**Annex-B**

**Lot (2): Technical Specification for Solar Water Pumping System**

1. **Background**

UNDP Sudan is supporting rural communities, Government of Sudan with associated ministries in various of its initiatives including to provide clean and green energy to meet its demands through solar photovoltaic water pumps for small scale irrigation. Agriculture has been the back bone of the economy and livelihood in the rural areas of Sudan. Most of the people are dependent upon the scarce rain fed and diesel water pumps for meeting their needs.

The promotion of Solar Photovoltaics water pumps will help to meet the demands for increasing productivity with enhanced reliability for water pumping for Agricultural products integrated together with the efficient farming methods and technologies in Sudan. This also contributes to reduce highly subsidized diesel consumption in the rural areas for water pumping applications thus reducing dependency on scarce fuel and promote clean energy. There are number of UNDP projects, its government partners and agencies supporting the installation of solar water pumping system across Sudan. One of the projects supported by UNDP Sudan is to support farmers in the River Nile State in providing 450 numbers of Solar Water Pumping system for agricultural application to provide irrigation facility for various crops. In total, UNDP will support around 1500 solar water pumps across the country.

This technical specification is prepared for range of solar water pumping products that UNDP Sudan will be supporting in future from its different project across different location in Sudan. The water pumping sources are from deep bore hole or directly pumped from the river water to irrigate farmlands.

1. **General Description**
2. The Solar Water Pumping System comprises of Solar Modules/Array with appropriate voltage and current level to operate the water pump, Water pumps (DC Brushless or AC-centrifugal pumps) and controller unit and Balance of Systems.
3. The major components Solar module, pump and controller should be provided with a letter from the principle manufacturer on the warranty and performance parameters, ratings. . In addition, an accreditation certificate from recognized institution is recommended for each product.
4. The solar pump has to undergo testing at the solar pump testing center established by UNDP and the Ministry of Energy and Mines.
5. Installation, testing and commissioning should be separately mentioned including the provision for spare parts and after sales services for the water pumps.
6. In order to avoid or minimize theft risks for solar PV panels, anti-theft measure is recommended.
7. The pumping requirement is at least 100,000 Liters per day for individual pumping system.
8. Required Civil construction for the operation of pumps and solar structure needs to specified.
9. **Location**
10. The solar water pumps will be installed across various location in Sudan supported by UNDP project. One of the identified locations is in the River Nile State of Sudan having coordinates: -Latitude 17.50 North and Longitude of 33.50 East.
11. Specific location will be specified while the sites for these installations are identified during project implementation.
12. **Project Requirements**
13. Solar Irradiance of 6 kWh/m2/day should be used to calculate solar PV output for Solar Module.
14. The water source that the water to be pumped is either from the river or the deep bore hole pumps.
15. Gross Head for river lifting is less than 15 Meters for river water lifting and gross head for bore hole water pumps is 15-40 meters. Hence, the options should be provided in the range with its specific requirement and performances of the pumping system.
16. Before supply and delivery of the pumps, details for matching required specifications will be provided.
17. The water is used mainly for irrigation purpose, with integration of efficient small-irrigation and agricultural practices including drip irrigation facilities.
18. The land area is generally 5 Feddan to 10 Feddan and more however most of the pumps are sized to irrigate up-to 10 feddan of land. (1 Feddan = 4200 m2). The sizes of Solar Water Pumps for the projects preferably sized from 3 kWp to 5.5 kWp for application in the River Nile State. Water requirement is minimum of 100000 Liters per day for each pumping set combinations.
19. **Specification of Solar Water Pumping System Components**

Bidder needs to bid for each component in available ranges and sizes such as pump ranges 3-10 kW in ranges and various configuration. The specific needs will be defined by the site survey and design data at the time of delivery. Solar modules also ranges from 250 Wp or more, preferably with larger systems. Please specify any terms and condition in the remarks for each configuration. Separate quote in the following format for the various combinations in range should be provided. UNDP intends to support for 450 Solar water pumping systems to be installed in River Nile State of Sudan with sizes of 3-6 kW capacity.

1. **Solar Photovoltaic Module:**

* Mono or Poly Crystalline Silicon Solar cells should be used in the solar module that are used for Solar Water Pumping application.
* Modules supplied with the Solar Water Pumping systems shall have certificate as per IEC 61215-1-1:2016 – (Special requirements for testing of crystalline silicon photovoltaic (PV) modules) specifications. In addition to accreditation certificate from recognized institute recommended by Global Lighting (World Bank).
* Modules must qualify to IEC 61730 Part I and II for safety qualification testing.
* The efficiency of the PV modules should be minimum 14%.
* 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.
* Power temperature coefficient of PV modules shall be at most: -0.043%/0K
* Peak Power of individual module for the solar water pumps at STC must at least be 250 Wp or more. Use of PV module with higher power output is preferred. Module IV characteristics at STC, its temperature coefficient shall be provided for the module.
* Each module must be labeled 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)
* All PV modules used in the array offered for one project must be of same type, same model, same power rating and same manufacturer
* 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.

1. **Motor Pump Set**

* The Solar Water Pumping system should use the following types of motor pump sets a) Surface Mounted motor pump set b) Submersible motor pump set.
* The moto-pump set shall be mono block DC/AC centrifugal motor pump set with impeller mounted directly on the motor shaft and with appropriate mechanical seals which ensures zero leakage.
* The motor shall be either AC or brushless DC type. Pumps which will require replacement of brushes, diaphragms, bushings or other components as part of routine maintenance during this period **are not acceptable.**
* The pump shall have the following built protection- dry run protection, over and under voltage protection, overload protection, temperature protection.
* Water meter is also provided
* The wire to water efficiency shall not be less than 50% and the performance curves for the pumps should be provided.
* The motor pump set shall be securely marked with the following parameter declared by the manufacturer:-
  1. Manufacturer name, logo or trade mark
  2. Model, size, and Serial Number of the pump set
  3. Motor rating (kW/HP)
  4. Total Head in m at the guaranteed duty point
  5. Capacity (m3/day) at guaranteed head.
  6. Operating head range in m.
  7. Maximum Current (A)
  8. Voltage Range (V)
  9. Type – AC or DC Pump Set
  10. Photovoltaic (PV) array rating in Watt Peak (Wp).
* All parts of the pump and the motor of the submersible pumps should be made of corrosion-resistant stainless steel with a minimum grade of AISI 304 or higher. The motor-pump set should have a 5 years warranty and therefore, it is essential that the construction of the motor and pump should be made using parts which have a higher durability and do not need replacement or corrode for at least 5 years of operation after installation.
* Pump performance curve i.e. flow vs input pump power should be provided with its technical data sheet provided by the principle manufacturer.

1. **Solar Pump Controller/Inverter:**

* Maximum Power Point Tracker (MPPT) embedded solar controller should be used to optimally utilize the power from Solar PV array and maximize the discharge.
* Solar controller shall have IP 65 protection.
* Protection system with sensors should be incorporated in the controller to protect the solar water pump set against dry running, open circuit, accidental output short circuit, under voltage, reverse polarity, lightening arrestor.
* Reliable DC circuit breaker suitable for switching DC power ON or OFF shall be provided in the solar pump controller.
* Suitable size of UV cable shall be used in enough length for interconnection between solar PV array to the controller and the controller to the solar water pump set.
* Controller shall be provided its specification with maximum input voltage, maximum current, and its maximum efficiency which should not be less than 95%.

1. **Array Mounting Structure**

* The Solar PV modules should be ground mounted on metallic structures of adequate strength and design that can withstand weight of the modules and high wind velocities upto 150 km/hr.
* The modules should be ground-mounted with silver painting or hot dip galvanized.
* The array mounting structure will hold the photovoltaic modules. The modules must be mounted on a support structure made of corrosion resistant material that assures stable and secure attachment.
* The structure must be mounted such that the modules are at a tilt angle of 20 degrees to the horizontal facing the equator.
* There should be no shading from nearby trees or buildings in the solar module.
* All nuts and bolts should be made of very good quality and should be corrosion resistant.
* The structure should be designed to allow easy replacement of any module.
* The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels.
* Schematic design of the array mounting structure should be provided for the pumping application.
* In order to minimize theft risk, Modules fixation on the support structure has to be of anti-theft type.

1. **Balance of Systems**

* The supplier should list all required equipment and accessories like plumbing materials, valves, connectors for water pipeline, PV and pump installation materials, cables, connectors required for specified solar water pumps.
* Separate list of equipment or earthing and lightening arrestor should be provided.

1. **Installation, testing and commissioning**

* Separate quote for the installation, testing and commissioning of the pumps 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** |  |

**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 and design parameters.**

**Solar Water Pumping Systems**

1. **3 KWp Solar PV Water Pump System Set:**

|  |  |  |
| --- | --- | --- |
| Solar PV Module Mono/poly crystalline, (> 250 Wp)  \*Individual module should be greater than 250 Wp. | 3000 | Wp |
| Solar Surface Centrifugal pump (3 HP) | 1 | No. |
| Solar Pump Controller | 1 | No. |
| Solar Array support structure complete | 1 | set |
| Balance of systems |  |  |
| UV cable between solar array to junction box (JB) and from JB to pump controller. | 1 | M2 |
| Cables, switches, Junction Boxes | 1 | Set |
| Earthing set and Lighting Arrestor | 1 | Set |
| Plumbing materials, pipes and Fittings | 1 | Set |
| PV and pump Installation accessories | 1 | Set |
| Spare Parts |  | Pcs. |
| Installation and testing commissioning | 1 | Set |

1. **4 KWp Solar PV Water Pump System Set:**

|  |  |  |
| --- | --- | --- |
| Solar PV Module Mono/poly crystalline, (> 250) Wp  \*Individual module should be greater than 250 Wp. | 4000 | Wp |
| Solar Surface Centrifugal pump  (4HP). | 1 | No. |
| Solar Pump Controller | 1 | No. |
| Solar Array support structure complete for individual panel. | 1 | set |
| Balance of systems |  |  |
| UV cable between solar array to junction box (JB) and from JB to pump controller. |  | M2 |
| Cables, switches, Junction Boxes | 1 | Set |
| Earthing set and Lighting Arrestor | 1 | Set |
| Plumbing materials, pipes and Fittings | 1 | Set |
| PV and pump Installation accessories | 1 | Set |
| Spare Parts |  | Pcs. |
| Installation and testing commissioning | 1 | Set |

1. **5 kWp Solar PV Water Pump System Set**

|  |  |  |
| --- | --- | --- |
| Solar PV Module Mono/poly crystalline, (> 250) Wp  \*Individual module should be greater than 250 Wp. | 5000 | Wp |
| Solar Surface Centrifugal pump  (5 HP). | 1 | No. |
| Solar Pump Controller | 1 | No. |
| Solar Array support structure complete for individual panel. | 1 | set |
| Balance of systems |  |  |
| UV cable between solar array to junction box (JB) and from JB to pump controller. |  | M2 |
| Cables, switches, Junction Boxes | 1 | Set |
| Earthing set and Lighting Arrestor | 1 | Set |
| Plumbing materials, pipes and Fittings | 1 | Set |
| PV and pump Installation accessories | 1 | Set |
| Spare Parts |  | Pcs. |
| Installation and testing commissioning | 1 | Set |

1. **6 KWp Solar PV Water Pump System Set**

|  |  |  |
| --- | --- | --- |
| Solar PV Module Mono/poly crystalline, (> 250) Wp  \*Individual module should be greater than 250 Wp. | 6000 | Wp |
| Solar submersible Centrifugal pump  (6 5 HP). | 1 | No. |
| Solar Pump Controller | 1 | No. |
| Solar Array support structure complete for individual panel. | 1 | set |
| Balance of systems |  |  |
| UV cable between solar array to junction box (JB) and from JB to pump controller. |  | M2 |
| Cables, switches, Junction Boxes | 1 | Set |
| Earthing set and Lighting Arrestor | 1 | Set |
| Plumbing materials, pipes and Fittings | 1 | Set |
| PV and pump Installation accessories | 1 | Set |
| Spare Parts |  | Pcs. |
| Installation and testing commissioning |  | Set |

1. **7.5 kWp Solar PV Water Pump System Set**

|  |  |  |
| --- | --- | --- |
| Solar PV Module Mono/poly crystalline, (> 250) Wp  \*Individual module should be greater than 250 Wp. | 7500 | Wp |
| Solar submersible Centrifugal pump  (7.5 HP). | 1 | No. |
| Solar Pump Controller | 1 | No. |
| Solar Array support structure complete for individual panel. | 1 | set |
| Balance of systems |  |  |
| UV cable between solar array to junction box (JB) and from JB to pump controller. |  | M2 |
| Cables, switches, Junction Boxes |  | Pcs |
| Earthing set and Lighting Arrestor | 1 | Set |
| Plumbing materials, pipes and Fittings | 1 | Set |
| PV and pump Installation accessories | 1 | Set |
| Spare Parts |  | Pcs. |
| Installation and testing commissioning | 1 | Set |

1. **10 kWp Solar PV Water Pump System Set**

|  |  |  |
| --- | --- | --- |
| Solar PV Module Mono/poly crystalline, (> 250) Wp  \*Individual module should be greater than 250 Wp. | 10000 | Wp |
| Solar submersible Centrifugal pump  (10 HP). | 1 | No. |
| Solar Pump Controller | 1 | No. |
| Solar Array support structure complete for individual panel. | 1 | set |
| Balance of systems |  |  |
| UV cable between solar array to junction box (JB) and from JB to pump controller. |  | M2 |
| Cables, switches, Junction Boxes |  | Pcs |
| Earthing set and Lighting Arrestor | 1 | Set |
| Plumbing materials, pipes and Fittings | 1 | Set |
| PV and pump Installation accessories | 1 | Set |
| Spare Parts |  | Pcs |
| Installation and testing commissioning | 1 | Set |

Total number of solar water pumping systems is dependent upon the requirement the project would be implemented through UNDP during the project period. It is estimated to be in the range up to 1000 Solar water pumps of different sizes and configuration to be determined after the actual site survey.

**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)”**