ANNEX II + III: TECHNICAL SPECIFICATIONS + TECHNICAL OFFER

Contract title: Construction of the Solar Power Plant in Barclayville **p 1 /…**

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Columns 1-2 should be completed by the contracting authority
Columns 3-4 should be completed by the tenderer
Column 5 is reserved for the evaluation committee

Annex III - the contractor's technical offer

The tenderers are requested to complete the template on the next pages:

- Column 2 is completed by the contracting authority shows the required specifications (not to be modified by the tenderer),
- Column 3 is to be filled in by the tenderer and must detail what is offered (for example the words ‘compliant’ or ‘yes’ are not sufficient)
- Column 4 allows the tenderer to make comments on its proposed supply and to make eventual references to the documentation

The eventual documentation supplied should clearly indicate (highlight, mark) the models offered and the options included, if any, so that the evaluators can see the exact configuration. Offers that do not permit to identify precisely the models and the specifications may be rejected by the evaluation committee.

The offer must be clear enough to allow the evaluators to make an easy comparison between the requested specifications and the offered specifications.

1. Item No.	2. Specifications required (* see full details at the end of the Table)	3. Specifications offered	4. Notes, remarks, ref to documentation	5. Evaluation committee's notes
1	Solar PV Array 200 kWp			
2	PV mounting structure 200 kWp			
3	Inverter 140 kW			
4	Battery 400 kWh			
5	Diesel Genset 180 kW (225 kVA)			
6	Electrical BOS 200 kWp			
7	Powerhouse buildings and parking			
8	Installation labour and equipment			
9	Monitoring system			
10	Warranty			
11	Manuals for installation, maintenance and troubleshooting			
12	Sub-station (0.4 / 11 kV) – 500 kVA			
13	Mini-grid Survey, Design, Mobilization Prelims			
14	Underground MV network (Concrete H-Pole structures for 11kV outgoing feeders with surge protectors for 11 kV feeders, earthing and all other structural components)			

1. Item No.	2. Specifications required (* see full details at the end of the Table)	3. Specifications offered	4. Notes, remarks, ref to documentation	5. Evaluation committee's notes
15	4 km of Transmission Line Cables (11kV 54 mm² AAAC (covered) single-circuit overhead three-phase line on concrete poles)			
16	11 km of Distribution Line Cables (0.4 kV 70 mm² ABC 4 Core X 70 mm² Hard Drawn Al Conductor on concrete poles)			
17	2 x Step-down transformers – 160 kVA (Pole Mounted with load break switch and Fuse costs and all other structural components)			
18	1 x Step-down transformer – 100 kVA (Pole Mounted with load break switch and Fuse costs and all other structural components)			
19	1 x Step-down transformer – 63 kVA (Pole Mounted with load break switch and Fuse costs and all other structural components)			
20	1,072 Customers connection using single phase prepayment meters split type electronic prepayment and all other structural components			
21	58 Customers connection using three phase prepayment meters split type electronic prepayment and all other structural components			
22	70 Solar Home Systems (100 Watt / 12 V) for remote houses in Barclayville			
23	Spare parts			

- **In the following pages, the full details of the Specifications required are detailed, for each of the contract components.**

1. Solar PV Array

Capacity of 200 kWp at STC (25ºC, A.M. 1.5 and 1,000W/m2). Silicon PV modules guaranteed with more than 80% of minimum rated power for 25 years of suitable nominal voltage and peak power rating and certified by IEC or UL standards is considered. Modules must be supplied with a manufacturer warranty which should state that fabrication is in compliance with at least one of the above-referred standards and guaranteed with more than 80% of minimum rated power for 25 years with not more than 1% degradation over a period of one year. In addition, PV modules must qualify to IEC 61730 for safety qualification testing. Many series-connected photovoltaic modules should easily be wired using preassembled solar cables and multi-contact plugs.

Solar panel

- Technology used:
  - monocrystalline or polycrystalline
- Performance:
  - Peak Power between 20Wp and 350Wp
- Warranty:
  - Minimum 10 years product warranty;
  - Minimum 25 years performance warranty (90% power output guaranteed for the first 10 years, 80% for 25 years);
- Information to written on the product:
  - Brand and Model;
  - Nominal Power;
  - Rated Voltage and rated Current at Pmax;
  - Open Circuit Voltage and Short Circuit current
- Quality standard to respect:
  - Factory quality standard compliance: ISO 9001:2008 and ISO 14001:2004;
  - Performance testing standard compliance: IEC 61215 and IEC 61730

2. PV mounting structure

Modules shall be mounted on a non-corrosive support structure suitable for site condition (extreme site conditions to be taken account) with facility to adjust tilt to maximize annual energy output. The structure will be designed for simple mechanical and electrical installation and there should be a 4 metre gap between array structures and the boundary fence and 2 metre wide pathways to access all PV arrays for maintenance. It shall support solar PV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly. The frames and legs of the array structures shall be made from hot dip galvanized/ anodized aluminium of suitable sections of angle, channel, tubes or any other sections as may deemed fit conforming to national/ international standards for steel structure to meet the design criteria. Minimum thickness of galvanization should be at least 120 microns. All nuts & bolts will be made of very good quality stainless steel. The minimum clearance between the lower edge of the modules and the developed ground level shall be 800 mm. The array structure shall be so designed to withstand storm condition with wind speed up to maximum 150 kph.

- Materials: MS Galvanized/ 5nodized aluminium
- Coating: Hot dip galvanized/ 5nodized
- Wind rating: 150 km/hour
- Fixing type: SS 304 fasteners

3. Inverter

Grid interconnection of PV systems is accomplished through the inverter, which converts DC power generated from PV modules to AC power used for ordinary power supply. It will also change batteries when the AC load is fully met, since is cheaper to do so from the PV system than with the diesel generator. The nominal capacity of the inverter should be 140 kW.

Other technical specifications should be:

- Typical conversion efficiency of >95%;
- No-load loss <1% of rated power;
- Wide range of grid voltage & frequency parameters for synchronization;
- Sinusoidal current modulation with excellent dynamic response;
- Optional VAR control;
- Unit wise & integrated data tagging;
- Dedicated Prefabs / Ethernet for networking;
- Protection against – Over current, Sync loss, Over temperature, DC bus over voltage and Power regulation in the event of thermal overloading;
- Set point pre-selection for VAR control;
- Degree of protection-IP31;
- Bus communication via -interface for integration;
- Remote control via telephone modem or mini web server;
- Integrated protection in the DC and three phase system;
- Insulation monitoring of the PV array with sequential fault location; and,
- Ground fault detector – which is essential for large PV generators in view of appreciable discharge current with respect to ground.

4. Battery

The required 400 kWh battery for energy storage and mini-grid stabilization must have these features:

- High power density (more important than high energy density).
- High efficiency and little change of efficiency with the change of the rate of discharge.
- Discharge duration at its rated power (or higher if possible) for a minimum of two minutes
- High reliability.
- Very fast response time.
- Flexible ramp rate.
- Technology used:
    - Lithium-ion;
- Performance:
    - Cycle life of minimum 1,000 cycles at 90% DOD, C10 rate, 25°C;
    - Maximum self-discharge does not exceed 5% of rated capacity per month
- Warranty:
    - The battery warranty is assumed to include a capacity retention figure of at least 80% at two years, benchmarked to the rated battery capacity.
- Information written on the product:
    - Brand and Model;
    - Rated voltage;
    - Capacity;
    - Terminal polarity
- Quality standard to respect:
    - Factory quality standard compliance: ISO 9001:2008 and ISO 14001:2004;
    - Performance testing standard compliance: IEC 61427-1 or equivalent

5. Diesel Genset

The 180 kW (225 kVA) diesel generator will have 'Generator set' application type & to confirm to ISO 3046 / BS 5514 / IS 4722/1992.

The engine must have Cold starting capability up to 0 deg. C and shall have capability to start directly to RUN speed (1,500 RPM) without any interim warm up speed (idle speed). Smart starting control system to be provided. The diesel engine shall be of four stroke cycle multi-cylinder, water cooled, turbo charged with after cooler, developing required BHP @ 1,500 rpm under NTP condition of BS 5514 with an over load capacity of 110% for one hour in any specified 12 hrs of continuous operation.

It shall have the facility like monitoring, metering and controlling of DG set with PC interface facility. The unit shall be environmentally sealed, solid state and microprocessor based and shall have following minimum features:

- Digital governing, voltage regulation, synchronizing and load sharing controls;
- Single/parallel mode of operation with existing Diesel generators with PCC 3100;
- Engine and Alternator protections;
- Amps entry protection for true alternator over current protection;
- Analogue and Digital AC output metering;
- Battery Monitoring system to sense and warn against a weak battery condition;
- Digital Alarm and Status message display;
- Gen. Set monitoring: Displays status of all critical engine and alternator and Gen. set functions;
- Smart Starting control system: Integrated fuel ramping to limit black smoke, frequency overshoot, to optimized cold weather starting.

6. Electrical BOS

Cables

The size of the cables module/array interconnections, array to junction boxes, and junction boxes to PCU, etc. shall be selected to keep the voltage drop and losses to the minimum. All cables shall be PVC insulated with appropriate grade conforming to UL 4703/equivalent. Cables in the array yard shall be laid direct in ground at a depth of 500 mm in the excavated trenches along the approved route and covered with sand cushion. A continuous single brick protective layer of first class brick shall be placed over the entire length of the underground cable before refilling the trench with loose soil. Alternatively, 6 wide continuous layers of 11/2'' thick concrete cable markers may also be provided as protective cable cover. The cables shall be laid inside class-B. GI pipes of suitable size under road crossings, drains, sewerage lines, entry of exit points of the buildings, or where there are chances of mechanical damage. Only terminal cable joints shall be accepted. No cable joints to join two cable ends shall be accepted. Cables inside the control room shall be laid in suitable Cable Trays of approved type.

All wires used on the LT side shall conform to IEC/UL standard and should be appropriate voltage grade. Only bright-annealed 99.97% pure bare copper conductor wires, which offer low resistance, lower heating and of reputed make shall be used. Cable terminations shall be made with suitable cable lugs & sockets, etc., crimped properly and passed through brass compression type cable glands at the entry & exit point of the cubicles. The panel's bottoms should be properly sealed to prevent entry of snakes / lizard, etc., inside the panel. All cable/wires shall be marked with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.

General specifications of the electrical cable:

- All cables are insulated conductors and have different wiring colours to clearly identify different polarities;
- All cable lengths and cross-sections ensure reduced power loss with a maximum power loss of 0.5% between the battery(ies) and the charge controller and a maximum power loss of 3% on other cables;
- Sufficient cable length is available to adapt to typical installation situations, with a suggested average of 60m for energy sharing
- Working voltage Up to 1100V
- Temperature range -15°C to +80°C
- Specification UL 4703 or equivalent

Junction Boxes

Three types of Junction Boxes will be used in the power plant,

- Array Junction Box
- Sub Main Junction Box
- Main Junction Box

The junction boxes shall be dust, vermin, and waterproof and made of metal or thermoplastic. The junction boxes will have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables or alternatively the modules may be provided with connector cables. Each Array Junction Box will have Suitable Reverse Blocking Diodes of maximum DC blocking voltage of 1,000 V with suitable arrangement for its connecting. The Array junction Box will also have suitable surge protection such as MOV devices.

7. Powerhouse buildings and parking

The solar PV power plant will require a powerhouse or control room (with office space) which can be located on the road-side near to the entrance of the site which allows routing of the overhead line for export without interfering with the PV array layout. The control room is also aligned near a main 6 metre wide internal road for delivery of equipment during installation and for movement of operating & maintenance personnel/vehicles and should have a minimum amount of parking for 3 vehicles. Inverters and the transformers will be installed close by to reduce transmission loss in DC wiring and AC transmission from the inverters. The final location of inverters and load centre transformers will be decided by the tenderer based on optimum distance between equipment to have minimum voltage drop. The control administrative building will house the batteries, switch gears and other control panels, an administrative office, toilet, and pantry facilities and will have a nominal area of 120 metres squared. Two gatehouses will be provided at the entry to the site through the existing roads.

8. Transportation, installation labour, tools and equipment

The equipment for the solar PV plant and associated mini-grid will be transported to site which is suggested as shipped from Monrovia port to Harper port, then delivered by truck from Harper via Pleebo, ideally in shipping containers. All equipment will be stored safely at the PV power plant site, away from incursions from theft or weather, then installed by competent workers using the required and correctly specified tools and equipment for the job.

9. Monitoring System

The PV power plant will be monitored with SCADA facility. SCADA system shall have features for simultaneous monitoring and recording of various parameters of different sub-systems, power supply of the Power Plant at the DC side and AC side. This will enable monitoring the status of inverters to gather information on energy generation. Periodic reports of the plant's performance will be provided by the monitoring system. Remote data access will be provided through a secure login on a website. The computer controlled monitoring system be separate & individual system comprising of different transducers to read the different variable parameters. AC/DC converter, Multiplexer, De-multiplexer, Interfacing Hardware & Software, Industrial Type PC, which will be robust and rugged suitable to operate in the Control Room Environment. Reliable sensors for Solar Radiation, Temperature & other Electrical Parameters are to be supplied with the data logger unit. Required number of PCs shall be provided and PC shall be of industrial type, rugged & robust in nature to operate in a hostile environment and of latest technology adequate memory, RAM facility etc., perfectly compatible to the system. The data acquisition system will measure and record continuously the following parameters:

- Ambient Air Temperature near Array Field
- Control Room Temperature
- Module Back Surface Temperature
- Wind Speed at the level of Array Plant
- Solar Radiation incidental to Array Plant
- Inverter Output
- System Frequency
- DC Bus output
- Energy delivered to the GRID in kWh.

All data shall be recorded chronologically date wise. The data file should be latest version and compatible. The data logger shall have internal reliable battery backup to record all sorts of data simultaneously round the clock. All data shall be stored in a common work sheet chronologically. Representation of monitored data in graphics mode or in tabulation form. All instantaneous data can be shown in the Computer Screen. Bill acquisition system should be housed in a desk made of sheet steel.

The monitoring system shall be able to control the main parameters of the plant with the following minimum requirements:

- The system shall meet the standard IEC 61724.
- The solution proposed shall be available for its operation by any third-party.
- The monitoring system shall allow remote access through a web portal.
- The Contractor is responsible for the design, supply and installation of the whole communication system.

The data gathered by the monitoring system shall include the following parameters:

- Current and Voltage at string level.
- Input and output Inverter current and voltages.
- Global irradiation at Plane of Array (POA).
- Total energy production plant meter.
- Back-up memory to prevent data loss in the event of communication failures. The monitoring system shall record the following data:
    - Actual time,
    - Power output,
    - Inverter input/output,
    - Power factor,
    - Active, apparent, and reactive power;

- Real Time voltage and current for the following components:
  - Inverter, DC, and AC values,
  - String current;
- Values for the following sensors (if installed):
  - Irradiation, both inclined plane and horizontal plane,
  - Cell temperature,
  - Ambient temperature,
  - Wind speed, and direction;
- Energy production values of the following components:
  - Plant,
  - Inverter;
- Energy meter data (import and export);
- System alerts (if signals are provided by the hardware):
  - Inverters,
  - Data loggers,
  - Transformers,
  - Main AC-switches,
  - Overvoltage protection devices within combiner boxes and central inverters,
  - UPS,
  - Tilted Irradiation,
  - Horizontal Irradiation.

10. Warranty

- The minimum warranty period offered by the tenderer to the contracting authority is at least 2 years after provisional acceptance for the main system, including the PV module, control box, cables and lights and the system battery. The battery warranty is assumed to include a capacity retention figure of at least 80% at two years, benchmarked to the rated battery capacity.
- The warranty must cover, at a minimum, manufacturing defects that impede operation under normal use and protection from early component failure.
- The consumer-facing warranty must explain how the contracting authority can access the warranty (return to point of purchase/distributor/service center, call or SMS a number, etc.), how the warranty will be executed (repair, replacement, etc.), and should advise the contracting authority to inquire about the warranty terms prior to purchase. The consumer-facing warranty must be available to the consumer in writing in a way that enables the end user to verify and understand the terms of the warranty prior to purchase. The written information should be in English language. Consumer-facing warranties could be included on the product box, or on a user agreement or warranty card that is easily accessed prior to purchase.

11. Manuals for installation, maintenance and troubleshooting

The tenderer should provide at least three manuals per type of equipment described.

- Installation guide should explain step by step how to install the equipment at a customer's house. Explanation should be easily understandable, meaning the guide should consist of drawing and scheme in majority and language should be English.
- Maintenance guide is a technical document intended to train the technical teams of the contracting authority on i) the on-going maintenance activities required for the equipment to sustain and ii) the main breakdown and how to solve them. This guide should be addressed to people with limited theoretical background on mechanic and electricity and should be in English.
- Troubleshooting guide is a document listing all the recurrent issues that can occur when using the equipment: either due to misuse by the customer or due to breakdown of the product. For each item listed, the guide should describe how to identify it and suggest a solution.

The tenderer shall prepare the manuals for review and approval not later than two weeks before the planned testing and commissioning date.

12. Sub-station (0.4 / 11 kV);

The sub-station designed for the 11 kV mini-grid contains the step-up transformer and associated equipment at the solar PV plant, within an enclosed area (at least 10 m long x 7 m wide) for the nominal power of 500 kVA. The civil work required would be to excavate down to a good foundation placing structural concrete for the various components, namely; the Main Transformer, an Auxiliary Transformer for supply to the powerhouse and for the security lights around the perimeter fencing, Current & Voltage Transformers, Disconnectors and Earthing arrangements, and gantries for the power evacuation cables, then finishing with crushed stone and fencing, and installation of Lightning Protection poles.

13. Mini-grid Survey, Design, Mobilization Prelims

Tenderers should allow sums for the surveying and final design (for approval by the Client) of the mini-grid for Barclayville, then the mobilization and preliminaries for the installation of the following equipment (items 14 – 21).

14. Underground MV network;
15. Transmission Lines;
16. Distribution Lines;
17. Step-down transformers (160 kVA);
18. Step-down transformer (100 kVA);
19. Step-down transformer (63 kVA);
20. Customers connection (single phase);
21. Customers connection (three phase);

Items 14 to 21 are detailed in the following table:

UNDERGROUND MV NETWORKS	
1 unit	Concrete H-Pole structures for 11 kV outgoing feeders with surge protectors for 11 kV feeders, earthing and all other structural components
100 m	Underground 11 kV three phases cable, Al conductors 95 mm^2 for outputs of the SPP outgoing lines to Barclayville substation and all other structural components
OVERHEAD LINES MV/LV NETWORKS	
4 km	11 kV 54 mm^2 AAAC (covered) single-circuit overhead three-phase line on concrete pole and all other structural components
11 km	0.4 kV 70 mm^2 ABC 4 Core X 70 mm^2 Hard Drawn Al Conductor on concrete pole and all other structural components
5 units	Pole mounted load break switch and all other structural components
POLE MOUNTED 11 – 0.4 kV DISTRIBUTION TRANSFORMERS	
1 unit	63 kVA (Conventional, Cu Windings) Pole Mounted Substation Structure and fuse and all other structural components (Zone 3)
1 unit	100 kVA (Conventional, Cu Windings) Pole Mounted Substation Structure and fuse and all other structural components (Zones 5 and 6)
2 units	160 kVA (Conventional, Cu Windings) Pole Mounted Substation Structure and Fuse costs and all other structural components (Zones 2, 4, 7 and Zone 1 with RHC)
CUSTOMERS CONNECTIONS	
1,072 units	Customers connection using single phase prepayment meters split type electronic prepayment and all other structural components
58 units	Customers connection using three phase prepayment meters split type electronic prepayment and all other structural components

22. Solar Home Systems:

There should be 70 units of solar home systems (SHS) for the outer-lying areas of Barclayville where the mini-grid may not reach. Each should be supplied with a 100 Wp PV panel, 12 V DC battery with associated charge regulator / controller and a provision for a maximum of 4 lights and a power outlet, for the customer to operate their choice of DC TV, radio, DC electric fans etc. and for charging mobile phones.

23. Spare parts The tenderer should provide a list giving full particulars, including quantities, available sources and current prices of spare parts, special tools, etc., necessary for the proper and continuing functioning of the Goods during the period of one (1) year. The tenderer must provide a statement for the availability of spare parts and/or after sales services. Bidders statement indicating its acceptance or otherwise in offering Local after sales service of no less than three (3) years. The tenderer must state the nature of service that will be provided.
24. Training The tenderer should provide training as per the manuals, to at least 5 persons selected by the users committee.
25. After sales Services The tenderer should provide after-sales services of 3 years: including maintenance (preventative and corrective) and technical support (on-site and/or remote) including continued online monitoring and periodic checks as per Manufacturer's recommendations.