**Annex-A**

**Lot-1: Technical Specification for Range of Solar Products for Solar Electrification**

1. **Background**

UNDP Sudan is planning to implement range of solar products including solar lighting systems, solar for health center application, solar street lighting with its various ongoing and planned projects. These solar systems are intended to provide lighting facility for a household, for a health center or street lighting purpose. These are site specific and while the sites are identified, the details will be provided.

This technical specification is prepared for the major components of the solar Photovoltaic systems that will be used for various application in different projects supported by UNDP Sudan and its government partners and agencies across the country. UNDP will support around 100,000 systems in various location where projects located.

1. **General Description**

* The Solar Photovoltaic system comprises of Solar photovoltaic module, battery, charge controller, inverter, LED light and streetlight in case for solar street lighting system, with balance of systems for its installations.
* The major components Solar module, battery, charge controller, inverter, LED lights should be provided with a letter from the principle manufacturer on the warranty and performance parameters, ratings.
* Installation, testing and commissioning should be separately mentioned including the provision for spare parts and after sales services for the solar Photovoltaic systems.
* Specific location will be specified while the sites for these installations are identified during project implementation.
* Solar Irradiance of 6 kWh/m2/day should be used to calculate solar PV output for Solar Module.
* The Solar Photovoltaic systems components are recommended to have Photovoltaic Global Approval Programme (PV GAP) seal and certified according to PV Gap Recommended Specifications (PVRS).

1. **Specifications of the Core Component of Solar Photovoltaic System (SPVS)**
2. **Photovoltaic Module**

* Mono or Poly Crystalline Silicon solar cells should be used in the solar module that are used for Solar Photovoltaic systems.
* Solar Photovoltaic module must be certified by a Certifying Body Testing Laboratory (CBTL) or National Certifying Body (NCB) enlisted in the IECEE website and it have the scope for PV testing.
* Solar Photovoltaic Modules shall have certificate as per IEC 61215-1-1:2016 – (Special requirements for testing of crystalline silicon photovoltaic (PV) modules) specifications.
* The range of products of Solar PV modules should be provided with its rating from 10 Wp to 200 Wp that are suitable for various applications. The PV modules shall be suitable for use for 12 V systems.
* The module efficiency of the crystalline PV modules should be minimum 12% for output upto 100 Wp and 14% for output of more than 100 Wp.
* Deviation of maximum power from the nominal values stated by the manufacturer shall be within -5% and +20% at STC.
* The terminal box on the module should have a provision for "Opening" for replacing the cable, if required.
* Module Junction should have protection class of IP65, module connector MC4 with 4 mm2 cable with a length of 70% of module length.
* Solar Photovoltaic module must be labeled permanently indicating at a minimum: Manufacturer, Model Number, Serial Number, Maximum Power Point Watt Rating (Wp tolerance), Maximum Power Point Current, Maximum Power Point Voltage, Open Circuit Voltage and Short Circuit Current.
* The module framing should be such that it permits secure connection to the mounting structure, prevents edge damage and has the longevity to withstand environmental factors for the duration of the module warranty period. Modules frame minimum dimensions (35 x 35 mm and 1.7 mm)
* The PV modules must be warranted to retain at least 90 % of its rated wattage measured at STC for 10 years and 80% of the rated wattage at 20 years.
* The supplier is required to provide for each PV Module offered the following data: Equipment Origin, Type of Certification, I-V Curves, temperature coefficient, Dimensions, Warranty, any certificates for solar panels

1. **Deep Cycle Solar Battery**

* Battery test certificate to be provided according to relevant PV GAP, IEC 60896 (For lead Acid Batteries-GEL or Flooded type) or IEC61427 from the principle manufacturer stating the quality assurance and testing methods used for describing its technical specifications.
* Battery for the solar photovoltaic systems should be deep cycle type and could be tubular flooded lead acid battery, Valve Regulated Lead Acid Battery (Gel or other electrolyte type) tubular plate or Lithium Ion (LI) Battery.
* The operational life cycle life of lead acid battery must be at least 3000 cycles at 20% Depth of Discharge (DOD) and 1500 cycles at 70% DOD.
* Flooded type of battery should have electrolyte level indicator to alert addition of distilled water to the battery.
* The battery should have higher specific energy density and excellent high rate discharge characteristics.
* Battery charging instruction should be provided along with the specifications.
* The maximum permissible Self Discharge should not exceed 5% per month of rated capacity at 250C.
* The supplier is required to provide for each Battery offered the following data:
  + The battery must be labeled indicating at minimum Manufacturer, Model Number, Voltage and Capacity.
  + Type of the battery
  + Battery Nominal Voltage
  + Battery Capacity Ah@C10
  + Life cycle
  + Battery performance versus Temperature
  + Warranty should be provided minimum for 3 years.
* The battery should at least provide 2 days of autonomy to be used in the system.
* The supplier should quote different capacity batteries in the range that are suitable in the system. The capacity of the battery ranges from 20 Ah to 200 Ah.

1. **Charge Controllers**

* The charge controller must operate either with Pulse Width Modulation (PWM) or Maximum Power Point Tracking (MPPT) principles. Charge controllers with electro-mechanical relays are not accepted
* Charge controllers must be supplied with charge and discharge voltage set points (adjustable), which match the battery requirements to ensure adequate protection and cycling.
* The charge controller must ensure safe and reliable operation in the temperature range 5 – 500C.
* Self-consumption must be below 10mA.
* Connection terminals must easily admit cables of 6mm2 minimum.
* Charge controller housing must offer a protection at least IP22. And that used for street light should be IP68.
* The charge controller should withstand the rated current from the PV module to the battery and battery to the load.
* Charge controller must offer at least signs for Charging Mode, battery state of charge and load disconnect.
* Charge controller must be labeled indicating at minimum Manufacturer, model number, voltage & current ratings.
* Circuit Protection:
  + Battery overcharge and excessive water loss.
  + Battery undercharge and excessive deep discharge.
  + Circuit protection against short circuit of any load.
  + Circuit protection against reverse polarity of any load.
  + Circuit protection against reverse polarity of module or battery.
  + Circuit protection against damage by the high PV open circuit voltage when it is connected to the controller without battery.
* The supplier is required to provide for each Charge Controller offered the following data:
  + The charge controller must be labeled indicating at minimum manufacturer, Model Number, Voltage, PV and Load Currents.
  + Type of the controller (Series/Shunt, etc.)
  + Operating Voltage(s)/ PV and Load Currents.
  + Indicators, Battery Sensor.
  + Warranty
* The supplier should quote different capacity charge controller in the range that are suitable in the system. The current range for charge controller should be provided between 3 A to 15 A.

1. **Inverters**

* Pure sign wave output of AC with 230 V and 50 Hz.
* Inverters should be labeled indicating minimum Manufacturer, Model Number, Power Rating, Voltages and Frequency.
* Total Harmonic Distortion (THD) should be < 5%
* The inverter should have protection against Reverse Polarity, AC Short Circuit, AC Overload, High Voltage Disconnect, Low Battery Disconnect and High Temperature Disconnect.
* Indictors with main, charging, inverter ON, Short Circuit and Overload should be incorporated in its design.
* The supplier is required to provide full specifications for each DC/AC Inverter offered with the following information:
  + System rating (W/VA)
  + Input Voltage (DC)
  + Output Voltage (AC)
  + Output Frequency and Waveform
  + Warrant

1. **LED Lamps**

* LED Lamps should have a nominal voltage of 12/24 VDC
* LED Lamps must ensure safe and reliable operation in the temperature range -5C0 to 50 C0.
* Minimum Lumen efficacy for the LED lamp should be 75lumen/W.
* LED Lamps should be marked with Manufacturer name, model, rated voltage and Watt.
* Performance guarantee should cover 3 Years with operational life of the lamp to be at least 30000 hours.
* Integrative design for heat sink and housing; The LED is closely connected to the surface.
* The heat from LED is removed through the heat dissipation wing and also by the air ventilation.
* The die-casting aluminum alloy housing is effective in waterproofing and dust prevention.
* It also helps in removing the heat properly. The surface of the light is specially treated, so it is able to bear an ultraviolet ray and resist to corrosion. The whole light meets the standard of IP65
* No ill-glare; no abrupt and frequent flashes. The design ensures that bad glare is eliminated, vision fatigue and disturbance aroused by traditional
* No delay start; no waiting. It can reach its normal light as soon as it is turned on.
* Environment friendly. Does not have lead, hydrargyrum, and any other
* Contamination. No pollution to the air.
* Provide high reliability connection of the solar panel, battery and charge controller.
* For AC LED lamps, an LED driver is used to rectify higher voltage, alternating current to low voltage, direct current.

LED General Properties:

* The luminaries should use white LEDs. The colour temperature of white LEDs should be in the range of 5500o K – 6500oK. Use of LEDs which emit ultraviolet light will not permitted.
* The light output from the white LED light source should be constant throughout the operation of the lights.
* The lamps should be housed in an assembly suitable for indoor use with an appropriate heat sink to dissipate the heat generated by LEDs during operation. The temperature of LED should not increase more than 10° above room temperature. This condition should be complied for 5 hours of operation of the lamp at a stretch while battery operating at any voltage between the loads disconnect and the charge regulation set point.
* The luminaries must use the optics and diffuser in order to have uniform and glaze free light.
* The make, model number, country of origin and technical characteristics (including IESNA LM-80 report) of white LEDs used in the lighting system must be furnished along with the system.
* All Luminaries should have a built in ON/OFF switch and fuse.
* Following information on LED lamps must be provided, including but not limited:
  + Bulb catalog with full specifications and manufacturer's name.
  + Light bulb power consumption for nominal voltage current
  + Voltage, Frequency and current of the bulb.
  + Flood light of the bulb in lumens
  + The entire life of the bulb is estimated by hours.
  + power factor of the bulb

1. **Module Support Structure:**

Module support structure should be corrosion resistant (galvanized or rustproof painted steel or aluminum) and electrolytically compatible with that of module framing material, fasteners, bolts and nuts. Module support structure design should be flexible in such a way that it allows proper orientation and system expansion. In Sudan, roof mounting is preferable, as possible and structures should firmly be attached to roof beams. Doing so, a clearance of at least 10 cm should be kept between modules and the roof to allow proper ventilation/cooling. Pole mounted structures should be secured by guy wires to increase rigidity. In all installations, modules accessibility should be considered. The tilt angle is around the latitude angle at the given location.

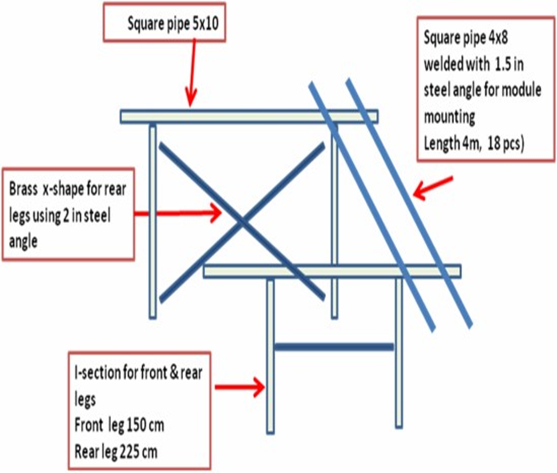
The minimum requirement for support structure is as follows:

1. For one or two PV panels iron angle of 1 ½× 1½ inch, 3 mm thickness.

All metallic frame structure (dully pre-treated with corrosion resistance paint) to be fixed on the roof of the house to hold the SPV module. The frame structure should have provision to adjust its angle of inclination to the horizontal between 0 and 45, so that it can be installed at the specified tilt angle.

2. **Drawing of Ground Mounted Module Support Structure**

Ground mount system for solar panels:



1. **Balance of Systems (BOS)**

* The supplier should list all required equipment and accessories like cable, cable tray, switches, junction box and other accessories for particular application along with the major components.

1. **Installation, testing and commissioning**

* Separate quote for the installation, testing and commissioning of the individual solar photovoltaic systems should be provided.
* List of spare parts shall be specified.
* The bidder should have clear plans to provide after sales service after its installation and preferably local representative in Sudan to provide after sales service and maintenance if required during its operation.

1. **Roles and Responsibilities among UNDP, Government Partners/UN agencies and Contractor**

|  |  |  |  |
| --- | --- | --- | --- |
| **Roles & Responsibilities** | **UNDP** | **Government Partners/UN Agencies** | **Contractor** |
| Preparation of designs | **x** | **X** |  |
| Supply and delivery |  |  | **X** |
| Installation, testing and commissioning |  |  | **X** |
| Inspection | **X** | **X** |  |

1. **Specific Requirement for Solar Street Light**

**Street lighting**

* Total length of pole: 5 m and 7 m
* Thickness 2.5 mm for 5 m and 3 mm for 7 m
* Base plate 300 x 300 mm and 10 mm thickness
* Base bolts: 20mm dia. And 150 mm long (able to withstand the pole)
* Light Source High bright LED 15 or 30 W
* Luminous flux Bright code: 1578lm，Dim mode: 580lm, Visual Angle: 120°
* Color Temperature: 6000K~7000K
* Light Photosensitivity (typ.): 30 lx
* Working Time (In sufficient sunlight charge after 8 hours): Bright mode: ≥8hrs; Dim mode: ≥24hrs
* warranty 3 years

1. **Specific Scenarios are presented for various configurations however actual scenarios will be provided after the demand analysis and project specific requirements to be configured from the actual systems design.**
   * + 1. **Solar Photovoltaic Lighting System**

**i. 20 Wp Systems:**

|  |  |  |
| --- | --- | --- |
| Solar Module 20 Wp | 1 | Pc |
| Deep Cycle Battery 40 Ah | 1 | Pc |
| Charge Controller 3A | 1 | Pc |
| LED Lamps 5 W | 3 | Pc |
| Module Support Structure | 1 | Pc |
| Cables and accessories | 1 | LS |
| Balance of System | 1 | LS |
| Installation | 1 | LS |

**ii. 40 Wp Systems**

|  |  |  |
| --- | --- | --- |
| Solar Module 40 Wp | 1 | Pc |
| Deep Cycle Battery 60 Ah | 1 | Pc |
| Charge Controller 5A | 1 | Pc |
| LED Lamps 5 W | 4 | Pc |
| Module Support Structure | 1 | Pc |
| Cables and accessories | 1 | LS |
| Balance of System | 1 | LS |
| Installation | 1 | LS |

**iii. 60 Wp Systems**

|  |  |  |
| --- | --- | --- |
| Solar Module 60 Wp | 1 | Pc |
| Deep Cycle Battery 80 Ah | 1 | Pc |
| Charge Controller 10A | 1 | Pc |
| LED Lamps 5 W | 5 | Pc |
| Module Support Structure | 1 | Pc |
| Cables and accessories | 1 | LS |
| Balance of System | 1 | LS |
| Installation | 1 | LS |

1. **Solar Photovoltaic Street Light (two configurations)**
   * 1. **Small Street Light Systems:-**

|  |  |  |
| --- | --- | --- |
| Solar Panel 60 Wp | 1 | Pc |
| Deep Cycle maintenance Free VRLA Battery 80 AH | 1 | Pc |
| Pole 5 M with solar mounting bad Battery stand | 1 | Pc |
| Solar street light LED type 15 W | 1 | Pc |
| Balance of Systems for Solar St. Light | 1 | LS |
| Installation | 1 | LS |

**ii. Large Street Light Systems:**

|  |  |  |
| --- | --- | --- |
| Solar Panel 120 Wp | 1 | Pc |
| Deep Cycle maintenance Free Valve Regulated Lead Acid (VRLA) Battery 150 AH | 1 | Pc |
| Pole 7 M with solar Mounting and battery stand | 1 | Pc |
| Solar street light LED type 30 W | 1 | Pc |
| Balance of Systems for Solar St. Light | 1 | LS |
| Installation | 1 | LS |

1. **Solar for Education/ Solar for Health**

|  |  |  |
| --- | --- | --- |
| Solar Panel 200 Wp | 1 | Pc |
| Deep Cycle maintenance Free VRLA Battery 200 AH | 2 | Pc |
| Solar Charge Controller 15 A | 1 | Pc |
| Inverter 500 W | 1 | Pc |
| Solar Panel Mounting Structure | 1 | Pc |
| Balance of Systems including Cable for | 1 | LS |
| Installation | 1 | LS |

**Pc = Piece**

**LS = Lump-sum**

**The equipment to be served by the solar system varies as per the requirement from the demand survey. The specific scenarios are presented on the technical specification sheet for estimating the required configurations at the site.**

**Important Note: The selected vendor/s make sure that all imported solar item into Sudan has to be certified by Sudanese Standards and Meteorology Organization (SSMO)”**