Annex 2 – Technical Specifications (Mandatory)

الملحق 2 - المواصفات التقنية (إلزامية) (مرفق)

Bid Reference	Installation of solar power systems to smallholder farmers in Akkar-BMZII2025TRI06

1. Scope

Three women (2 in Mohammara, one in Daouret Akkar) will receive solar energy systems for irrigation in order to solve the problems of water and electricity supply and reduce production costs under the project entitled “Strengthening the Resilience of Vulnerable Women, Young Adults, and Men in Lebanon through Livelihood Improvement and Increased Food Security” funded by the German Cooperation (BMZ) and implemented by Mada Association in partnership with arche noVa.

There are three sites designated for the installation of solar systems, each with specific technical requirements:

- Mohamara 1 (0.75 HP pump): Installation of 4 PV panels mounted on 4 galvanized steel structures. Each leg will be embedded 30 cm into a 40x40 cm concrete-filled pit. The system will include 1 VFD inverter, an electrical panel (enclosure) to house all necessary components, and the required cabling.
- Mohamara 2 (3 HP pump): Installation of 8 PV panels mounted on 8 galvanized steel structures, with two curbstones supporting each leg. The system will include 1 VFD inverter, an electrical panel (enclosure), and the necessary cabling.
- Daouret Akkar (0.75 HP pump): Installation of 4 PV panels mounted on 4 galvanized steel structures, with two curbstones supporting each leg. The system will also include 1 VFD inverter, an electrical panel (enclosure), and all required cables.

1.1 General conditions and requirements.

- The solar panels will be installed on a galvanized steel structure.

- The contractor shall provide a simulation report “using software” for the system based on real field data (to confirm the design of the system and ensure the normal functionality of the system).

- The contractor is responsible for informing Mada’s team if any missing items that may impact the system's functionality must be added to the initial BoQ prior to the implementation and/or completion of work.

- The selected contractor, prior to starting the work and upon the request of Mada's team, shall verify the safety and adequacy of all electrical cables, electrical items, steel structures, concrete work, and accessories. This includes providing calculation notes to confirm that components are appropriately sized, considering relevant factors such as wind and snow load for the steel structure and concrete work among others, and submitting these for the engineer's review.

- The contractor will be responsible for any technical or electrical issues that arise during the operation and functioning of the system for at least one year after the completion of the work.

- The contractor shall submit data sheets for the quoted inverter and panels, which will be subject to the engineer's approval.

- The contractor shall label all electrical components in the electrical panels and install safety signs wherever necessary, as requested by the engineer.

- The IP rating of electrical panels should be suitable for the installation environment and as per the engineer's request.

1.2 General Specifications

The systems should function with the following specifications:

- All system components should be water and corrosion-resistant.
- System components should be manufactured according to International Quality and Environment Management System Standards ISO 9001 and ISO 14001 respectively.

The system should be fully operational in the following conditions:
o Relative humidity up to 95%.
o Ambient temperature from -10˚C to 45˚C.
o Rural environment with presence of dust, insects…
o Wind speed up to 120 km/h.

Existing services:

The Contractor will be held responsible for damage caused during the execution of the Works to such existing works and services and shall indemnify the Employer, the Engineer, and their agents against any claims arising from such damage (including consequential damages). Any damage caused must be made good at the Contractor's own expense.

ACCESS TO PROPERTIES

- **Bill of quantities and measurement:**

General

The Bill of Quantities is not and does not purport to be either exhaustive or explanatory of all the obligations and duties of the contractor who shall be deemed to have satisfied himself as to the

correctness and sufficiency of the rates and prices entered by him in the Bill of Quantities all of which shall cover all his obligations under the Contract (including those in respect of the supply of goods, materials, plant, or services or of contingencies for which there is a Provisional Sum) and all matters and things necessary for the proper execution and completion of the Works and the remedying of any defects therein and which may reasonably be inferred to be necessary for the Works as described in the Contract whether expressly mentioned therein or not.

MEASUREMENT

The Bill of Quantities includes items as lump sum and others as measured quantities.

Lump Sum

The lump sum items shall not be subject to re-measurement and shall include the prices for all necessary construction, installation, testing, and commissioning among others. The lump sum entered in the Bills shall include the price for a complete installation as described in the specifications.
The prices shall cover all work required for the completion of the project, including all necessary tasks, safety measures, and access arrangements.

Measured Quantities

All measurements in the Bill of Quantities are taken strictly net. The principle of net measurements shall apply to all Works executed. All quantities measured for payment shall be measured by the Engineer on the basis of actual net quantities of Work fixed in position. Item not used shall neither be measured nor included by the Contractor in his statements.

1.3 Systems Components and technical specifications.

1.3.1 Photovoltaic Modules

a. Product Specifications

- Manufacturer must be one of the worldwide renowned solar manufacturers, Tier 1.
- Solar Panel Wattage at STC ≥585Wp
- Maximum Power Voltage (Vmp) ≥ 41.80V
- Open circuit voltage (VOC) ≥ 50.00V
- Short circuit current (ISC) ≥ 13.90A
- Module Type Mono Crystalline, N-Type, Half-Cut Cell
- Module efficiency > 21%
- Operating temperature -40°C to +85°C

- Module frame anodized Aluminium alloy, the anodizing Thickness shall be ≥ 15 micron.
- Glass High transparency & transmittance, tempered glass of 3- or 4-mm thickness.
- Module Characteristics: Resistant of water, abrasion, hail impact, humidity & other environmental factors for the worst situation at the site.
- Sufficient encapsulation and sealing arrangements to protect the silicon cells from the harsh environment.
- Power tolerance Positive Tolerance +3%
- Higher cell efficiency with 4 Bus bars.
- Maximum load 5400 Pa
- Official manufacturer PV module certifications must be achieved for: IEC 61215, IEC 61730, IEC 61701, UL 1703, IEC 62716 & IEC 60068.
- Official manufacturer must be achieved standard certifications: ISO 9001, ISO 14001.
- Minimum official manufacturer warranty paper for minimum duration 10 years.
- Warranty for power output of at least 98% for the first year after commissioning date, at least 93% for the first 10 years after commissioning date, at least 85% for the 15 to 25 years after commissioning date.
- Relevant codes and standards: IEC 61215, EN/IEC 61730, IEC 62716, IEC 61701, IEC 60891 ed2.0, IEC 60904, NL 137 Produced in ISO 9001 and ISO 14001 certified factory, IEC 61000-3 - Electromagnetic compatibility (EMC), IEC 61727 - Photovoltaic Systems - Characteristics of the Utility Interface, IEC 61730 - Photovoltaic (PV) module safety qualification, UL-61730-2/UL 1741/IEEE 1547 – Standard for Inverters, Converters, and Controllers for Use in Independent Power Systems, IEEE 929 - Recommended Practice for Utility Interface of Photovoltaic (PV) Systems, IEC 60034 - Rotating Electrical Machines, IEC 61345 - UV test for photovoltaic (PV) modules, IEC 61194 - Characteristic parameters of stand-alone photovoltaic (PV) systems, IEC 61724 - Photovoltaic system performance monitoring – guidelines for measurement, data exchange and analysis, IEC 61727 - Photovoltaic (PV) systems – Charact. of the utility interface, IEC 62124 - Photovoltaic (PV) standalone systems – Design verification, IEC 62446 - Grid connected photovoltaic systems, IEC 62548 - Installation and Safety Requirements for Photovoltaic (PV) Generators, IEC 61140 - Protection against electric shock, IEC62116 - Test procedure of islanding prevention measures for utility- interconnected photovoltaic inverters.

b. Installation Requirement

- Installation works in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer.
- Where multiple parallel PV strings exist, there may be a requirement to install overcurrent protection (e.g., string fusing).
- Contractor should provide a site-specific full system design including all shading issues, orientation, and tilt, along with the system's site-specific energy yield, including average daily performance estimate on kWh for each month of solar generation
- Contractor should ensure array configuration is compatible with the inverter specification
- Contractor should ensure all equipment is fit for purpose and correctly rated

- The Contractor shall be responsible for all off loading and handling of module on site and shall ensure that module is delivered to site on drums properly protected against mechanical damage.
- The Contractor shall be responsible for open circuit voltage test on each PV string and on the total array.

c. Submittals

- Full details and datasheet.
- Datasheet of PV module that contains the P-V & I-V Curves, all electrical and mechanical Data, Dimensions, Module area, Weight…etc
- Electrical wiring diagram showing the detailed PV strings, combiner boxes connection, exact routing of PV modules, also the electrical schematic diagram that includes the electrical ratings of: Modules, The PV array, DC & AC isolators, Overcurrent devices (ie. fuses, circuit breakers, etc), upon request.
- Essential official manufacturer certifications must be achieved and submitted: IEC 61215, IEC 61730, IEC 61701, UL 1703, IEC 62716 & IEC 60068, upon request.
- Essential official manufacturers must achieve standard certifications: ISO 9001, and ISO 14001.
- Provide electrical wiring diagrams, upon request:
  - Diagram showing the number of modules in series in a string
  - Diagram showing the number of strings in parallel in the PV array
  - Diagram showing the PV array tilt
  - Diagram showing the PV array orientation
- Provide the recommended maintenance for the system (provide maintenance checklist sheet)

1.3.2 Support Structure Clamp

a. Product Specifications:

- Clamp material should be anodized aluminium 6005 – T5.
- Clamps must be Compatible with the PV module that will be used
- The clamp dimensions and thickness should withstand a wind load of 120 km/hr or higher as required by the AASCE 7.05 code.

b. Installation Requirement

- Solar modules should be attached to the array structure using clamps.
- When using clamps, the solar panel manufacturer's installation requirements shall be followed. The installer shall consider the following:
  - Amount of overhang allowed from clamp to end of module; and size of clamp required.
  - At least 4 clamps for each PV panel (top and bottom).
  - Attaching a solar module in such a manner (e.g. drilling, pop riveting) that causes a hole in the anodized aluminium frame of the solar module typically voids the manufacturer's product warranty with respect to defects in material and workmanship. If the installer

intends to undertake an installation in this manner, they shall obtain written verification from the manufacturer that it does not affect the warranty. This shall be included in the system documentation supplied to the customer.

c. Submittals

- Essential official manufacturer certifications must be achieved and submitted, upon request: ISO 9001, ISO 14001, OHSAS 18001, TUV, SGS…
- Official manufacturer warranty paper for the minimum duration of 10 years (warranty includes all the mounting structure components), upon request.

1.3.3 VFD Solar pumping Inverter

a. Product Specifications

- Power input with DC solar priority and AC power support.
- With MPPT controllers.
- Operating temperature range: −10 °C to +50 °C
- Data interface with remote control and monitoring system.
- Minimum one-year warranty.
- Solar pump protection function: Dry run, low frequency, low power, dormancy, pump over current protection.
- Heavily reduced energy losses in the supply lines.
- Increases starting torque to ensure the pump starts in all conditions.
- Stops the pump when there is too low torque on the motor shaft.
- DC fuses to be installed to protect the inverter modules.
- Surge protection devices on both DC & AC sides. Relevant codes and standards: IEC 61643-11.
- Output Filter: All inverters use IGBT transistors as an output element to give the correct voltage to the motor.
- Inverter Max. generating power as shown in the BOQs.
- Relevant codes and standards include: IEC 61800/ TUV / CE Certification or equivalent.

b. Installation Requirement

- Complete with configuration accessories, wiring (with earth connection), and installation.
- Installation works in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer.
- At both the proposal and design stages, it is important to consider the proposed location of inverters, in relation to the main switchboard or sub-board where the inverter AC output is to be connected.

c. Submittals

- Full details, datasheet and three years warranty.
- Essential official manufacturer must be achieved standard certifications: ISO 9001, and ISO 14001, upon request.

- Official manufacturer warranty paper for a minimum duration of 3 years (warranty includes all the inverter components), upon request.

1.3.4 Metallic "support" Support Structure for the PV array.

a. Product Specifications:

- Support structure mounting arrangements should comply with applicable building codes, regulations, and standards to ensure the best efficiency. Particular attention should be given to wind loads on the PV generators and their structures so that they withstand winds up to 120 km/h.
- All structures shall be made of corrosion-resistant materials e.g., hot dip galvanized steel, etc. Material will be tested.
- The use of hop dip galvanized steel mounting structures must include the use of epoxy paint or similar approved zinc paint as protection against corrosion on welding spots.
- All welding joints shall be fully welded, reasonably smooth, uniform, and painted with pre-approved paint.
- The mounting structures shall be either continuous one-core skeletons or multiple arrays with enough spacing to prevent shadows at proposed tilt angles.
- All bolts, nuts, and fasteners to be galvanized or stainless steel.
- PV module wiring and associated components should resist UV, wind, water, and other environmental conditions. Wiring and components should be fit for this purpose and built in such a way as to minimize exposure to detrimental environmental effects. Particular attention is drawn to the need for the prevention of water accumulation in cable/ module support systems.
- The steel structure must include bracing between its columns to withstand any lateral loads.
- The sheet steel plate, with dimensions of 30 cm x 10 cm x 6 mm, shall be welded securely to the leg of the structure and fastened to the curbstone using bolts, ensuring a robust and stable connection.

b. Installation Requirement

- Installation works shall be carried out in accordance with approved standards, as per the manufacturer's recommendations, and to the satisfaction of the Engineer.
- Tilt and orientation of PV have to be optimized for max efficiency depending on the geographical location.
- The PV modules shall be mounted on fixed metallic structures having adequate strength and appropriate design, which can withstand the load of the modules and high wind velocities.

- The work shall be carried out by qualified and certified personnel (Lebanese manpower in preference) with respect to the designs approved by the Engineer.

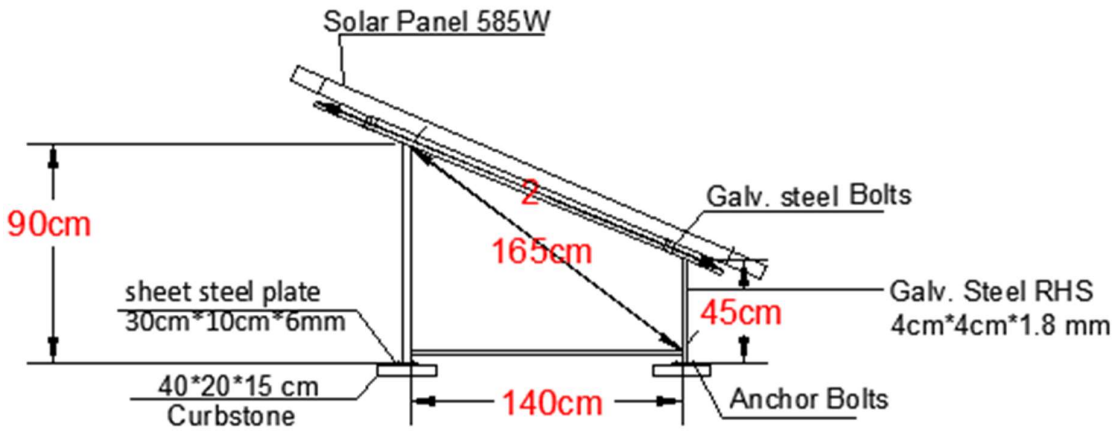
c. Submittals

- Structural design analysis with an official report according to the international codes and standards:

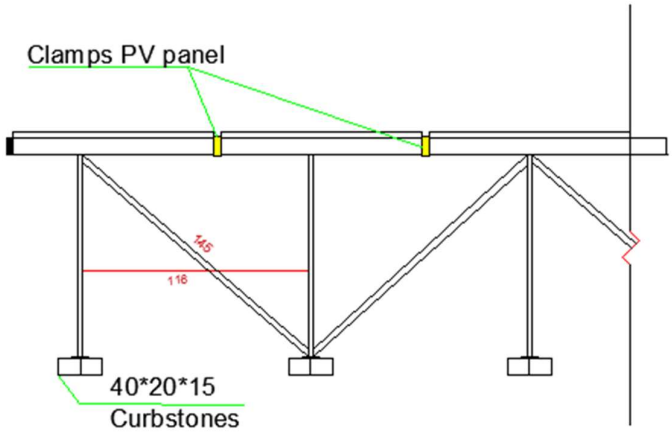
  - **Cold formed components:** AISI. "American Iron and Steel Institute" Cold Formed Steel Design Manual, 1996 Edition.
  - **Reinforced concrete elements in accordance with:** ACI 318. "American Concrete Institute" Building Code Requirements for Structural Concrete, 2019 Edition

- Shade analysis
- Layout of the Support Structure for the PV Array including all the connections, arrangement, tilt angle, strings…
- Official manufacturer certifications must be achieved and submitted, upon request: ISO 9001, ISO 14001, OHSAS 18001, TUV, SGS…

Drawings of the steel structure:



Section



Rear View

General notes:

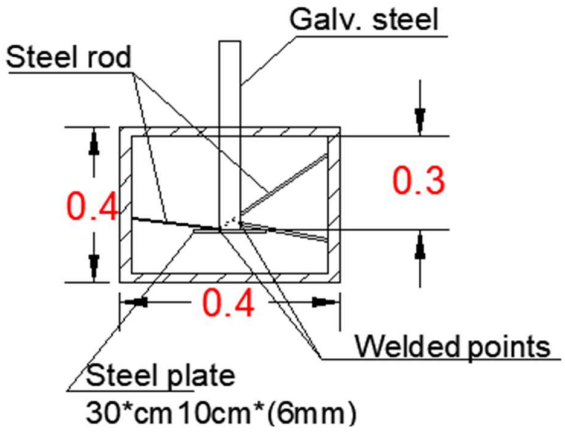
- Concrete strength 25 MPa.
- Steel structure: Galvanized steel S 275 G90, Bolt Grade 5.8.
- Welding conform AWS and AWS filler.
- Touch up of joints with Zinc-rich coating.
- The contractor shall be responsible for ensuring that there is no shading between the strings.
- The contractor is responsible for verifying during the field visit whether the above drawings are suitable for the system, the available space, the south-facing direction, and the optimal angle for the system's functionality. If necessary, the contractor should make adjustments to enhance the system's efficiency.

- **As specified in the Bill of Quantities (BOQ), the unit of measurement for the steel is per piece, which includes the complete steel structure for each photovoltaic (PV) panel, along with all associated dimensions and accessories such as curb stones, plates, bolts, and other necessary components.**

1.3.5 Concrete Works:

- The contractor must provide concrete blocks (curb stone) as supports to the steel frame structure with dimensions as specified in the BOQ.
- The contractor shall excavate a small pit with dimensions of 40x40 cm to embed the leg of the galvanized steel structure to a depth of 30 cm. Additionally, three steel rods must be welded to secure the leg in place. The concrete used for this work shall have a compressive strength of 30 MPa.

- **Drawings of small pit:**



1.3.6 Solar "PV" Cables:

a. Product Specifications

- Pure copper material single-core
- String, cables between array interconnections, array to junction boxes, junction boxes to inverter etc. shall also be sized to avoid excessive voltage drop under load. For LV PV arrays, under peak output conditions, the voltage drop from the most remote module in the array to the input of the inverter should not exceed 3% of the Vmp voltage (at STC).
- General Description All cables and connectors use for the installation of solar systems must be of solar grade which can withstand harsh environmental conditions including High temperatures, UV radiation, rain, humidity, dirt, salt, burial, and attack by moss and microbes for 25 years and voltages as per latest IEC standards.
- The wire cross-sectional area of the cable chosen is such that the voltage drop introduced by it shall be within 3% of the system voltage at peak power.

- Temp. Range: –10°C to +105°C.
- Voltage rating: 600/1000V.
- Excellent resistance to heat, cold, water, oil, abrasion.
- All conductors shall be copper.
- All cable schedules/ layout drawings shall be approved prior to installation.
- Official manufacturer certifications must be achieved and submitted for the following: TUV, ROHS, CE, class 5, IEC 60228
- Official manufacturer warranty paper for the minimum duration of 10 years on material and manufacturer.
- Relevant codes and standards : IEC 60227, IEC 60502, IEC 62930, EN 50521, EN 50396, HD 605/A1-3, EN 50267-2-1, EN 60811-2-1, DIN EN 53516, VDE 0482-332-1-2, DIN EN 60332-1-2, IEC 60332-1.

b. Installation Requirement

- Installation works by approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer.
- The Contractor must ensure that all DC cables specified are rated to handle the PV array's maximum voltage.
- The operating temperature for cables installed near or in contact with PV modules should be considered equal to 105°C.
- Cable routing/ marking: All cable/wires are to be routed in pipes and suitably tagged and marked properly so that the cable is easily identified and not subject to damage.
- The supplier must indicate size and length as per system design requirements.

c. Submittals

- Size of conductors in conduits, details of supports, details of connection, etc.
- List of feeders & sub-feeders with their sizes, route length, voltage drops, etc.

1.3.7 MC4 Connectors

a. Product Specifications

- Degree of protection IP68
- Rated Voltage TUV 1000 DC/ UL 600V DC
- Rated Current 20A-30A
- Contact material copper, tin-plated
- Contact resistance less than 0.5 m ohm

- Compatible Solar cable 2.5/4.0 /6.0 mm² (14/12/10 AWG)

b. Installation Requirement

- Installation works by approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer.

c. Submittals

- Warranty paper for the minimum duration of 10 years on material and manufacturer.

1.3.8 AC Cables

a. Product Specifications

- Sizes of cables between Inverters, and loads… are selected carefully to keep the voltage drop of the entire solar system to the minimum (not exceeding 3%).
- Cables shall have stranded copper conductors for required sections depending on the maximum power that the wire will be used for
- Cable cores shall be color-coded for identification.
- Single conductor wires and cables for wiring and conduits are to have high conductivity, electrolytic annealed copper conductors insulated with PVC flame retardant, and suitable for conductor temperature of 70ºC.
- PVC insulated cables are to have high conductivity electrolytic annealed copper conductors insulated with PVC flame retardant suitable for conductor temperature of 70ºC, bedded with a suitable filler and sheathed with PVC. Cables are rated 0.6/1 kV.
- Fire-resistant power cables are to have plain annealed copper stranded conductors, insulated with mineral ceramic fire-resistant tapes and a 90°C, cross-linked insulation, bedded with extruded steel wires and sheathed with a low smoke-free halogen sheath. Fire-resistant cables are rated 0.6 / 1 kV,
- Control cables are to be multi-core, PVC insulated, and sheathed, rated 0.6/1 kV.
- Insulated conductors are to be numbered.
- Sheathed and insulated flexible cords shall be 300/500V and shall only be used for lighting pendants.
- Relevant codes and standards: IEC 60502, IEC 69947, IEC 60331, IEC 61034, IEC 60754-2, IEC 60332-3.

b. Installation Requirement

- Installation works in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer.

- The Contractor should check the size of AC cables between the proposed inverter and the electricity distributor's point of supply to avoid excessive voltage rise within the installation when the PV system is generating at its peak output.
- The Contractor should consider best practice as a voltage drop/rise of 1% from the point of attachment to the main switchboard; and, 1% from the main switchboard to the inverter terminal (including via any distribution boards).

c. Submittals

- Cable sizing calculations including voltage drop.

1.3.9 Conduits and Wireways

a. Product Specifications

- Work is deemed to include:
  - Heavy gauge PVC rigid conduits.
  - Flexible steel conduits.
  - Cable trays and cable ladders.
  - Mounting fitting, fixing, etc.
  - Cutting and jointing, bending, etc.
  - Junction boxes, expansion joints connectors, etc.
  - Components for earth continuity.
- Rigid heavy gauge PVC conduits and fittings
  - Material is to be of rigid plasticized PVC, high impact, resistant to chemical
  - corrosion, self-extinguishing. Conduits shall have a compression resistance of 750 N per 5cm.
  - Material shall operate in a temperature range of -5°C to 60°C. Conduits shall be marked at intervals of 1 to 3 meters.
  - Inside and outside surfaces of conduits shall be free from burrs, flash and other similar defects.
  - Wall thickness of conduits shall be uniform.
  - Conduits shall comply with BS 6099-2-2.
- Flexible Steel Conduits
  - Flexible conduits and assemblies are to be made from galvanized steel to BS 731.
  - Where exposed to moisture conditions, conduits are to have PVC sheath.
- Cable Trays
  - Heavy-duty cable trays shall be of the return flange type slotted and perforated. Trays shall be Hot-dip galvanized after perforation and protected by two pack epoxy finish, a minimum 1mm thick (galvanizing in accordance with BS 729). Trays shall be jointed with flange coupling strops that virtually make the flanges continuous. These shall be secured in

place with nuts and bolts.

- All cable tray runs shall be continuous and constructed of bends, tees and other accessories that are purpose made by the manufacturer of cable tray.
- Cable tray shall have adequate mechanical strength for the load to be carried and shall have provision for the addition of a minimum of 20% of the initial installed cable and/or load. The deflection shall not exceed that recommended by the manufacturers.
- The cable trays shall have engraved marks of the serial and identification numbers.

- Cable ladder
  - Cable ladder shall be constructed in mild steel galvanized after perforation and protected with a two-pack epoxy finish (galvanizing in accordance with BS729).
  - All cable ladders shall have sufficient strength and space allowance to accommodate the future installation of an addition of 25% of the initially installed load.
  - Cable ladders shall not be used with greater loading or spans than those recommended by the manufacturers.
  - All bends, tees or other accessories shall be purpose-made by the manufacturer of the cable ladder.
- Relevant codes and standards: National Electrical Code (NEC), IEC 61386 Conduit Systems for Cable Management, IEC 60670 Boxes and enclosures for electrical accessories.

b. Installation Requirement

- Installation works in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer.

1.3.10 Protection Circuit

- Differential circuit breakers should be provided for short-circuit conditions.
- All electronic components must take into consideration temperature compensation issues.
- Full protection against open circuits, accidental short circuits, and reverse polarity by blocking the diode should be provided.
- Diodes and DC totalizers shall be installed in the electrical panels if deemed necessary and recommended by the engineer.

Notes:

- The contractor shall take in his offer all the needed items and fittings that are needed to operate the pumps and price it in the different items in the BoQ.
- The contractor shall train the farmers on the operation and maintenance of the installed system.

Date	
Name of Company / Vendor	
Name of Representative	
Signature	
Company / Vendor stamp (if any)	