



**TECHNICAL SPECIFICATION FOR  
SOLARIZATION**

**GOAL ETHIOPIA**  
**April 2024**

## **1. Introduction**

Product Certifications and Standard work procedure may demonstrate or depict quality, durability, safety and longer life of a product and works. A rigorous testing of a product and installation affirms that products or installation works has achieved a specific benchmark of either performance or quality in accordance with the international or national level standard(s). Under this section, general specification for works and installation for solar water pumping system from solar array to pumping position are discussed. Therefore, PV solar modules, mounting structure, PV combiner box, solar pumping inverter controller, system cable, flexible pvc pipe cable holding and their installation, must also confirm to a range of regulation and standard to qualify before then can be considered for supply and installation at a specific location.

## **2. Setting Out**

The Contractor shall be responsible for the true and proper setting-out of the works (PV modules, inverter, switch box, cables and other ancillary works) in relation to original points, lines and levels of reference given by GOAL Engineer in writing and for the correctness, subject as above mentioned, of the position, levels, dimensions and alignment of all parts of the Works and for the provision of all necessary instruments, appliances and labour in connection therewith. If, at any time during the progress of the works, any error shall appear or arise in the position, levels, dimensions or alignment of any part of the Works, the Contractor, on being required so to do by the Engineer or the Engineer's Representative, shall, at his own cost, rectify such error to the satisfaction of the Engineer or the Engineer's Representative. The checking of any setting-out or of any line or level by the Engineer or the Engineer's Representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof and the contractor shall carefully protect and preserve all bench marks, sight rails, pegs and other things used in setting-out the Works.

## **3. Solar PV system Specification**

Before supply and installation, the PV panel shall comply the following international standard.

- IEC 61215 Ed 2.0 – Crystalline Silicon PV Module Design Qualification and Type Approval. This helps to determine a panel's performance metrics at standard test conditions (STC), including temperature coefficient, open-circuit voltage, and maximum power output.
- IEC61730 Ed. 2 - PV Module Safety Qualification. This standard addresses the safety aspects of a solar panel, encompassing both an assessment of the module's construction and the testing requirements to evaluate electrical, mechanical, thermal, and fire safety and to show, as far as is possible within reasonable constraints of cost and time, that the module is capable of withstanding prolonged exposure in general open-air climates.
- IEC 60904-1 – Measurement of PV Current-Voltage Characteristics. This part of IEC 60904 describes procedures for the measurement of current-voltage characteristics (I-V curves) of photovoltaic (PV) devices in natural or simulated sunlight. These procedures are applicable to a single PV solar cell, a sub-assembly of PV solar cells, or a PV module. They are applicable to single-junction mono-facial PV devices.

#### **4. Mounting Structure Specification**

- All the mounting structures member shall be designed, constructed and erected as per the Ethiopian Building standard code of EBCS-3.

#### **5. Solar Pumping Inverter Controller**

- IEC 62109-1, Safety of power converters for use in photovoltaic power systems – Part 1: General requirements
- IEC 62109-2, Safety of power converters for use in photovoltaic power systems – Part 2: Requirements for inverters

#### **6. Lightning Protection and Surge Device**

- IEC 62305-2, Protection against lightning – Part 2: Risk management.
- IEC 61643-32, Low-voltage surge protective devices – Part 32: Surge protective devices connected to the DC side of photovoltaic installations-Selection and application principles.

#### **7. System Cables**

- IEC 60364-5-52, Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems.

### **ANNEX-1 : Technical Specification for Solar System**

Each component is meeting the following specifications as minimum:

<b>No. 1</b>	<b>PV MODULES</b>
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1.0	The capacity of the solar modules should be at least 69 % greater than AC motor pump, i.e at least 68 % losses should be considered in the design, measured @ STC
1.1	The solar modules should be designed to run near the MPPT;
1.2	Type of cell: Mono Crystalline,
1.3	Module capacity should not be less than power stated on the BOQ specification @STC
1.4	Module efficiency: should not be less than 21%;
1.5	Tolerance of maximum power rating: 0-5 W;
1.6	The PV modules junction box must be IP67;
1.7	Module Voltage: Not less than 1000 VDC;
1.8	Operating temperature: -40°C to 85°C;
1.9	Temperature Characteristics: P max: -0.42% /C° or less VOC: -0.31% /C° or less;
1.10	Weather-proof DC rated MC4 connector. Fully Secured, not allowing for any loose connections.
1.11	High transmittance tempered glass: Minimum thickness of 4.0 mm;
1.12	Must conform to IEC 61215, 61730, and 61701
1.13	Certificates and Data sheet of PV module that contains the P-V & I-V Curves, all electrical and mechanical Data, Dimensions, Module area should provide by bidder;
1.14	Installation warranty: 1 years;

<b>No. 2</b>	<b>MOUNTING STRUCTURE</b>
2.0	The array structure is designed to occupy minimum space without scarifying the output from SPV panels;
2.1	The structure is designed to allow easy replacement of any module & the array structure is fabricated out of galvanized iron pipes, steel u-bolt and steel C-channel or Angle Iron;
2.2	Access for panel cleaning and maintenance: All solar panels are accessible from the top for cleaning and from the bottom for access to the module-junction box with closest point from bottom to the ground level is a maximum of 90 cm in height.
2.3	Necessary Earthing/ Grounding is to be provided for each mounting structure;
2.4	The support structure & foundation are designed to withstand following loads DL= 0.25 KN/m <sup>2</sup> , LL= 0.25 KN/m <sup>2</sup> , wind speed = 120 km/h
2.5	The support structure design is incudes to: steel members (based on the design), reinforced concrete foundation (based on the design), cut and backfill, bolts/ welding (based on the design);
2.6	The modules support structure is mild steel, galvanized iron or steel for holding the PV modules;
2.7	Bolts, nuts, fasteners, panel mounting clamps: Stainless steel;
2.8	The structure is designed to allow easy replacement and cleaning of any module;
2.9	The structure is designed to be Anti-theft for the PV modules which will be surrounded by chain link fence;
2.10	Concrete base, Minimum 35X35 cm and Concrete base height is 70cm (20cm above ground level and 50cm below)
2.11	The prospective Installer shall specify installation details of the solar PV modules and the support structures with lay-out drawings and array connection diagrams. The work shall be carried out as per the designs approved by the Inspector. The structure layout diagram and Detailed engineering drawings with shading calculation must be submitted with bid (There should be no shading from nearby trees or buildings during the day); use the tilt angle of PV module 13°-15° and to the direction of southern hemisphere.
2.12	The item shall include all preparation work such as levelling the earth ground, removing all undesired material... etc;
2.13	Earthing clamps shall be used along the project;

<b>No. 3</b>	<b>PV DC BREAKER &amp; COMBINER BOX</b>
3.0	The PV combiner box shall be used to combine the multiple DC input to one output, and it shall comply with the following specifications as minimum:

3.1	Enclosure materials: Coated metal with lockable door;
3.2	Enclosure protection: IP65;
3.3	Number of input circuit: total number of strings in addition to 2 spare inputs;
3.4	DC fuse rating for each string:1000V;
3.5	DC output circuit: In accordance with the maximum current X 1.25, 1000 VDC breaker;
3.6	Built in surge protection device;
3.7	Anti-backflow diodes;
3.8	Operational Environment Temperature: -30 °C ~+70 °C;
3.9	Product warranty shall be at least 2 years.

<b>No. 4 SOLAR INVERTER CONTROLLER</b>	
4.0	The solar pumping drive is required, the drive should have a long lifetime, low maintenance cost, inbuild MPPT + VFD (Variable Frequency drive). The drive rating should be min. 1.25 X AC pump rating and it shall follow below features:
4.1	Three phase output, voltage range 380-440 V;
4.2	Efficiency: Not less than 95%;
4.3	Output Frequency: 50H±3%;
4.4	Enclosure class should be not less than IP55;
4.5	Maximum input voltage (Voc): not less than 800 VDC;
4.6	The system should be designed to run near its MPPT range;
4.7	Operating temperature: up to 50 °C;
4.8	The device shall allow hybrid operation with external power source, where solar power should be configured as the primary power source;
4.9	soft start, V/F stable speed control during solar radiation changes, adjustable auto/ manual start in early morning, auto wakeup after adjustable hibernation time in cloudy days, o inputs for pressure switch and water level sensor to protect the pump against dry running and tank full water or closed pipeline (high pressure)
4.10	Display: LCD Screen display with Cover + LED status indicator;
4.11	Protection: Over-Voltage, pump Over-Current, pump Over-Load, Over-Temperature, pump Phase Loss, pump Short-Circuit, ground fault, solar low power, DC Input Anti-reverse, AC output unbalance (3Phase);
4.12	Display content: PV status (Current, Voltage, Power, Energy), AC input voltage, AC output voltage, Load, Running Status, RPM, and Frequency
4.13	Product warranty should be at least 1 years;

<b>No. 5 SYSTEM CABLES</b>	
5.0	Cables should be sized in accordance with IEC 60364-5-52 standard
5.1	DC Cable (From array to DC Breaker & Combiner Box) Made of double insulation material and jacket, TUV certified, 1000VDC, Sheath colours: black, red, Type of Conductor: tinned copper, flexible, finely multi stranded
5.2	DC Cable (From Combiner Box to inverter) Made of double insulation material and jacket, TUV certified, 1000VDC, Sheath colours: black, red, type of Conductor: tinned copper, flexible, finely multi stranded;
5.3	3phase, AC Submersible Pump Cable Voltage rating:450/750VAC, Type of Conductor: copper, flexible, finely multi stranded, Insulation: black poly chloroprene, HO7RN -F or equivalent material

<b>No. 6 PVC pipe for cable holding</b>	
6.0	Must be used for wires and cables with all required accessories such as spacers, saddles, couplers, and bends, inspection or non-inspection type elbows, tees, junction box(s) of required ways and resin/adhesive to make all joints rigid;

6.1	Pipe type: Rigid PVC conduits for underground laid & flexible PVC conduit for DC & AC laid above the ground;
6.2	Thickness: 4mm to 8mm;
6.3	Colour: White or Black.

<b>No. 7</b>	<b>AC BREAKER WITH ENCLOSURE</b>
7.0	Installation between solar pump inverter and solar pump;
7.1	Mounted: Surface mounted;
7.2	Material: impact resistant reinforced polystyrene or equal or equivalent;
7.3	enclosure with door;
7.4	protection rating : IP65;
7.5	AC output circuit: In accordance with the maximum current, & 480 VAC breaker;
7.6	Operational Environment Temperature: -30 °C ~+70 °C;

<b>No. 8</b>	<b>EARTHING SYSTEM</b>
8.0	<p>The bidder must supply and install grounding systems:</p> <ul style="list-style-type: none"> <li>- All PV modules shall be grounded in accordance with the manufacturer instruction.</li> <li>- Earthing clamps shall be used.</li> <li>- Bidders shall supply necessary equipment for system grounding and lightening protection including SPD, earth pits and rods</li> </ul>
8.1	The measure of grounding resistance should be not more than 5 ohm

<b>No. 9</b>	<b>Chain link fences to protect the system .</b>
9.0	Protecting the solar array & components by the barbed wire, wire diameter 3 mm), It shall not cause any shading effect to the solar array, all works shall be approved by GOAL representative prior to execution stage
9.1	The height of the column is 2 meters from the ground level.
9.2	The total height of the wire is 2.2 with 20 cm of wires from ground level.
9.3	The work of columns of angle iron post 50x50x3 and length 2.5 meters from the level of the ground, the distance between the columns 2 meter.
9.4	The columns bases are to be min. of (W× L× H) 40X 40 X 60 cm and 20 N/mm2
9.5	All columns are completed with concrete post
9.6	Gates to be manufactured from medium-quality corrugated iron sheet;
9.7	Maximum width of gate to be 0.9m;