture instructions and regulations;
* The contractor will be responsible for supply, connecting new main distribution board (MDB) and integration with existing MDB, in accordance with the specifications and drawings
* The contractor will be responsible for installing, wiring and connecting new distribution boards as presented in the drawings including wiring of essential loads from old distribution boards to new distribution boards.
* The contractor will be responsible for dismantling and disposing of old fluorescent or incandescent lights and replacing these with LEDs;
* The contractor will be responsible for wiring and connecting new A/C units inside the control room include providing switching control for both A/Cs units and all required works for safe operation and connection for supply from the DG;
* System configuration, testing and commissioning should be carried out by an experienced electrical engineer.
* The contractor shall provide permanent equipment marking, labelling and signage for the project including all electrical items;
* It is the contractor’s responsibility to clean the modules once the construction work is completed;
* The contractor will be responsible for constructing a new control room in line with the specifications, drawings and BoQ if required;
* The contractor will be responsible for relocating any existing water tanks where applicable;

**System Commissioning**

* The contractor shall provide a time plan and test procedure for the process of commissioning;
* The contractor shall prepare a commissioning report and carry out all needed test procedures of commissioning. The commissioning process should be witnessed and approved by IMPLEMENTING GOVERNMENT AGENCY;
* Such testing should include the following tests as minimum:
* Cable insulation and continuity test: such tests should be carried before commencing installation;
* System earthing test;
* Battery testing which includes the following:
	+ Ensure that batteries are fully charged by measuring the terminal voltage, if not batteries should be charged before carrying out testing and commissioning;
	+ Battery Inspection and Cleaning: A visual inspection should be done to assess the general condition of the system’s batteries. Check for any electrolyte leak, cracks in the batteries, or corrosion at the terminals or connectors;
	+ Terminals and connections: ensure that all terminal and connections are tight, and make sure that the same cross section is used for jumpers, measure the negative and positive pole cable length to ensure that it is equal.
* Module testing which includes the following:
	+ Checking the cleanness of surface (glass) area of the module as it should be free of any dirt and dust;
	+ PV modules Visual Inspection: A visual inspection of the modules should be done to check for defects in the modules such as cracks, chips, de-lamination, fogged glazing, and discoloration, this should be done for the front glass and back sheet;
	+ PV modules connector and cable Inspection: Check the sealing gels of the junction box to ensure it have no crack or crevice;
	+ Ensure that all modules have been tested before shipping by double checking the flash reports;
	+ DC voltage measurement: This can be done either on the modules level or on combiner box level;
* Inverter and Charge Controller
	+ Ensuring that all components are free of dust, if not, a dry cloth should be used to wipe away any accumulated dirt/dust;
	+ A visual inspection should be done to ensure that all the indicators such as LED lights are working and a check on the tightening of the bolts both DC and AC;
	+ Charging: The charge controller should indicate that the system is charging when the sun is up, the charging current should be measured for each string/ array;
	+ If such measurement were taken at noon time, the charging current should be close to the maximum current;
	+ Discharging: checking that the battery is discharging when connected to the load;
	+ Inverter: Checking the voltage and current in the inverter, measuring the output voltage and frequency;
* Wiring, Connections and Electrical Panels: Wiring installations should be checked for any cracks, breaks or deterioration in the insulation/conduits, inspect connections for any corrosion and/or burning. Switches should not spark when turned on or off;
* Combiner Boxes and fuses Box: must check strings fuses using a multimeter (continuity test on each fuse) to insure no blown fuse exist, check the tightening of the bolts of the fuse holders should be checked as per manufacturer manual, visual check of the cables and fuse holders;
* Contractors to segregate the heavy loads in the HC such as X-rays (if available) to be supplied directly from the existing generator.
* AC Panels: After switching off loads and inverters, check the functionality of the RCDs and RCBOs by pushing test button and noticing the breaker open, check the tightening of all cables and bolts as per manufacturer manual, visual check of all cables and breakers.

**Installation Completion**

* The Contractor shall complete any required document or list, clean up the construction site and remove any temporary structures, equipment or services, and construction debris;
* Copies of all final approvals and certifications shall be provided to GOVERNMENT IMPLEMENTING AGENCY.
* The Contractor shall provide three (3) hard copy sets and one electronic copy of the final Project as-built documentation.

**Training Program**

* The contractor will be responsible for providing a training course focusing on system operation, maintenance and management, the scope of training and schedule shall be proposed by the contractor and approved by GOVERNMENT IMPLEMENTING AGENCY;
* The training should focus on three major topics which are listed below, and it shall be provided at the site level to ensure competence in the operation and maintenance of the system provided, it shall include hands on training;
* The training program shall include but not limited to the following elements and activities:
* System safety and Operation
* System description including system features, components and their functions, system software and interface;
* Running PV system safely;
* System operating procedures;
* System operating characteristics;
* System limitations;
* On-site system operation.
* System Maintenance
* System and components and simple troubleshooting;
* On-site inspection and operation and maintenance
* Schedule of maintenance, safety checks and procedures
* Types of alarms and notifications;
* Energy Efficiency
* Contractor should provide basic training to all staff on energy efficiency best practices and energy efficient alternatives;
* Customized basic energy management session for each site to all users on which appliances they can run using the solar system;
* Printed leaflet should be available in the local language presenting system on/off operation, simple troubleshooting and basic maintenance;

**System Warranty and Maintenance**

* The contractor shall provide maintenance for 2 years, including replacement or repairs of necessary equipment and components to run the system safely;
* The contractor shall also carry out periodic preventive maintenance visits at least one visit each three months, the scope and nature of such visits shall be consulted and agreed with IMPLEMENTING GOVERNMENT AGENCY engineer, bidders are entitled to provide signed checklist by the end-user.
* The preventive maintenance shall include the following as minimum:
* Battery System: A visual inspection should be done to assess the general condition of the system’s batteries. Check for any electrolyte leak, cracks in the batteries, or corrosion at the terminals or connectors. Ensure that all terminal and connections are tight;
* PV Modules: Checking the cleanness of surface (glass) area of the module. A visual inspection of the modules should be done to check for defects such as cracks, chips, de-lamination, fogged glazing, and discoloration. Check the sealing gels of the junction box to ensure it have no crack or crevice;
* DC voltage measurement: This can be done either on the modules level or on combiner box level.
* Charge Controller/ Inverter: Ensuring that all components are free of dust, if not, a dry cloth should be used to wipe away any accumulated dirt/dust; A visual inspection should be done to ensure that all the indicators such as LED lights are working and a check on the tightening of the bolts both DC and AC;
* Electrical Panels: Wiring installations should be checked for any cracks, breaks or deterioration in the insulation/conduits, inspect connections for any corrosion and/or burning. Switches should not spark when turned on or off;
* Combiner Boxes and fuses Box: must check strings fuses using a multimeter (continuity test on each fuse) to insure no blown fuse exist, check the tightening of the bolts of the fuse holders should be checked as per manufacturer manual, visual check of the cables and fuse holders;
* AC Panels: After switching off loads and inverters, check the functionality of the RCDs and RCBOs by bushing test button and noticing the breaker open, check the tightening of all cables bolts as per manufacturer manual, visual check of all cables and breakers.
* The contractor shall assign a service technical personnel (local focal point) to provide satisfactory and uninterrupted services during the maintenance period
* It’s the contractor’s sole responsibility to establish sufficient inventory of spare parts to run the system without interruption during maintenance period;
* The contractor shall provide necessary labels highlighting warranty details and phone numbers to call in case of problems;