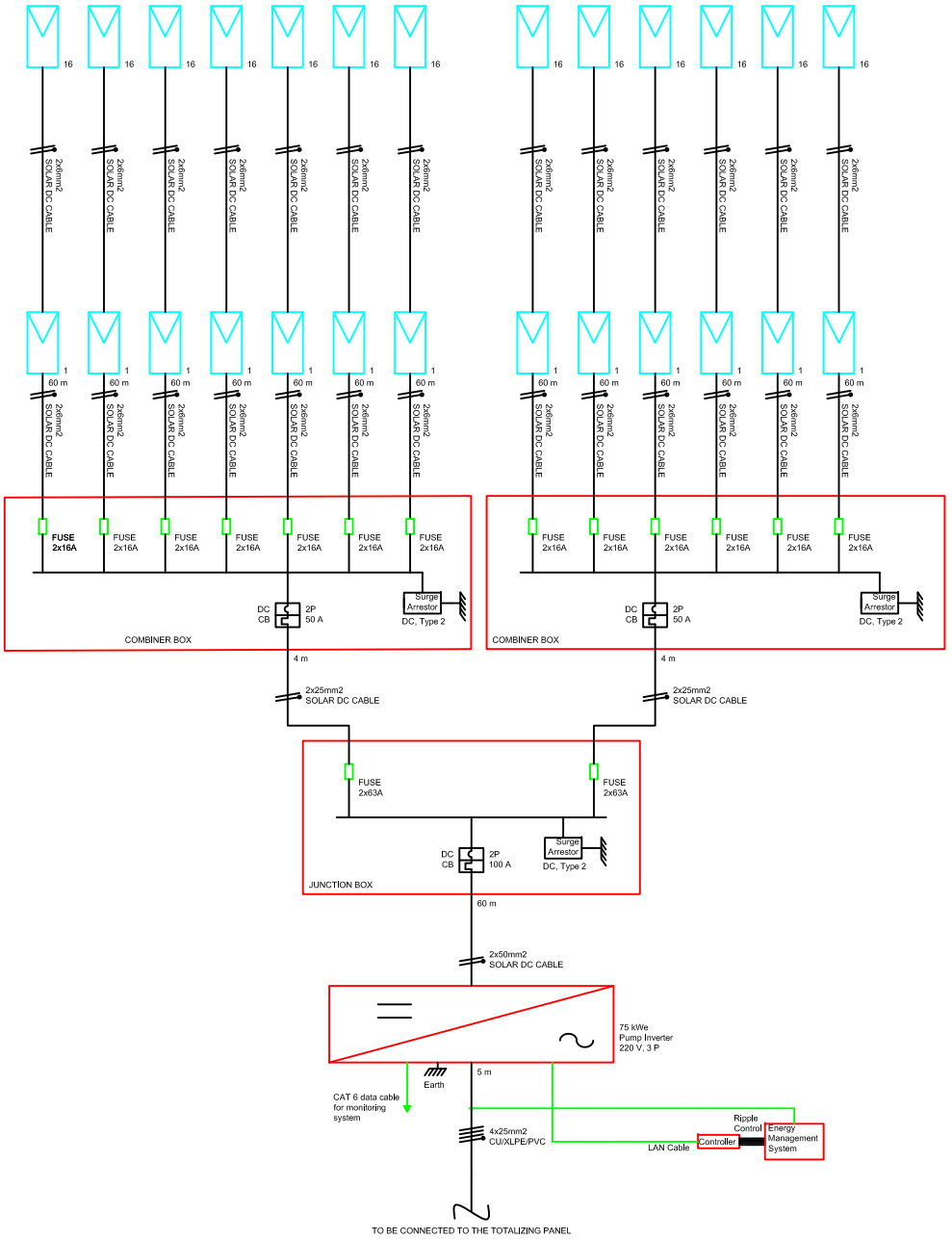
		LIST OF DRAWINGS	
DRAWING REF.	REV.	DRAWING TITLE	SCALE
QLA-EL-PV-100	00	72.8kWp SOLAR FARM LIST OF DRAWINGS	N.T.S.
QLA-EL-PV-101	00	72.8kWp SOLAR FARM SCHEDULE OF EQUIPMENT	N.T.S.
QLA-EL-PV-102	00	72.8kWp SOLAR FARM SINGLE LINE DIAGRAM	N.T.S.
QLA-EL-PV-104	00	72.8kWp SOLAR FARM LIGHTNING PROTECTION DETAILS	N.T.S.
QLA-EL-PV-105	00	72.8kWp SOLAR FARM EARTHING AND LIGHTNING SCHEMATIC SECTION	N.T.S.
QLA-EL-PV-106	00	72.8kWp SOLAR FARM LAND SURVEY LAYOUT	N.T.S.
QLA-EL-PV-107	00	72.8kWp SOLAR FARM ZONING AND PV PANELS LAYOUT	N.T.S.
QLA-EL-PV-108	00	72.8kWp SOLAR FARM ZONING AND STRING CONNECTION LAYOUT	N.T.S.
QLA-EL-PV-109	00	72.8kWp SOLAR FARM ZONING AND COMBINER BOXES LAYOUT	N.T.S.
QLA-EL-PV-110	00	72.8kWp SOLAR FARM FENCING LAYOUT	N.T.S.
QLA-EL-PV-111	00	72.8kWp SOLAR FARM FENCING TYPICAL DETAILS	N.T.S.
QLA-EL-PV-112	00	72.8kWp SOLAR FARM ELECTRICAL POLE & CABLE TRAYS DETAILS	N.T.S.

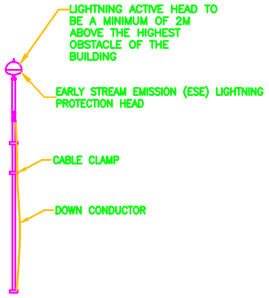
SCHEDULE No. 1
PV PANELS

TYPE	MONOCRYSTALLINE
NOMINAL POWER	> 350 Wp
MODULE EFFICIENCY	> 17%
QUANTITY	AS SHOWN ON DRAWINGS
DIMENSIONS LxWxH	APPROX. 2000*1000*40mm
J-BOX INGRESS PROTECTION	IP 65 OR HIGHER

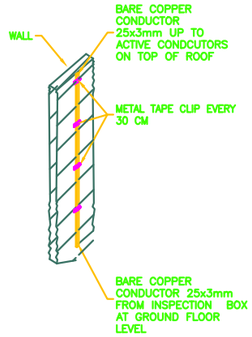
SCHEDULE No. 2
INVERTERS

TYPE	SOLAR PUMP INVERTER
RATED CAPACITY	75 KW
QUANTITY	AS SHOWN ON DRAWINGS
NUMBER OF PHASES	3
VOLTAGE, FREQUENCY RANGE	220/380V +/- 10% AT 50Hz
INGRESS PROTECTION	IP 66
REMARKS	INSIDE EXISTING ROOM

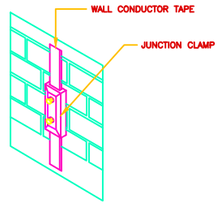

16
2x6mm2 SOLAR DC CABLE
1
60 m
FUSE 2x16A
COMBINER BOX
DC CB
2P 50 A
Surge Arrestor DC, Type 2
4 m
2x25mm2 SOLAR DC CABLE
FUSE 2x63A
JUNCTION BOX
2P 100 A
60 m
2x50mm2 SOLAR DC CABLE
75 kWe Pump Inverter 220 V, 3 P
5 m
Earth
CAT 6 data cable for monitoring system
4x25mm2 CU/XLPE/PVC
Ripple Control
Controller
Energy Management System
LAN Cable
TO BE CONNECTED TO THE TOTALIZING PANEL



1 EARLY STREAM EMISSION (ESE) LIGHTNING PROTECTION HEAD

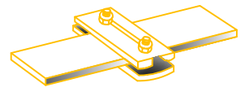


2 BARE COPPER TAPE INSTALLATION ON WALL

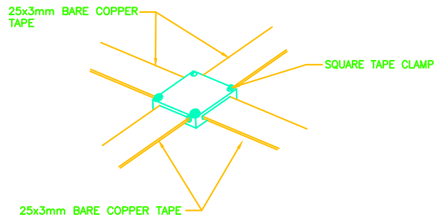


3 JUNCTION CLAMP/ TEST LINK

DOWN CONDUCTORS AND HORIZONTAL CONDUCTORS SHALL BE FIXED TO THE STRUCTURE AT AN INTERVAL OF 30cm WITH STRIP HOLDERS

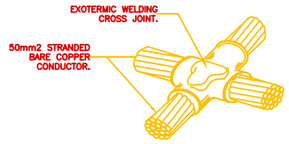


4 STRIP HOLDER

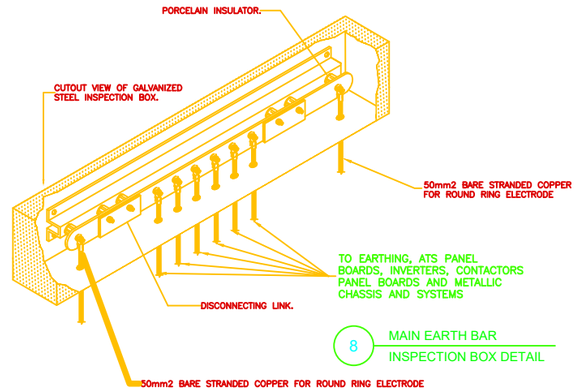


5 SQUARE TAP CLAMP FOR FLAT CONDUCTOR

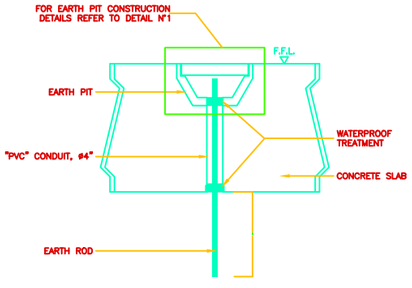
6 EXOTHERMIC WELDING
TEE JOINT



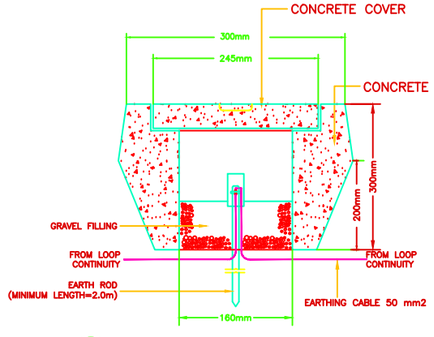
7 EXOTHERMIC WELDING
CROSS JOINT



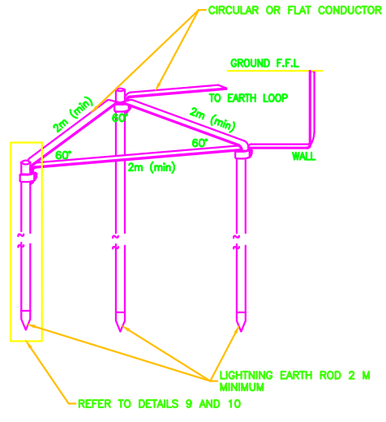
8 MAIN EARTH BAR
INSPECTION BOX DETAIL



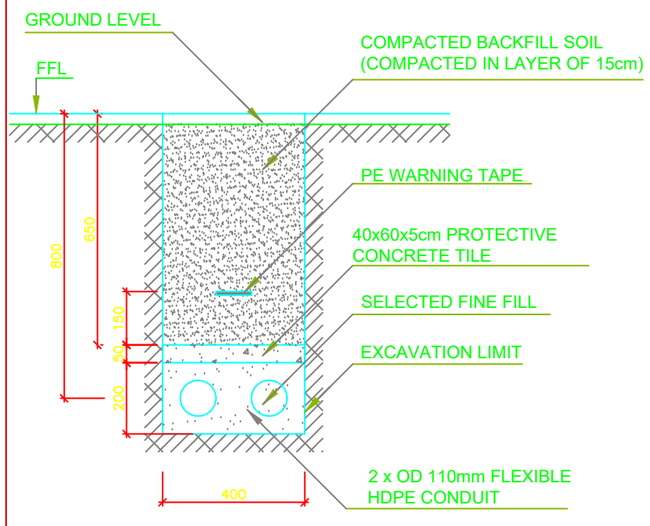
9 TESTING (MEASURMENT)
EARTH ROD INSTALLATION



10 EARTH PIT INSTALLATION DETAIL



11 LIGHTNING EARTH SYSTEM TRIANGLE ARRANGEMENT



12 TYPICAL TRENCH DETAILS

NOTE:

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LEGEND:

REV.	DATE	DRAWN	DESIGNED	CHECKED
0	09/2019	M.ZEIN	M.ZEIN	H.ROUMMANI

CLIENT:

REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOUTH LEBANON WATER AND WASTE WATER ESTABLISHMENT (SLWWE)

PROJECT NAME:

QLAILEH
WELL #2

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مؤسسة مياه لبنان الجنوبي

DRAWING TITLE:

100kWp SOLAR FARM
LIGHTNING PROTECTION DETAILS

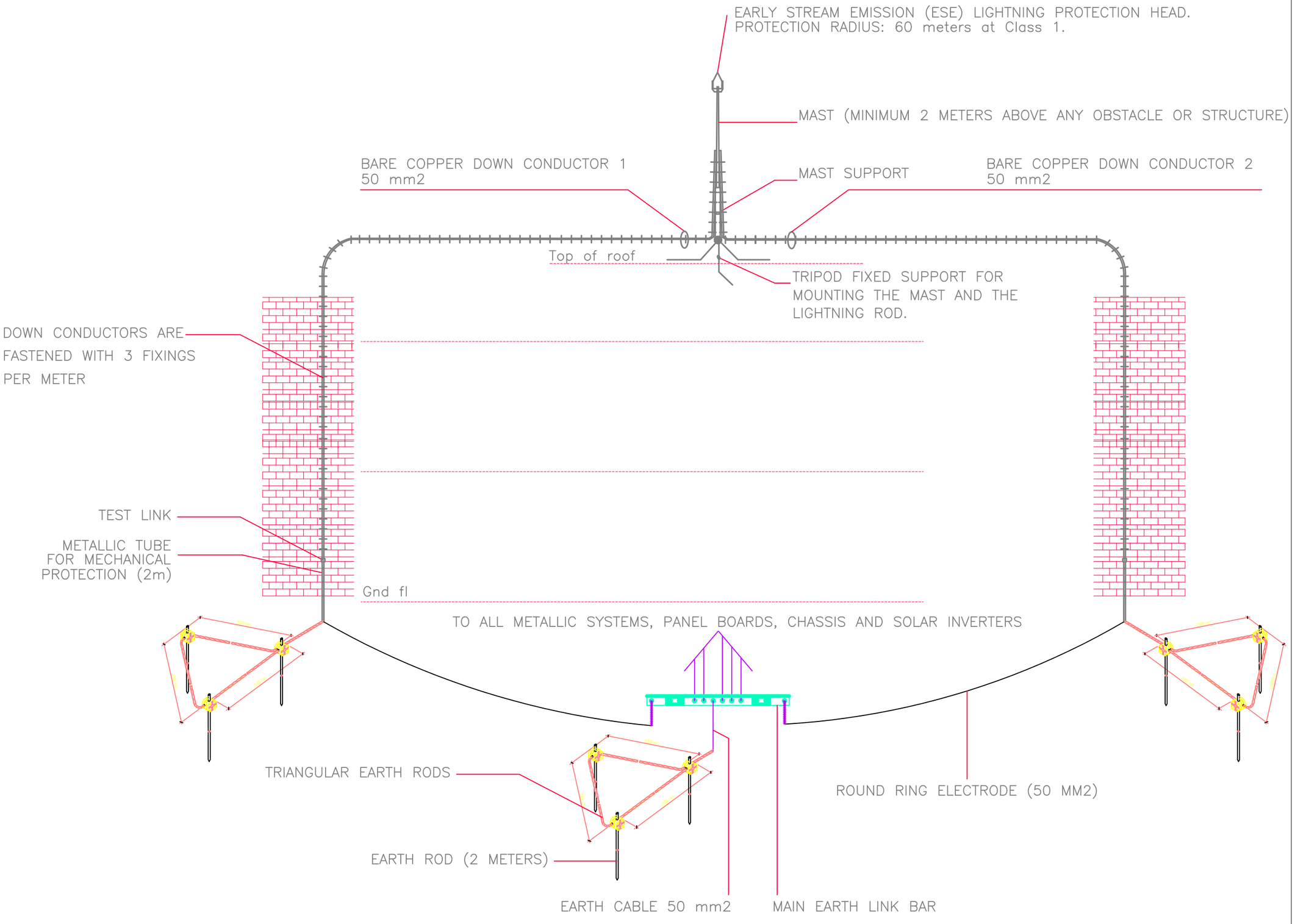
DRAWING NUMBER:

QLA-EL	PV	104	-
REFERENCE	DIVISION	SHEET NO.	REV.

SCALE : N.T.S	DATE : SEPTEMBER 2019
DISCIPLINE : SOLAR	PHASE : DESIGN

ARCH	CIVIL	MECH	ELECT
			X

بصليحة للدراسات والمشاريع



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LEGEND:

REV.	DATE	DRAWN	DESIGNED	CHECKED
0	09/2019	M.ZEIN	M.ZEIN	H.ROUMMANI

CLIENT:

REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOUTH LEBANON WATER AND WASTE WATER ESTABLISHMENT (SLWWE)

PROJECT NAME:

QLAILEH
WELL #2

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مؤسسة مياه لبنان الجنوبي

DRAWING TITLE:

100kWp SOLAR FARM
EARTHING AND LIGHTNING
SCHEMATIC SECTION

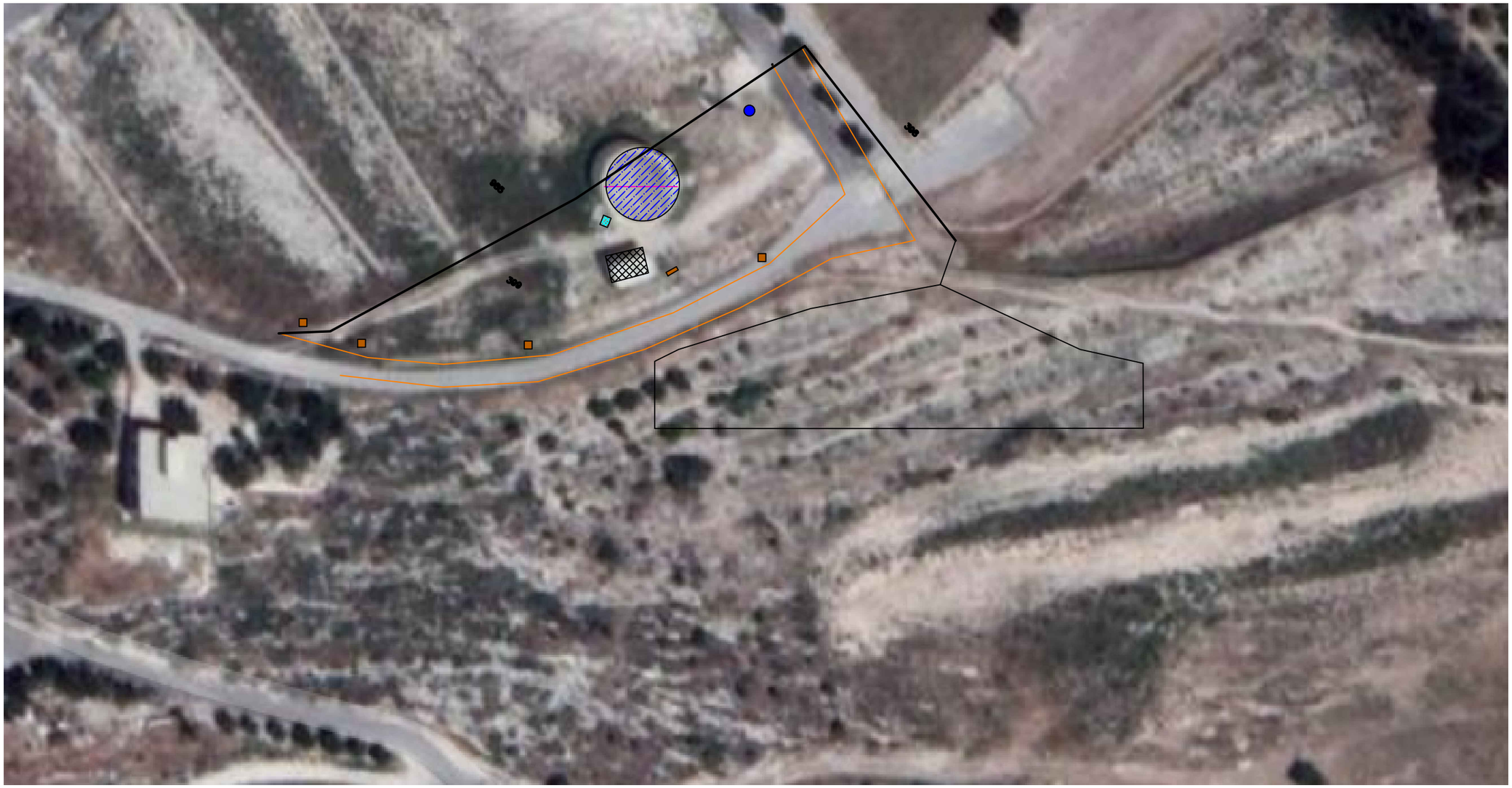
DRAWING NUMBER:

QLA-EL	PV	105	-
REFERENCE	DIVISION	SHEET NO.	REV.

SCALE : N.T.S	DATE : SEPTEMBER 2019
DISCIPLINE : SOLAR	PHASE : DESIGN

ARCH	CIVIL	MECH	ELECT
			X

مصلحة الدراسات والمشاريع



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LEGEND:

DESIGNATED AREA AT QLAILEH WELL #2

REV.	DATE	DRAWN	DESIGNED	CHECKED
0	09/2019	M.ZEIN	M.ZEIN	H.ROUMMANI

CLIENT:

REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOUTH LEBANON WATER AND WASTE WATER ESTABLISHMENT (SLWWE)

PROJECT NAME:

QLAILEH
WELL #2

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مؤسسة مياه لبنان الجنوبي

DRAWING TITLE:

100kWp SOLAR FARM
LAND SURVEY LAYOUT

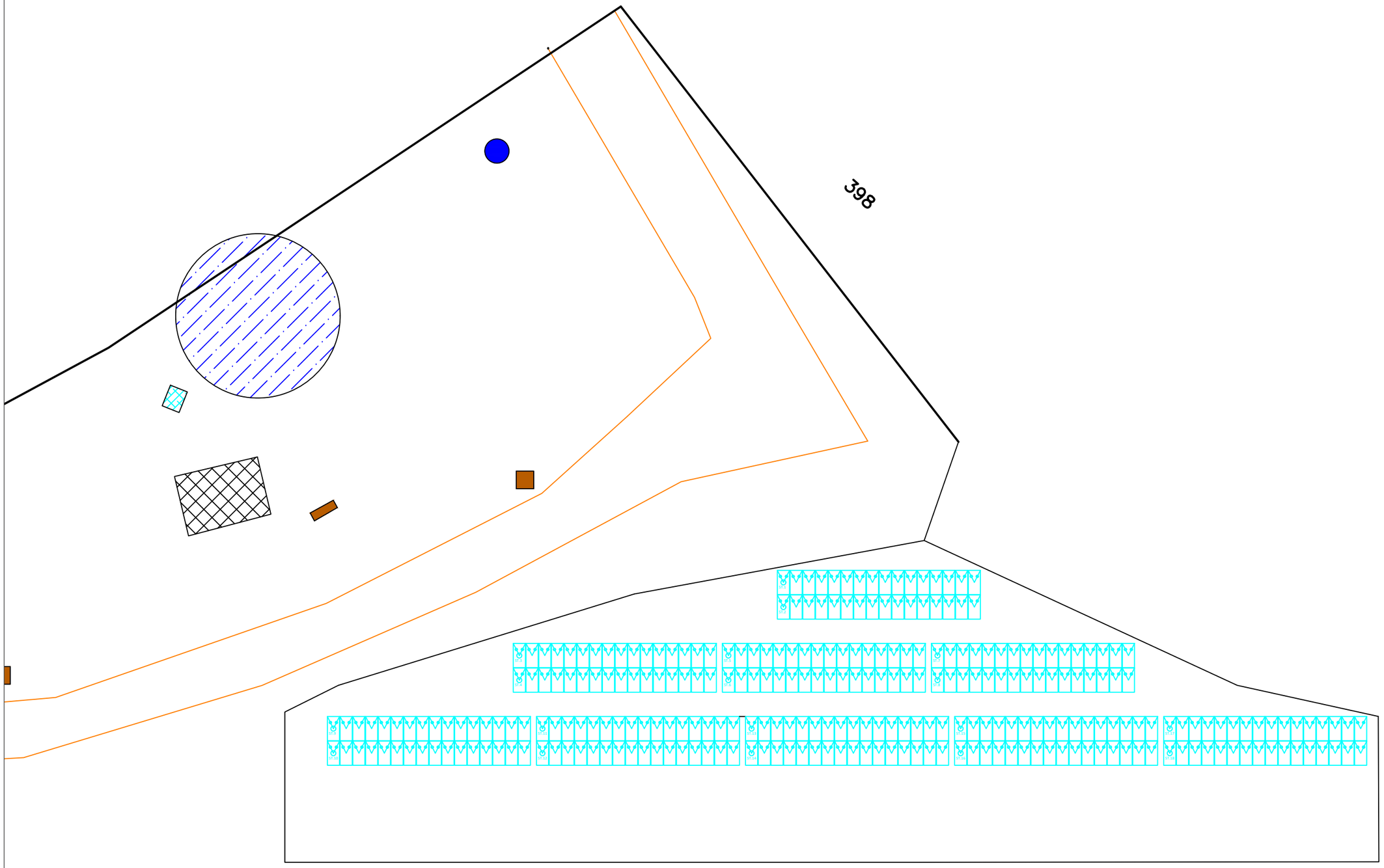
DRAWING NUMBER:

QLA-EL	PV	106	-
REFERENCE	DIVISION	SHEET NO.	REV.

SCALE : N.T.S	DATE : SEPTEMBER 2019
DISCIPLINE : SOLAR	PHASE : DESIGN

ARCH | CIVIL | MECH | ELECT

مصلحة الدراسات والمشاريع



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LEGEND:

- SOLAR PANEL
- CB.01 — COMBINER BOX
- JB.01 — JUNCTION BOX
- INV-01 — INVERTER
- CABLE TRAY

REV.	DATE	DRAWN	DESIGNED	CHECKED
0	09/2019	M.ZEIN	M.ZEIN	H.ROUMMANI

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REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOUTH LEBANON WATER AND WASTE WATER ESTABLISHMENT (SLWWE)

PROJECT NAME:

QLAILEH
WELL #2

.\logo.jpg

مؤسسة مياه لبنان الجنوبي

DRAWING TITLE:

100kWp SOLAR FARM
PV PANELS LAYOUT

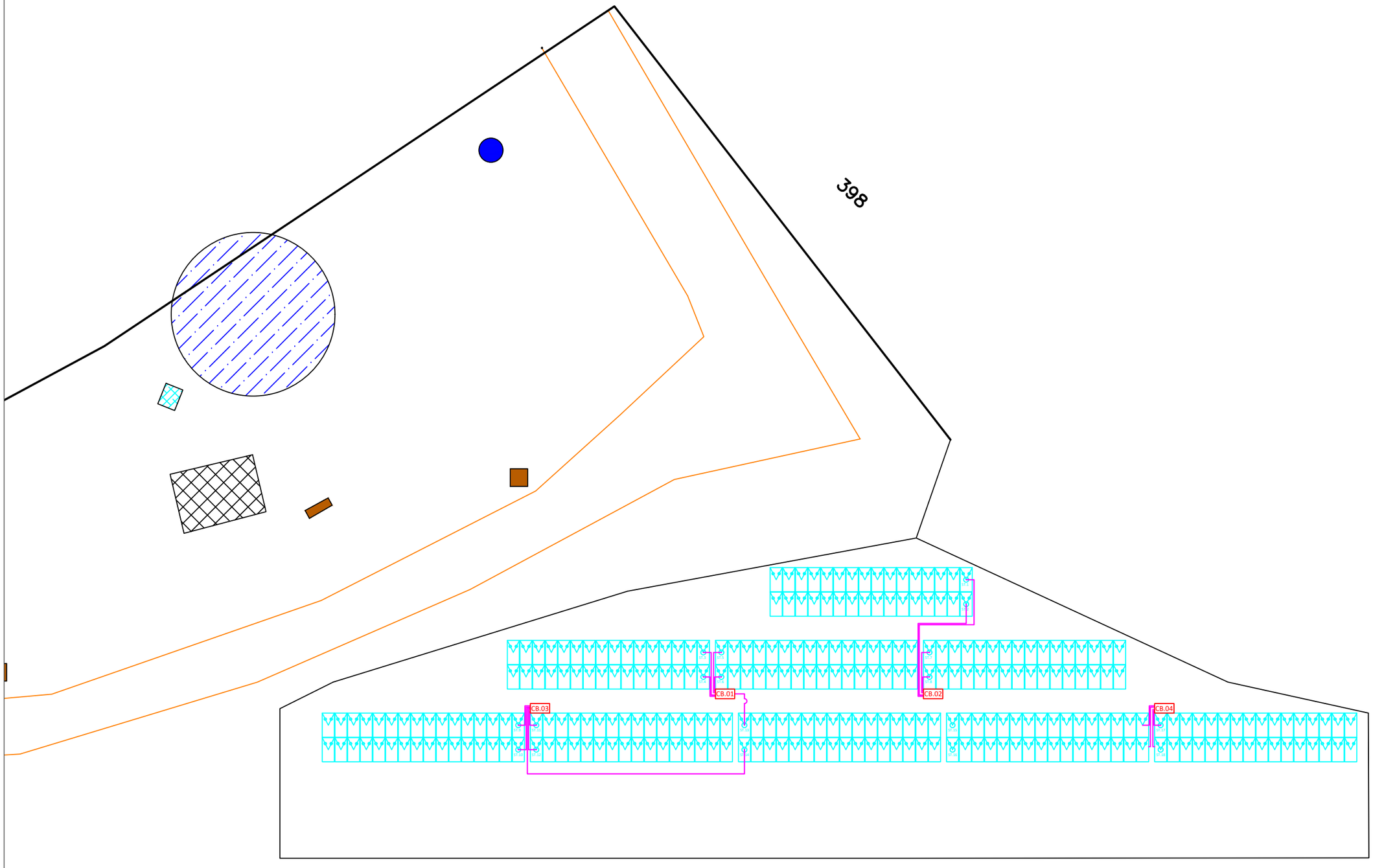
DRAWING NUMBER:

QLA-EL	PV	107	-
REFERENCE	DIVISION	SHEET NO.	REV.

SCALE : N.T.S	DATE : SEPTEMBER 2019
DISCIPLINE : SOLAR	PHASE : DESIGN

ARCH	CIVIL	MECH	ELECT
			X

مصلحة الدراسات والمشاريع



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LEGEND:

- SOLAR PANEL
- CB.01 — COMBINER BOX
- JB.01 — JUNCTION BOX
- INV-01 — INVERTER
- CABLE TRAY

REV.	DATE	DRAWN	DESIGNED	CHECKED
0	09/2019	M.ZEIN	M.ZEIN	H.ROUMMANI

CLIENT:

REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOUTH LEBANON WATER AND WASTE WATER ESTABLISHMENT (SLWWE)

PROJECT NAME:

QLAILEH
WELL #2

.\logo.jpg

مؤسسة مياه لبنان الجنوبي

DRAWING TITLE:

100kWp SOLAR FARM
STRING CONNECTION LAYOUT

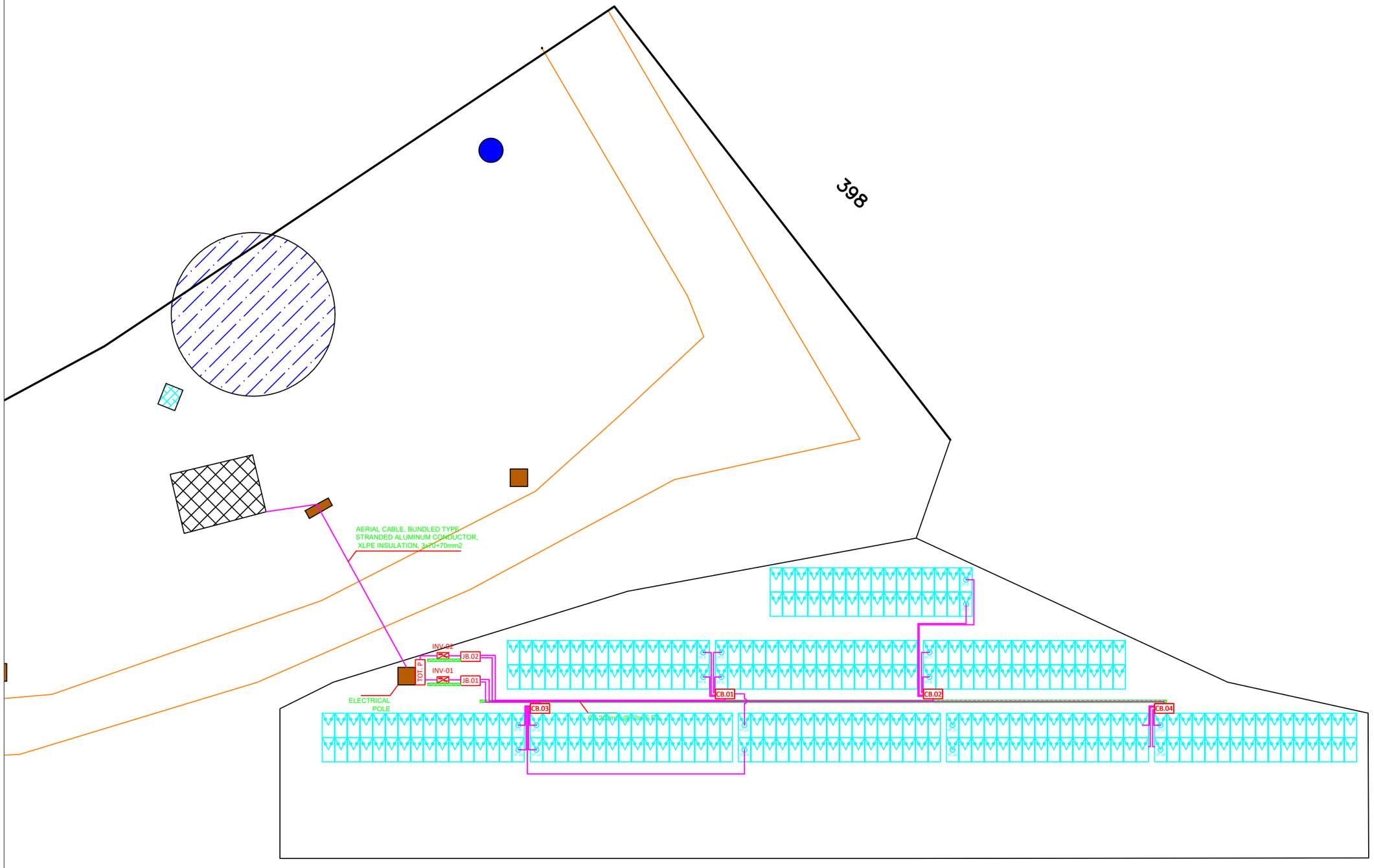
DRAWING NUMBER:

QLA-EL	PV	108	-
REFERENCE	DIVISION	SHEET NO.	REV.

SCALE : N.T.S	DATE : SEPTEMBER 2019
DISCIPLINE : SOLAR	PHASE : DESIGN

ARCH	CIVIL	MECH	ELECT
			☒

مصلحة الدراسات والمشاريع



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LEGEND:

- SOLAR PANEL
- CB.01 — COMBINER BOX
- JB.01 — JUNCTION BOX
- INV-01 — INVERTER
- CABLE TRAY

REV.	DATE	DRAWN	DESIGNED	CHECKED
0	09/2019	M.ZEIN	M.ZEIN	H.ROUMMANI

CLIENT:

REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOUTH LEBANON WATER AND WASTE WATER ESTABLISHMENT (SLWWE)

PROJECT NAME:

QLAILEH
WELL #2

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مؤسسة مياه لبنان الجنوبي

DRAWING TITLE:

100kWp SOLAR FARM
TRENCHING AND RACEWAYS LAYOUT

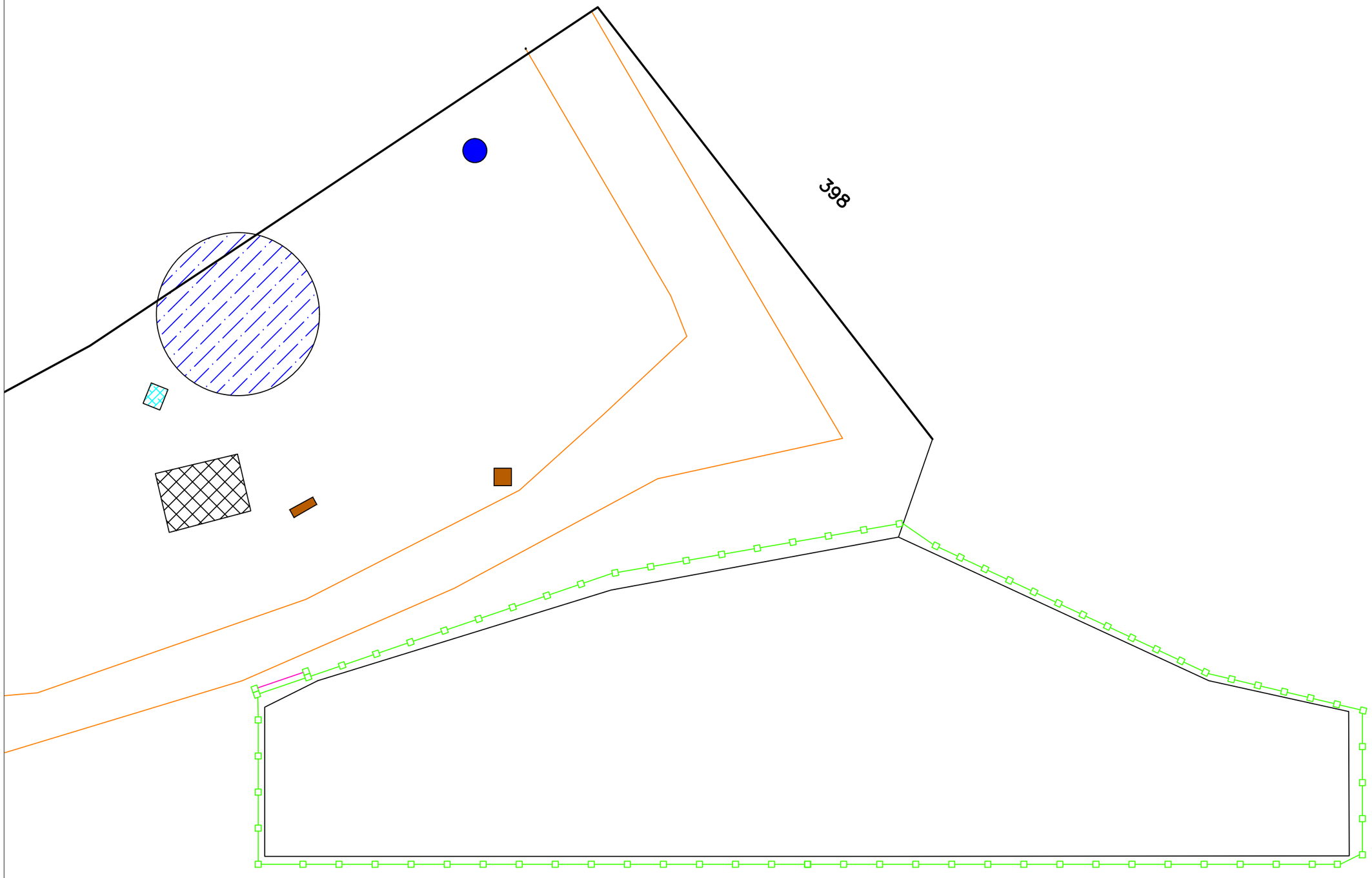
DRAWING NUMBER:

QLA-EL	PV	109	-
REFERENCE	DIVISION	SHEET NO.	REV.

SCALE : N.T.S	DATE : SEPTEMBER 2019
DISCIPLINE : SOLAR	PHASE : DESIGN

ARCH	CIVIL	MECH	ELECT
			X

بصلحة الدراسات والمشاريع



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CLIENT:

REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOUTH LEBANON WATER AND WASTE WATER ESTABLISHMENT (SLWWE)

PROJECT NAME:

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QLAILEH
WELL #2
مؤسسة مياه لبنان الجنوبي

DRAWING TITLE:

100kWp SOLAR FARM
FENCING LAYOUT

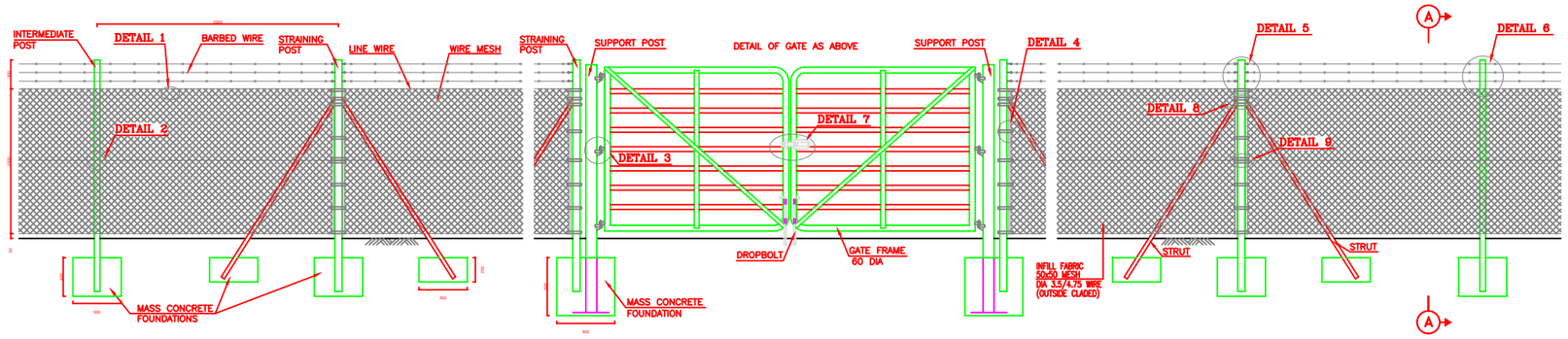
DRAWING NUMBER:

QLA-EL	PV	110	-
REFERENCE	DIVISION	SHEET NO.	REV.

SCALE : N.T.S	DATE : SEPTEMBER 2019
DISCIPLINE : SOLAR	PHASE : DESIGN

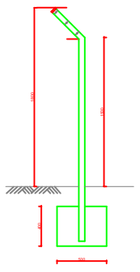
ARCH	CIVIL	MECH	ELECT
			X

بصلاحة الدراسات والمشاريع

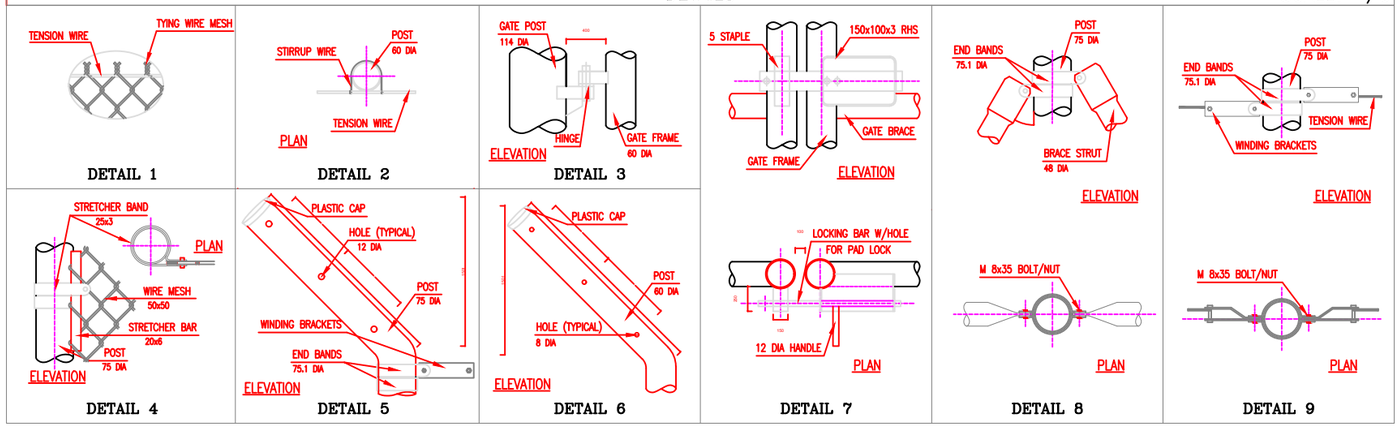


GATE AND FENCE (1.8m HIGH)

Scale 1/25



DETAILS SCALE: 1/5



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MINISTRY OF ENERGY AND WATER
SOUTH LEBANON WATER AND WASTE WATER ESTABLISHMENT (SLWWE)

PROJECT NAME:

QLAILEH
WELL #2

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مؤسسة مياه لبنان الجنوبي

DRAWING TITLE:

100kWp SOLAR FARM
FENCING TYPICAL DETAILS

DRAWING NUMBER:

QLA-EL	PV	111	-
REFERENCE	DIVISION	SHEET NO.	REV.

SCALE : N.T.S	DATE : SEPTEMBER 2019
DISCIPLINE : SOLAR	PHASE : DESIGN

ARCH	CIVIL	MECH	ELECT
			X

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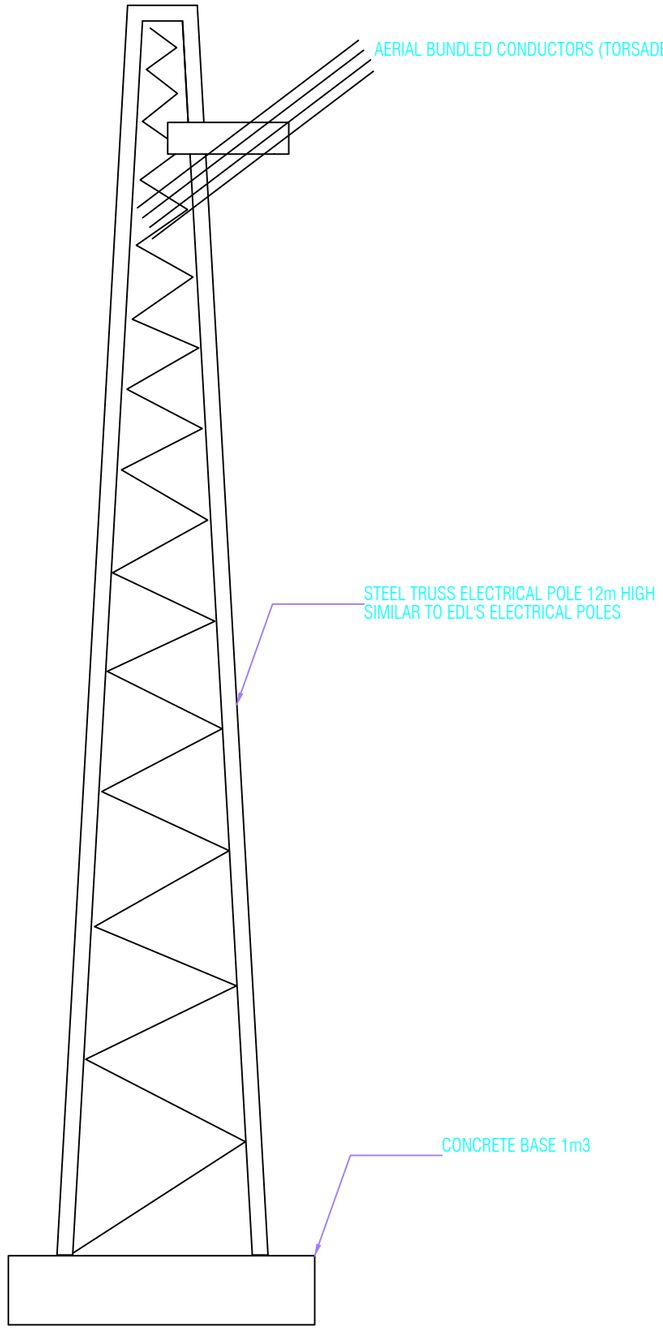

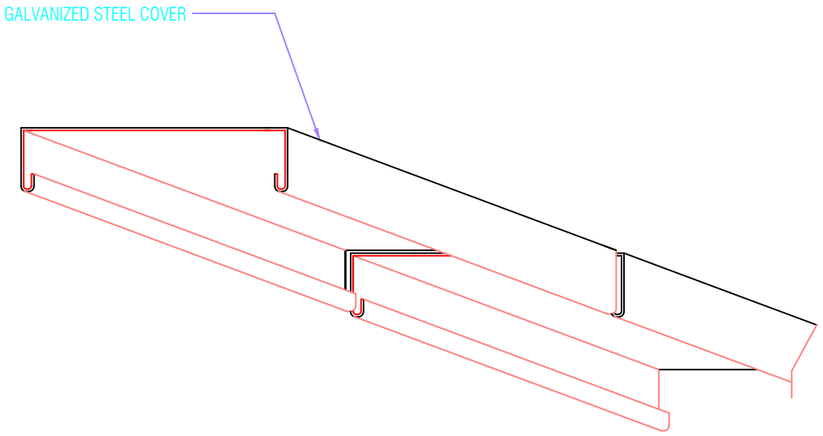

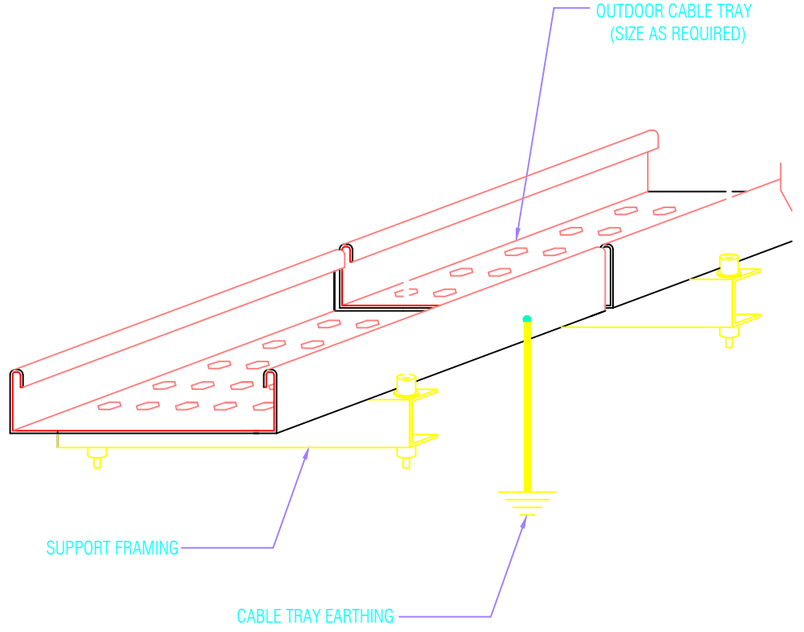

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MINISTRY OF ENERGY AND WATER
SOUTH LEBANON WATER AND WASTE WATER ESTABLISHMENT (SLWWE)

PROJECT NAME:

QLAILEH
WELL #2

.\logo.jpg

مؤسسة مياه لبنان الجنوبي

DRAWING TITLE:

100kWp SOLAR FARM
ELECTRICAL POLE & CABLE TRAYS DETAILS

DRAWING NUMBER:

REFERENCE	DIVISION	SHEET NO.	REV.
QLA-EL	PV	112	-

SCALE : N.T.S	DATE : SEPTEMBER 2019
DISCIPLINE : SOLAR	PHASE : DESIGN

ARCH	CIVIL	MECH	ELECT
			X

مصلحة الدراسات والمشاريع

1-2 الشروط الفنية

توريد وتركيب وتشغيل نظام طاقة شمسية كهروضوئية 72.8 kWp لمحطة القليلة بئر رقم 2

(72.8 kWp PV Solar Pumping System)

لزوم مؤسسة مياه لبنان الجنوبي

لعام 2019

Part 1 General

1. Datasheet Requirement

- Provide relevant documentation, including manufacturer datasheets for suppling any items.
- Bidders are responsible for providing equipment/products datasheets, catalog pages, and certificates of compliance to standards that clearly show the specification of the material to be supplied.
- The supplier must provide as built s hop drawings for wiring.
- The supplier must provide the official required product warranties
- All documentation shall be arranged in a folder with a clear table of contents for easy lookup of references.
- The documentation shall be provided in two hard copies, and one soft copy.
- The supplier must provide call-email technical support on request

2. ISO 9001 Certification

- Imported manufactured products and equipment shall comply with their relevant international standards. The quality assurance of all imported goods shall be granted the ISO 9001 certification.
- Manufactured products and equipment shall comply, manufactured & design with US or Western European Standards. ISO 9001 certification for main manufactured goods is essential for the following items: PV module, mounting structure, inverters & DC cables. However other goods shall be approved by SLWE Engineer.

3. Eligibility Criteria

- Famous European or American manufacturers of Solar Cells and PV Modules is highly recommended in the bidding.
- The firm should also have experience in installing solar PV power plant with different technologies modules. (Please attach copies of PO's and completion / satisfactory report in support of the same)
- The bidder should meet all above criteria, and is mandatory for the eligibility.
- The bidder should have long experience and expertise in field of Solar PV Domain, and must have designed, manufactured, supplied, installed & commissioned similar projects for last five years cumulating**.** The firm should also have experience in installing solar PV power plant with different technologies modules.
- The bidder responsible for estimating the energy cost savings by installing solar farm
- The bidder site visit is a must.
- Bidder should submit list of similar PV projects

4. Solar Access & Shading Analysis

- A detailed shading analysis should be conducted on the site so that system performance can be accurately estimated. Also, the shading estimate should be calculated over a whole year. Where tilt frames are used, the designer shall ensure there is adequate spacing between rows of tilted modules, to avoid each row of modules shading the row behind them.

5. Drawings, Reports and Documents

5.1 Drawings

- All works shall be performed in accordance with the drawings furnished with the Contract documents and any such additional drawings as may be issued by SLWE Engineer from time to time during the progress of the work or any drawing furnished by the Contractor and approved by the SLWE Engineer. Additional drawings (if any) will be furnished to the Contractor in due time so as to enable him to perform the work shown thereon in its proper sequence and for any advance planning that may be necessary for the efficient performance of such work.
- The Engineer will decide in each instance whether additional drawings are required for advance planning of the works and determine the time required for same. In all cases, detailed shop drawings for all components of the Works shall be prepared by the contractor, after the approval of all related equipment items. The design and the shop drawings shall be submitted to the SLWE engineer who shall within 30 days approve, reject or ask the Contractor to revise or modify such documents and resubmit them for approval. All these documents shall be approved by the Engineer prior to commencement of the work.
- The contractor shall provide detailed layout plans and wiring diagrams along with his proposal. The drawings shall consider the following: Dimensions of arrays, including tilt and orientation, The total number of modules, DC and AC cables routing, location of the inverters, junction boxes, circuit breakers, DC isolator, surge arrester, ….

5.2 Records and “As-built” Drawings

- After the work has been completed, the Contractor shall furnish “as-built” drawings prepared whilst surveying during construction, showing the Works as constructed together with all other information that may either be required or be useful for the operation and maintenance of the Works in the future
- Unless specific items are included in the bill of Quantities, the cost of preparing the shop drawings, “as-built” Drawings and Records shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately. The As-built Drawings shall be submitted, if required by the Engineer, on computer diskettes.

5.3 Ownership of Drawings and Documents

- The Drawings and documents are issued to the Contractor for the purpose of the execution of the Works under the Contract and shall remain the property of the Employer to whom they are to be returned by the Contractor after completion of the work, as a precondition for the issue of the Certificate of Completion.

6. Labelling and signage

- Contractor responsible for labeling all AC and DC isolating switches need to be appropriately identified, in particular for strings and multiple inverters.
- Contractor responsible for Customized labels may be required for the System Shutdown Procedure, and numbered labels for the DC isolators, AC isolators and inverters.
- Contractor responsible for labeling multiple sub arrays connected to an inverter, and there are several DC isolators adjacent to the input, the isolators need to be suitably grouped to allow for isolation of the inverter, and labelled with a warning notice to indicate the need to shut off multiple supplies to isolate the equipment.
- In particular, if an inverter is connected to a distribution board or sub-board, signs shall be installed in prominent positions on the main switchboard and all intermediate distribution boards. This ensures that personnel working on other parts of the electrical installation will be aware that the system has multiple supplies, and how to isolate parts of the system safely.
- The contractor shall supply and install safety signs which shall be treated against oxidation, and supplied with the descriptions below:
  - Danger High Voltage
  - Warning do not touch
  - The minimum dimensions of the safety signs must be 20 cm height and 50cm length.

WARNING

DUAL SUPPLY

ISOLATE SOLAR SUPPLY AT

DISTRIBUTION BOARD DB01

Example sign for a main switchboard or intermediate distribution switchboard when Inverter Energy System (IES) is connected to a subsequent distribution switchboard

7. Materials

7.1 General

- Materials failing to comply with the Specifications shall be immediately removed from the Works, at the Contractor's expense.

7.2 Approval of Materials

- Before entering into any sub-contract for the supply of any material or goods, the Contractor shall obtain the Engineer's approval in writing of the manufacturers and/or suppliers from whom he proposes to obtain such materials or goods. If requested, the Contractor shall submit to the Engineer samples of such materials and shall have them tested.
- The Engineer, at any time, be dissatisfied with such material or goods or with the methods of production or operation carried out at the manufacturer's or supplier's works or place of business, he shall be empowered to cancel his previously given approval of such supplier and to specify any other supplier whom he may choose for the supply of such material or goods. The Contractor shall then obtain such said material or goods from such other supplier and shall bear any additional costs thereof.
- Materials which, in the opinion of the Engineer, do not comply with the Specification, shall be classified as rejected materials and shall be cut out and removed from the Works and replaced as directed by the Engineer, at the Contractor's own expense.

7.3 Alternative Materials

- Where brand names or products of a specific manufacturer are specified in the Contract, the Contractor may, subject to the Engineer's approval (which shall not be unreasonably withheld) supply alternative materials, having similar characteristics and showing performance and quality at least equal to those specified.
- Whenever the Contractor wishes to propose an alternative material he shall submit detailed information concerning the type of material and/or product, the Vendor's name, drawings if required, test certificate, etc. If the alternative material is not approved by the Engineer, the Contractor shall supply the material originally specified in the Contract.
- If the price of the approved alternative material is in excess of the material specified in the Contract, the Contractor shall not be entitled to extra payment over the rates in the Bill of Quantities.

8. Lifting Equipment and Loading (Material Handling)

- Contractor responsible for mechanized lifting equipment (cranes, scissor lifts etc.) will generally be required for getting PV system components installation or for moving heavy components.
- All materials shall be of the best quality throughout. Materials delivered to the Works shall be equal in all respects to the samples approved by SLWE Engineer. The methods of stocking, mixing, transporting, fixing, placing and applying all materials

shall be in compliance with the specifications and to the approval of the Engineer, who shall be kept advised of any change of plan.

9. Project Sign Board

- Content The single signboard must provide the following information:
  - Owner
  - Donor
  - Project Name
  - Designer & Consultant
  - Contractor
  - The names and titles of main contractor and SLWE project engineers
  - Project Duration
- Sign Board design drawing, dimension, painting, printing and material should be submitted and approved due to the satisfaction of the Engineer (SLWE Engineer).

Part 2 Civil Works

1. Support Structure for PV Array (Ground Zones)

1.1 Product Specifications:

- The support structure material shall be galvanized
- The structure should be fixed by concrete foundation of withstanding a wind load of 150 km/hr after installation (approved by SLWE civil engineer).
- Tilt angle shall be 28 degree facing true south direction
- Minimum clearance of the structure from the ground-roof level should be at least 200 mm.
- The elevated structure has to be Securely anchored to the supporting surface.
- Concrete foundations of appropriate weight and depth for elevated structures mounted directly on the ground, bolted with anchor bolts of appropriate strength for elevated structures mounted.
- The structures shall be designed for simple mechanical on-site installation. Access for panel cleaning and maintenance all solar panels must be accessible from the top for cleaning and from the bottom for access to the module-junction box.
- Welded Mounting system is not acceptable.
- The work shall be carried out as per the designs approved by the SLWE.

1.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- Tilt and orientation of PV have to be optimized for max efficient 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.
- Modules must have installed in such a way that the junction box is to the side or at the bottom, care must be taken to ensure this is permitted by the manufacturer.

1.3 Submittals

- Full details, catalogues and product manufacturer datasheet.
- Provide the recommended maintenance for the mounting structure (provide maintenance checklist sheet)
- Shade analysis
- Layout for the Support Structure for PV Array including all the connections, arrangement, tilt angle to the horizontal, strings…
- Essential official manufacturer certifications must be achieved and submitted: ISO 9001, ISO 14001, OHSAS 18001, TUV, SGS…
- Official manufacturer warranty paper for minimum duration 10 years (warranty includes all the mounting structure components)

Proposed land for panels mounting structure (solar farm)

2. Support Structure Clamps

2.1 Product Specifications

- Clamp material should aluminum
- Clamps must be Compatible to the PV module that will be used
- The clamp dimensions and thickness should be withstanding a wind load of 150 km/hr.

2.2 Installation Requirement

- Solar modules should be attached to the array structure using the mounting holes provided by the manufacturer & via clamps.
- When using clamps, the solar panel manufacturer's installation manual 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 module
- Attaching a solar module in such a manner (e.g. drilling, pop riveting) that causes a hole in the anodized aluminum 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.

2.3 Submittals

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

3. Reinforced Concrete Foundation for the Mounting Structure

3.1 Product Specifications:

- All concrete foundation shall be completely or partially buried under ground.
- Foundation for the mounting structure shall comply with the following minimum specification
- Reinforced concrete with a steel cage shall be used for all footings.
- Concrete shall be suitable to withstand compression of 30 Mpa on 28 days.
- Anchor bolts ("J" or "L"), 2 or 4 bolts per base for mounting structure bases.
- The contractor is responsible of conducting the foundation design and determine the required reinforcing steel and the required embedment length of the 4 bolts and that the provided foundation dimensions are adequate.
- Concrete base shall be troweled, brushed, edged, and finished in a neat manner.

3.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).

3.3 Submittals

- Full details drawing for the reinforced concrete foundation

4. Trenches for Cable Ducts

4.1 Product Specifications:

- Cable Route Markers Cable route markers shall be constructed of reinforced concrete and shall be of dimensions to be approved by the engineer
- The trench shall be excavated to a depth indicated on the drawings for the different cables. Where depths are not indicated on the drawings, the following shall apply: For MV cables 1,0 m and for all LV cables the trench shall be deep enough so that the top layer of LV cables is buried a minimum of 500 mm below final ground levels.
- Cut trenches to width indicated on drawings. Remove water or materials that interfere with Work.
- Bottom of trenches shall be pipe invert level in addition to the thickness of the pipe and pipe bedding.
- Excavate trenches to depth indicated on drawings. Provide uniform and continuous bearing and support for bedding material of utilities.
- Backfill must be done by the contractor

4.2 Installation Requirement

- The cable trench shall be excavated along the routes indicated on the relevant drawings. The trench shall be absolutely straight and shall comply with all requirements. The Engineer shall determine the length of the trench to be excavated, which shall not exceed 400 m, before the cable is installed and the trench backfilled. If any obstacle or interference should be encountered which may require alterations to the trench or routes, such alterations shall receive prior written approval of the engineer.
- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- The bottom of the trench shall be level and shall follow the contours of the final ground level. Where the excavation is in excess of the required depth, the excavation shall be backfilled and compacted with suitable material to the required depth.
- The Contractor shall trim the trenches and clean up the bottom of the trenches after he has completed the required excavation. Bedding and cables shall not be laid until the trench has been approved by the engineer. Where bedding has already been laid the Engineer may instruct the Contractor to demonstrate that the minimum thickness of bedding has been provided for before authorizing cable laying to proceed.
- The Contractor shall remove all sharp projections, which could damage the cable where the trench is excavated through rocky formations, and shall remove all loose rocks, material, etc from the bottom of the trench.
- Once the excavations for cable trenches and joint pits have been completed, the Contractor shall give the Engineer 24 hours' notice to inspect the trench and to be present when the measurements are made. No inspections shall be undertaken on Saturdays, Sundays and public holidays.

- Full detail of the cable trench dimensions and classification of the type of excavation shall be recorded and signed by the Contractors representative and the engineers representative as the final quantities for such excavations. Inspections and recordings shall be completed before the installation of any bedding or backfilling. The Contractor shall be responsible to keep all records as proof of progress and as basis for claims for payment.
- The method to be used for laying cables shall be approved by the Engineer prior to the commencement of the laying of the cables.
- The maximum tension on a cable during laying operations shall not exceed the value specified by the manufacturer.
- When subsurface materials at bottom of trench are loose or soft, notify the Engineer and request instructions, then excavate to greater depth as directed.
- Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

4.3 Submittals

- Trench drawing with dimensions (need to be submitted to SLWE engineer for approving before execution)
- As build trench trajectory (need to be submitted to SLWE engineer for approving before execution)

5. Precast Concrete Manhole

5.1 Product Specifications:

- Precast or cast-in-place reinforced concrete manholes and structures, with masonry transition to cover frame,covers, steps, anchorage and accessories.
- Shape: square
- Grout pipe entrances.
- Grout base of manhole to achieve slope to manhole channel. Trowel smooth.

5.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).

5.3 Submittals

- Manhole(s) drawing with dimensions (need to be submitted to SLWE engineer for approving before execution)
- Manhole(s) locations (need to be submitted to SLWE engineer for approving before execution)

6. Earthing Excavation

6.1 Product Specifications:

- The brief scope of work shall be carrying out necessary excavation, providing and fixing of earth electrode with GI pipe and funnel, providing and filling of soil enhancement material, construction of earth pit chambers, Providing earth pit cover, painting of earth pit covers, measurement of earth pit resistance and connecting the earth pit to earth grid/equipments conforming to IS- 3043.
- Funnel with a mesh shall be provided on the top portion of the earth electrode for watering purpose.
- GI earthing strip welded to the earth electrode at the top shall have hot dip galvanized coating of not less than 10 microns' thickness.

6.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- Excavation shall be carried out by means of manual digging the soil where ever is practicable or by means of auguring the soil. After excavation broken lumps and stones, if any, are to be removed from the earth pit.
- The job includes measurement of resistance of the new earth pits when connected to grid as well as individually.
- The values will be tabulated and submitted to SLWE Engineer-in-charge.
- If the individual earth pit resistance is not within the limits (10 ohms) then soil enhancement material shall be added or new earth pit shall be provided.

6.3 Submittals

- Earth pit(s) drawing with dimensions (need to be submitted to SLWE engineer for approving before execution)
- Earth pit(s) locations (need to be submitted to SLWE engineer for approving before execution)

7. Fencing and Gate

7.1 Product Specifications:

- Fence comprising concrete parapets and metal fence with all necessary accessories; and gates.
- The bidder shall supply and install galvanized steel perimeter fencing to surround and secure the complete solar power plant. All associated equipment within the scope of supply shall be enclosed within the fence, except for items installed in already secured electrical or mechanical rooms.
- The Fence shall include all necessary foundation, fixing, supports and access gates to facilitate the operation and maintenance of the plant.
- For more details about the fencing layout and specifications, refer to the drawings.
- Fencing and gate work should include the excavation, backfill, cast-in-place concrete, metal fabrication and paints and coatings.
- All fences, gates and wickets shall be in accordance with the layout and details shown on the Drawings and/or described in the particular specification.
- The ground along the fence alignment shall be levelled so as to provide an even gap between the bottom wire and the ground surface.
- All main and tie wires, all barbed wires and all other metal parts shall be hot-dip galvanized, unless otherwise specified or directed.
- Unless otherwise specified or directed, the entrance gates shall be double leaf and wickets single leaf, to the widths and heights shown on the Drawings, fabricated form standard galvanized water pipe and fittings including bracing, and covered with 5 x 5 cm wire mesh made of minimum 3 mm diameter galvanized and plastic coated wire.
- Wherever shown on the Drawings or directed by the Engineer, the Contractor shall erect fences, gates and wickets.
- The gates shall be hinged to gateposts and shall be complete with locks and stops.
- All wires and metal parts shall be hotdip galvanized, unless otherwise specified or directed.
- Fences shall be measured for payment in linear meters of finished fence, as shown on the drawings.
- The rates under this Section shall include for all materials, equipment and labor required to complete the fences, gates and wickets in place, in accordance with the Drawings and Specification, and to the satisfaction of the Engineer.
- Minimum official manufacturer warranty paper for minimum duration 10 years.
- All accessories including fasteners and anchors, adhesive, sealer, etc., shall be to manufacturer's recommendations.
- Gate Types, Opening Widths and Directions: As per approved shop drawings.
- Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

7.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (MUNICIPALITY-SHEILD-SLWE Entity).
- The fence shall be stretched and fastened by means of approved fasteners, to the satisfaction of the Engineer. Stretching shall not be commenced until the concrete foundations have sufficiently hardened and in no case before 14 days from the pouring of the foundations.
- Installer: Company specializing in performing work of this section with minimum five years documented experience.

7.3 Submittals

- Shop Drawings: Indicate plan layout, spacing of components, parapets, foundation dimensions, hardware anchorage, gates, and schedule of components.
- Samples: Submit two samples of metal fence illustrating construction and finish.
- Submit data on posts, accessories, fittings and hardware.
- Full details, catalogues and manufacturer data.
- Provide the recommended maintenance for the system (provide maintenance checklist sheet)

Part 3 Photovoltaic Works

8. PV Module

8.1 Product Specifications:

- Brand manufacturer must be famous European or American brand
- Solar Panel Wattage at STC ≥ 350Wp
- Maximum Power Voltage (Vmp) ≥ 38V
- Open circuit voltage (VOC) ≥ 47.5V
- Short circuit current (ISC) ≥ 9.5A
- Module Type Mono Crystalline
- number of cells per module 72
- Module efficiency More than 17%
- Operating temperature -20°C to 70°C
- Module frame anodized Aluminum 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 environment factors for the worst situation at site.
- Sufficient encapsulation and sealing arrangements to protect the silicon cells from the harsh environment.
- Power tolerance Positive Tolerance +3% or +5W
- Higher cell efficiency with 4 Bus bars.
- Maximum load 5500 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 97% for the first 5 years after commissioning date, at least 90% for the 5-15 years after commissioning date, at least 85% for the 15 to 25 years after commissioning date.

8.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE 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 and take the approve from SLWE.

8.3 Submittals

- Full details, catalogues and manufacturer data.
- Data sheet 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)
- Essential official manufacturer certifications must be achieved and submitted: IEC 61215, IEC 61730, IEC 61701, UL 1703, IEC 62716 & IEC 60068.
- Essential official manufacturer must be achieved standard certifications: ISO 9001, ISO 14001.
- Provide electrical wiring diagrams:
  - Diagram showing the number of modules in series in a string
  - Diagram showing the number of strings in parallel in 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)

9. Solar Pump Inverter

9.1 Product Specifications:

- Contractor shall supply, deliver and install the solar pump inverters according to the following criteria:
- Rated power of the solar drives should be at least:
  - Qlayleh Water Well 1 75 KWe
- Nominal power is understood for high torque machines
- Minimum Protection class for solar pump inverter should be IP54
- Solar pump inverter should have a Solar Pumping Application software with integrated MPPT Functionality.
- Integrated input Noise Filter.
- Brand manufacturer must be famous western European made or north American made.
- Line voltage: 3 AC 380 V ... 480 V
- Rated power LO (kW): 110 kW
- Integrated with built in cooling system
- Built In DC link choke to filtering and controlling the DC bus voltage and current in a variable speed drive/inverter
- Ambient temperature: –10 °C to 40 °C without derating /to 60 °C with derating
- Integrated MPPT software
- Minimum efficiency 98%
- Integrated with Ethernet port
- Warranty for minimum duration 3 years (warranty includes all the VFD components)

9.2 Supplying Item(s) Requirement

- Supplying the item must be in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the supervising SLWE Entity.
- Contractor responsible for submitting list of equipment supplied with model, description and serial numbers.
- All inverter accessories (controller should be included)
- The Contractor shall be responsible for all off loading and handling of modules to SLWE warehouse and shall ensure that module is delivered properly protected against mechanical damage.
- Contractor should ensure all equipment is fit for purpose and correctly rated.
- The Contractor shall be responsible for open circuit voltage test for random PV modules and take the approve from SLWE.
- The item supplying must Include the control unit and all the inverter accessories
- The contractor should be available for inverter programming during the installation.
- The contractor shell provide all the technical support required during the installation phase
- Properly sized dv/dt filter for solar pump inverter shall be installed in accordance with inverter's manufacturer and application requirements.
- Pump operation selection through either DC Input or 3-Phases AC input of Inverter should be possible.
- Solar pump inverter should be equipped with communication ports: MODBUS/RS485 or other, allowing monitoring and control of inverter operation as well as interface with SLWE SCADA system.

- Proper external protection measures on AC and DC sides of solar inverter should be taken, including surge protection.
- Solar Pump inverter should be able to withstand Operating Temperatures of 60 °C.
- Meet relevant international standards such as EN 61800-1, EN 61800-3, EN 60204-1 or équivalent
- Any intervention on the inverter must be possible in full electrical safety. The necessary external protection devices need to be added in the immediate proximity of the inverter.
- Complete installation following recommendations by the manufacturer (minimum spacing, temperature of the room, etc.)

9.3 Submittals

- Full details, catalogues and product manufacturer datasheet.
- Warranty paper for minimum duration 3 years (warranty includes all the VFD components)
- Minimum manufacturer warranty of 2 years from commissioning.

10. PV Cables

10.1 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 that use for installation of solar system must be of solar grade which can withstand harsh environment 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 +80°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 minimum duration 10 years on material and manufacturer.

10.1 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- The Contractor must ensure that all DC cables specified are rated to handle the PV array maximum voltage.
- For cables installed near, or in contact with PV modules, the operating temperature should be considered to be equal to 80°C.
- Cable routing/ marking: All cable/wires are to be routed in pipes and suitably tagged and marked with proper manner so that the cable easily identified and not subject to damage.
- The ratings given are approximate. the supplier must indicate size and length as per system design requirement.

10.2 Submittals

- Full details, catalogues and product manufacturer datasheet & wiring diagram.
- Shop drawings showing exact wire routing
- 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.

11. MC4 connector

11.1 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)

11.2 Installation Requirement

- - Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).

11.3 Submittals

- Full details, catalogues and product manufacturer datasheet.
- Official manufacturer certifications must be achieved and submitted for the following: TUV, ROHS, CE
- Official manufacturer warranty paper for minimum duration 10 years on material and manufacturer.

12. DC Combiner Box

12.1 Product Specifications:

- Enclosure type outdoor use, double housing, Protection class IP65 and must be waterproof, dustproof, rustproof.
- Dc input fuses for each String 1000VDC , 10ADC (or larger)
- SPD Cutoff voltage Dc 500V
- Nominal Discharge Current 20KA or higher
- Imax (8/20)
- Voltage protection level 2.5Kv or lower
- Reverse protection (2dual blocking diodes) 52 ADC ,1000 VDC
- Operational Environment Temperature -30 °C ~+70 °C

12.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- Includes suitable DC fuses on each (+) and (-) polarities.
- Includes Protective devices against surge overvoltage suitable for photovoltaic systems. Using Type I plus II SPD (Surge Protective Devices) with fault signal
- Includes DC disconnect switch for load breaking
- Physical separation of positive and negative terminal blocks
- Voltage Protection Each String with over voltage and current protection, Anti-backflow diodes & anti-reverse protection.
- Glands size includes appropriate output cable glands & safety labels.
- Combiner Box shall be made of Corrosion resistance material and provided with lockable door and equipped with touch DC fuse-holders, DC fuses, reverse protection diodes, DC surge arrester and load disconnect switches.
- Installations are expected to last at least the lifetime warranty of PV modules (about 25 years), so installing durable, long-lived equipment that will stand up to the environment in which it is placed is critical. Combiner boxes should be Corrosion resistance, Durable, Rust proof, Abrasion resistant, reliable, lockable door, Longer service life, Sun shields (Available from top, sides, and door).
- Water ingress into DC wiring systems can result in arcing and fires.
- Only manufacturer-provided entry points shall be used.
- Penetrations shall be sealed following manufacturer's instructions including using glue or nylon tape if necessary.
- Installers shall make penetrations at the lower entry face first. Entry points on the vertical side are only used if essential. The top entry face penetrations are not permitted.

- Where the entry/exit to an enclosure is a cable gland, the following conditions shall be met:
  - The gland shall be rated to at least IP 56.
  - Where multiple cables go through one gland, a multi-hole cable gland shall be used.
  - Where a multi-hole cable gland is used, each cable shall go through an appropriately sized hole.
  - Products like silicone are not appropriate as a primary means of sealing.

12.3 Submittals

- Full details, catalogues and product manufacturer datasheet & wiring diagram.

13. DC Isolator

13.1 Product Specifications:

- Each “leg” of the DC isolator (positive or negative conductor) must be rated to break the full PV array maximum voltage.
- DC isolators shall also be adequately rated to break the full load current, or potential fault currents from the array.
- Switching OFF Lock

13.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer’s recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- Isolators shall not be installed mid string. For example, where one electrical string is split over different roof faces (all faces are at the same orientation), one isolator is required at the point where the PV panel wiring transitions from the PV array to the fixed wiring to the inverter at the array.
- Isolators shall not be fixed on any portion of the panel.
- Isolators shall be labelled “PV ARRAY DC ISOLATOR”.
- Isolators shall be rated for DC use.

13.3 Submittals

- Full details, catalogues and product manufacturer datasheet & wiring diagram.

14. PV System Monitoring & Sensors

14.1 Product Specifications:

- Supply, installation and commissioning of online data system with all necessary sensors and accessories
- Weather station must be connected for monitoring the wind speed/direction, Ambient Air temperature & global irradiance sensor with the proper Modbus needed.
- Monitoring and control (installation and supply of irradiance sensors, DC Current and Voltage Transducers, AC Meters, Temperature Gauge, ATS, GCU and synchronizer if required, Energy Management and Display Unit, and Fastening Brackets)
- Data logger with remote monitoring (installation and supply of data logger, evaluation software and fastening brackets)
- The plant parameters shall be measured by using SCADA or Equivalent system to monitor, maintain, and control the plant, and also to study the plant performance.
- The plant monitoring parameters shall include:
  - PV array energy production: Digital Energy Meters to log the actual value of AC/ DC Voltage, Current & Energy generated by the PV system shall have to be provided.
  - Solar Irradiance: An integrating Pyranometer (Class II or better) shall be provided, with the sensor mounted in the plane of the array. Readout shall be integrated with data logging, system.
  - Temperature: Temperature probes for recording the Solar panel temperature and ambient temperature shall be provided.

14.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- Recording energy generation data to confirm that the system performance is in line with the performance estimate. (DNS meters, which usually only record exported energy, do not provide suitable information for this purpose.)
- Collecting diagnostic data and fault notification from the inverter(s), so that system faults can be rectified as quickly as possible.
- The contractor should provide appropriate information to the installers so that the monitoring system can be installed, configured and tested.
- The following physical requirements should be considered:
  - Network access – wired, wireless or mobile (e.g. passwords, network IDs, etc.)
  - Physical network connection
  - Power supply requirements for monitoring devices
  - Physical wiring to sensor devices (e.g. irradiance, wind, temperature, string / panel monitoring).

14.3 Submittals

- Full details, catalogues and product manufacturer datasheet & wiring diagram.
- Online account (user name & password)

Part 4 Electrical Works

15. AC Cables

15.1 Product Specifications:

- Sizes of cables between Inverters, loads… is selected carefully to keep the voltage drop of the entire solar system to the minimum (not exceed 3%).
- Cables shall have stranded copper conductors for required sections depend on the max power that the wire will be used for
- Cable cores shall be color coded for identification.
    - "Red", "Yellow" and "Blue" shall be used for phase conductors.
    - "Black" for neutral.
    - "Green / Yellow" for earth conductors.
- 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 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 a mineral ceramic fire resistant tapes and a 90°C, cross-linked insulation, bedded with an extruded of 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.

15.1 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- For proper cabling an electrical utility pole (EDL pole design) is needed to be Supplied installed and commissioned with proper location as mentioned in drawings.
- 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 point of attachment to the main switchboard; and, 1% from the main switchboard to inverter terminal (including via any distribution boards).

15.2 Submittals

- Full details, catalogues and product manufacturer datasheet & wiring diagram.

16. Conduits and Wireways

Product Specifications:

- Work is deemed to include:
  - Heavy gauge PVC rigid conduits.
  - Heavy gauge steel conduits and 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 5 cm.
  - 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.
- Rigid Heavy Gauge Steel Conduits and Fittings
  - Conduits and fittings shall be of heavy gauge drawn and welded steel, screwed galvanized and not less than 20 mm external diameter.
  - Conduits shall be free from rust patches or mechanical damage and shall be adequately protected from damage whilst stored on site. All exposed threads, die marks and other abrasions shall be painted with two coats of an approved metallic paint immediately the conduit is installed.
  - Steel conduits and fittings shall comply with BS 4568 part 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 protected by two pack epoxy finish, 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 engraving 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.

16.1 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- The installation and capacity of the conduits shall be in accordance with the IEE Wiring Regulations.
- The installation shall be neat and tidy.
- Means shall be provided to prevent condensed or entrapped moisture remaining within the conduit system.
- The conduit system, joint boxes, loop boxes etc. shall be firmly supported.
- The system shall be clean and free of sharp edges, burrs etc.
- Due allowance shall be made for expansion and contraction.
- PVC rigid conduit to be formed on site. Prefabricated conduits shall not be accepted.
- Standard circular or looping in boxes shall be installed at intersections. Small circular channel type inspection fittings will not be approved.
- Cables connected to different category circuits shall not be run thru a common box.
- Standard conduit boxes shall be installed at all lighting points and shall be substantially fixed so as to be supported independent of the conduit system.
- Conduits shall terminate directly into fixed lighting fittings having provision for direct conduit entry.
- Conduit shall be installed at least 100 mm clear of, and preferably above, pipes and any other services.
- Under no circumstances shall accessories of one conduit system type be used with
- another type (e.g. black accessories may not be used with galvanized conduit).
- Not more than two right angle bends shall be allowed in any surface mounted conduit run without provision of an inspection fitting for drawing in purposes between them.
- Surface mounted Conduits shall not be dismantled for wiring, and must be capable of being wired complete without draw wires being installed during erection.
- Sleeves for cable must be filled with a fire retardant compound to prevent fire spread from one compartment to another.
- Conduits specified to run on the surface shall be fixed by means of galvanized distance saddles to allow a 5mm space between the surface and the conduit.
- All sizes of cable trays shall be attached to the building framework at intervals not more than that recommended by the manufacturer.

- Screws and bolts securing trays to brackets and joining trays shall be arranged so as to prevent damage to cables.
- Cutting and modification of straight tray, ladder will not be permitted without prior approval.
- Additional protection of fireproof barriers should be provided where cable trays pass through walls and partitions.
- Cable trays and ladders are to be earthen at maximum spacing of 30m, by a cable of 16mm² section.
- Spacing of saddles for supporting of surface mounted PVC conduits is not to be greater than:

- Spacing of saddles for supporting of surface mounted steel conduits is not to be greater than:

- Sizes of conduits not shown on the drawings are to be selected in accordance with the regulations and in relation to number and size of conductors as shown in table below:

16.2 Submittals

- Manufacturers catalogue with specifications.
- Samples.
- Shop drawings showing the exact routing of conduits, cable trays, boxes and accessories with their types and dimensions.

17. Lightning and Earthing System

17.1 Product Specifications:

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- The contractor shall be responsible for the installation of proper earth connections, and grounding of all electrical items accessible to personnel including but not limited to:
    - Solar modules frames
    - Mounting Structure,
    - Inverters,
    - Electrical Cabinets
    - Cable trays, combiner & junction boxes
    - Control, Data Monitoring Equipment
- Earth resistance shall not be more than 5 ohms. Earth resistance shall be tested prior to startup or commissioning activities.
- Resistance to earth of complete system measured at any point not to exceed 3 Ohms.
- Lightning earth consists of one or more earth pits providing an earth connection point with less than five ohms resistance to the general mass of the earth.
- Earth rods shall not be less than 16 mm diameter pure electrolytic copper molecularly bonded onto a high tensile steel core to a minimum thickness of 0.25 mm.
- Earth link conductors shall be of high conductivity, soft drawn stranded conductor 50mm².

17.1 Installation Requirement

- All metal works including in the installed system., in the vicinity of the lightning protective system must be bonded to it, to avoid the danger of side flashing.
- All bonds, saddles, clamps, clips, earth bonding points and flexible bonds are to be copper or copper alloy.
- Permanent earthing connections are to be made by exothermic welding process.
- Materials used for earthing are to be copper or approved copper alloys specially manufactured for the purpose. Electrical continuity is to be of durable construction providing an independent fault current return path of low resistance to the site earth.
- Air termination network consist of vertical and horizontal conductors, connected to the reinforcing bars in the number of positions required by the standards.
- Reinforcing bars shall be used as down conductors providing that they are electrically continuous and adequately earthen.
- The array structure of the PV modules shall be grounded properly using adequate numbers of earthing pits. All metal casing/ shielding of the plant shall be thoroughly grounded to ensure safety of the personal and power plant.
- The system should be provided with adequate earthing points. This includes earthing for lightning, system grounding, separately for DC and AC active points. The frame of the PV module array should be earthed at multiple points.

- Automatic ground fault protection circuits to be installed to monitor any unwanted current flow to the ground and should active to prevent any damage.
- Earth termination network consist of earth rod electrodes connected together via a ring conductor at foundation level and to reinforcing bars.
- Each solar power plant shall be provided with lightning protection. The purpose of which is to protect the Solar PV plant and existing equipment on site from lightning strikes, and overvoltage hazards. The source of over voltage can be lightning, atmosphere disturbance etc.

17.2 Submittals

- Full details, catalogues and product manufacturer datasheet.
- Layout diagram for earthing connection and lightning

18. UPS - Backup Power

18.1 Product Specifications:

- The bidder must provide a UPS with enough power to provide for the control circuit and the data logger/monitoring equipment for a period no less than 6 hours without charging.

18.2 Installation Requirement

- The UPS is essential to keep the data logger and PV controller online when no power is available.
- The UPS should be able to re-charge its batteries from available electricity on site, EDL or Generator.

18.3 Submittals

- Full details, catalogues and product manufacturer datasheet.

Part 5 Mechanical Work

19. Wall Mounted Fire Extinguisher

19.1 Products Specifications:

- ABC fire extinguisher minimum weight 6Kg
- Wall mounted fire extinguisher
- Powder fire extinguisher

19.1 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- The contractor is responsible for wall mounted bracket with installation

19.2 Submittals

- Full details, catalogues and product manufacturer datasheet.

20. Module Surface Cleaning Kit

20.1 Products Specifications:

- Portable 50m hose with reel, and spray nozzle, used for manual cleaning of solar modules
- Telescopic cleaning soft brush, used for cleaning modules surface
- Standard Polyethylene or PEX piping can be used underground protected from the sun, with designated access points using vertically installed galvanized steel piping and fittings, fixed in the ground with concrete ballast.
- Ball valves and fittings to be made from brass with anti-rust properties, fitted with push fit accessories for easier plug in of flexible hose used for cleaning.

20.2 Installation Requirement

- Install work in accordance with approved standards, as per manufacturer's recommendations, and to the satisfaction of the Engineer (SLWE Engineer).
- The contractor is responsible for providing access to water near the PV modules to facilitate cleaning.
- Proper connection to existing water network inside or outside mechanical room shall be coordinated with project manager.

20.3 Submittals

- Full details, catalogues and product manufacturer datasheet.
- Submit the detailed drawing

Part 6 Operation, Testing and Commissioning

21. Post Installation Documents

- Contractor responsible for submitting list of equipment supplied with model, description and serial numbers.
- Contractor responsible for basic system information including system rating and component ratings, commissioning date and equipment location.
- Contractor responsible for shutdown and isolation procedure for emergency and maintenance.

22. Operation and Maintenance

- The contractor shall provide operation and maintenance manuals in English.
- The contractor shall provide training for the technical staff on the operation of the PV System
- Supply of manual for Operation and Maintenance of all the system in English.
- Training to the user for operation and maintenance of the system after Installation and commissioning.
- Contractor responsible for detailed standard of system documentation which is necessary, so that safe operation and maintenance can be carried out throughout the life of the system. Operation and Maintenance manuals shall include information such as the following:
    - The location of all array isolators and applicable arrays/sub-arrays they serve.
    - Identifying all distribution boards or sub-boards that the inverters are connected to, and their location.
    - Full site-specific single-line schematic diagrams for the PV installation.
- If necessary, site plans to show the location of the site meter, main switchboard and distribution boards which are connected to the solar PV installation.
- Factors that can influence maintenance requirements include:
    - Panel tilt angle (shallow tilt angles may require more frequent cleaning)
    - Environmental factors (leaf litter, dust, salt spray, etc.)
    - Fauna (birds, possums, rodents, etc.)
- The contractor and installer shall document all maintenance actions that are required by the equipment manufacturers, and ensure any site specific maintenance actions are included.
- The supplier must provide Training of 2 people from the facility where the solar systems will be installed to operate and maintain the system. The training shall be undertaken on site and include the following subjects as a minimum:
    - Solar PV system operation
    - Inverter operation
    - System monitoring
    - Fault diagnosis
    - Safety and emergency shutdown procedure

23. Testing and Commissioning

- After completion of installation work, the whole system shall be on trial runs for a 20 clear sunny days to test smooth functioning of power plant in every aspect. Only after satisfactory inspection by a SLWE, the system will officially have commissioned to SLWE.
- One set of operation manuals complete with drawing, parts list (with part codes) circuit diagrams with list ratings of components and list of do's and don'ts for the main equipment as well as the sub-systems should be submitted to SLWE.
- One set of maintenance manuals with full information on drawings, circuit diagrams, list and suppliers addresses for bought out parts, troubleshooting charts, programs of built in controllers etc. for the main equipment as well as for the sub-system.
- These manuals should be in the form of hard (printed) copy in English Language as well as in electronic storage form (disc pen drive etc.)

24. Guarantee & Warranty

- System components supplied should be covered by standard terms of warranty for a period specified in separated required sheet, from the date of commissioning of the system approved after testing, whichever is later for manufacturing defects/performance.

25. Operation and Maintenance

25.1 GENERAL

Operation and maintenance DATA shall be submitted by the Contractor for the approval of the Supervising Entity at SLWE, including but not limited to all of the specified Submittals and Documentation listed hereafter.

25.2 1.1 RELATED DOCUMENTS

Any other specification documents included within the tender documents.

25.3 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Operation and Maintenance (O&M) Manuals, including the following:
   1. Preparing and submitting O&M Manuals for operating systems and equipment.
   2. Preparing and submitting instruction manuals covering the care, preservation, and maintenance of engineered components, systems, architectural products and finishes.
   3. Instruction of the Employer's operating personnel in the operation and maintenance of systems and equipment.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 1 "Data Requirements" for preparation of Shop Drawings and Product Data.

2. Divisions 2 through 16 Sections for special O&M data requirements for specific pieces of equipment or building operating systems.

25.4 1.3 QUALITY ASSURANCE

A. O&M Manual Preparation: In preparation of O&M Manuals, use personnel thoroughly trained and experienced in operation and maintenance of equipment or system involved.
   1. Where O&M Manuals require written instructions, use personnel skilled in technical writing where necessary for communication of essential data.
   2. Where O&M Manuals require drawings or diagrams, use CAD operators or drafters capable of preparing drawings clearly in a clear, understandable industry standard format.
   3. System-Level O&M Manuals for mechanical and electrical systems shall be developed specifically for this Project. Compilation of equipment vendor catalogues and O&M Manuals is not acceptable.

B. Instructions for the Employer's Personnel: Use experienced instructors thoroughly trained and experienced in operation and maintenance of equipment or system involved to instruct the Employer's O&M personnel.

25.5 1.4 SUBMITTALS

A. Submittal Schedule: Comply with the following schedule for submitting O&M Manuals:
   1. Not later than sixty (60) days prior to initial start-up of the subject work scope equipment, when each installation that requires O&M Manuals is nominally complete, submit two (2) draft copies of each manual to the Engineer for review and approval. Include a complete index or table of contents of each manual.
   2. The Engineer will return one (1) copy of the draft with comments within thirty (30) days of receipt.
   3. After receipt of the Engineer's approval, make any required corrections or modifications to comply with the Engineer's comments. After approval, and at least thirty (30) calendar days in advance of initial start-up of an item (i.e., within thirty (30) days of receipt of the Engineer's final comments and approval), submit the O&M Manuals, in final form, to the Engineer for distribution and use by the Employer, as follows:
      a) Three (3) bound sets of O&M Manuals
      b) One (1) loose set (blue line / black line prints) of O&M Manuals
      c) One (1) set of O&M Manuals in electronic editable format (in CD-ROM)

B. Form of Submittal: Prepare O&M Manuals in the form of an instructional manual for use by the Employer's operating personnel. Organize into suitable sets of manageable size. Where possible, assemble instructions for similar equipment into a single binder.
   1. Complete Listing: Provide a complete list showing the actual number of volumes and files of O&M Manuals, for the project. Also provide a list showing the number of volumes and files included in a particular submittal.

2. Binders: For each manual, provide heavy-duty, commercial-quality, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to receive Metric-Size "A4" (210 mm by 297 mm) paper. Provide a clear plastic sleeve on the spine to hold labels describing contents. Provide pockets on the inside of the covers to receive folded sheets.
   a. Where two (or more binders are necessary to accommodate data, correlate data in each binder into related groupings for similar items. Establish a logical, well organized table of contents and O&M Manual binders layout. Cross-reference other binders where necessary to provide essential information for proper operation or maintenance of the piece of equipment or system.
   b. Identify each binder on front and spine, with the printed title "OPERATION AND MAINTENANCE MANUAL", Works title or name, and subject matter covered. Indicate volume number for multiple-volume manuals. Indicate applicable 5-digit specification section number for reference as appropriate on the front of each major O&M Manual section.
   c. They must be filled with good quality files and proper labelling.
3. Organize each O&M Manual into separate sections for each piece of related equipment. Each manual section shall contain a title page; a table of contents; copies of pertinent product data, supplemented by drawings and written text; and copies of each warranty, bond, and service contract issued.
   a. Title Page: Provide a title page in a transparent, plastic envelope as the first sheet of each manual. Provide the following:
   1) Subject matter covered by the manual section.
   2) Name and address of the Works.
   3) Contract Number (e.g., AX….).
   4) Date of submittal.
   5) Name, address, and telephone number of the Contractor.
   6) Name and address of the Engineer.
   7) Cross-reference to related systems in other O&M Manuals or sections of the subject O&M Manual.
   b. Table of Contents: After title page, include a type written table of contents for each volume, arranged systematically. Include a list of each product included, identified by product name or other appropriate identifying symbol and indexed to the content of the volume. Where a system requires more than one volume to accommodate data, provide a comprehensive table of contents for all volumes in each volume of the set.
   c. General Information: Provide a general information section immediately following table of contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the subcontractor or installer and the maintenance contractor. Clearly delineate the extent of responsibility of each of these entities
   d. Product Data: Where the manuals include manufacturer's standard printed data, include only sheets that are pertinent to the part or product installed. Mark each sheet to identify each part or product included in the installation. Where the Project includes more than one item in a

tabular format, identify each item, using appropriate references from the Contract Documents. Identify data that is applicable to the installation, and delete references to information that is not applicable.

e. Written Text: Prepare written text to provide necessary information where manufacturer's standard printed data is not available, and the information is necessary for proper operation and maintenance of equipment or systems. Prepare written text where it is necessary to provide additional information or to supplement data included in the manual. Organize text in a consistent format under separate headings for different procedures. Where necessary, provide a logical sequence of instruction for each operation or maintenance procedure.

f.Drawings: Original project record documents as part of O&M Manuals.

g. Warranties, Bonds, and Service Contracts: Original documentation.

4. Dividers: Provide heavy paper dividers with celluloid-covered tabs for each separate Section. Mark each tab to indicate contents. Provide a typed description of the product and major parts of equipment included in the section on each divider.
5. Protective Plastic Jackets: Provide protective, transparent, plastic jackets designed to enclose diagnostic software for computerized electronic equipment.
6. Text Material: Where O&M Manuals require written material, use the manufacturer's standard printed material. If manufacturer's standard printed material is not available, provide specially prepared data, type written, on Metric Size "A4" (210 mm by 297 mm), 75-g/sq. m white bond paper.
7. Drawings: Provide reinforced, punched binder tabs on drawings and bind in with text.
   a. Where oversize drawings are necessary, fold drawings to the same size as text pages and use as a foldout.
   b. If drawings are too large to be used practically as a foldout, place the drawing, folded, in front or rear pocket of binder. Insert a type written page indicating drawing title, description of contents, and drawing location at the appropriate location in the manual.
8. Loose Copy: Shall be in blue / black line prints. Enclosed drawings shall be same sign as original mylar / polyester films.
9. Electronic Format: Provide one (1) set of O&M Manuals in CD – ROM format including file index, procedures and all related catalogues and brochures.
10. All O&M Manuals should be stamped as “Final Copy” on the front page assuring that such are final.
11. All drawings, sketches and diagrams included in the O&M Manuals shall also be stamped as “As-Built” and certified accordingly by the contractor.
12. Other Documents / Reports: Provide one list of full report about the project, Test results and any other information / documents, which are not included in the O&M manuals and As-Built drawings.

25.6 1.5 O&M MANUAL CONTENT

A. Each O&M Manual shall include the information specified in the applicable individual Specification Section and, as a minimum, shall include the following general sections/subsections and information. The O&M Manual shall address each component/equipment/item and its controls and each major facility included within the scope of work.

1. How to Use the Manual. This section shall be a guide to the contents, structure, and layout of the manual. It shall enable the reader to comprehend the scope of the document and identify readily where specific information can be obtained.

2. Overall Purpose. This section shall provide a general overview of the original design intent.

3. Description. This section shall include the following:
   a. Type of system.
   b. System location and what it serves.
   c. System inputs/interfaces; i.e., what the system depends upon in order to function.
   d. Design data, simulations, calculation notes, basic design parameters, and basic assumptions made during design. The appropriate Employer's Design Criteria documents will be made available for the Contractor's use and information and to assist in the preparation of this section of the O&M Manual.
   e. Rationale for selecting particular plant processes/equipment.
   f. Expected service life (where available).
   g. Planned operational efficiencies.

4. Equipment Schedule and Identification. This section shall include the following for all components within each system:
   a. Type of equipment.
   b. Name of manufacturer.
   c. Equipment model number of each component.
   d. Equipment serial number of each component.
   e. Items within each system shall be listed, together with the names of their respective manufacturers or suppliers.

5. Parts Identification and Recommended Spares. This section shall include the following for all components within each system:
   a. A parts identification list detailing and identifying replaceable assemblies, sub-assemblies, and components. It shall include suppliers' recommendation for both spares and "running spares" for the First year period and Second year period as a minimum; i.e., parts required for scheduled replacement due to wear or deterioration.
   b. Items normally held in stock locally by the supplier or for which a refurbishment service is available shall be clearly identified.
   c. Recommended stocking levels of spare parts.
   d. Manufacturing and shipping time required for imported spare parts.

6. Commissioning Data. This section shall include the following:
   a. Measured data.
   b. Measurement points.
   c. Test equipment used.

d. Calibration certificate details.
e. Test certificates.
f. Safety and fire certificates (where applicable).
g. A statement of whether the design requirements were achieved.

7. Operation. This section shall include instructions for the safe and efficient operation, under both normal and emergency conditions. These will be in addition to manufacturers' literature for all plant items and shall include the following:
   a. A recommended strategy for operation and control.
   b. An outline of the general operating mode.
   c. Control data (location, effect, object, sequence, limits of capability, modes, and set points).
   d. For electric and electronic systems, provide complete circuit directories of control panels, local panels/racks, programmable logic controller units, panel boards, etc. including the following:
      1) Electric service.
      2) Controls.
      3) Communications.
   e. Procedure and sequences for start-up, running, and shutdown, under both normal and emergency conditions.
   f. Interlocks between various plant items.
   g. Operating procedure for standby operations.
   h. Precautions necessary to overcome known hazards.
   i. The means by which any potentially hazardous condition may be made safe.
   j. Target figures for both energy consumption and energy costs.
   k. Forms for recording plant running hours, energy consumption, and energy costs where applicable.
8. Maintenance. This section shall include the following:
   a. Manufacturers' recommendations and instructions for maintenance for each item of plant and equipment. A clear distinction shall be made between planned tasks (preventative maintenance) and work done on a corrective basis. Instructions shall be given on each of the following, as appropriate:
      1) The isolation and return to service of systems and equipment.
      2) Adjustments, calibration, and testing.
      3) Dismantling and re-assembly.
      4) The exchange of components and assemblies.
      5) Dealing with hazards which may arise during maintenance.
      6) The nature of expected deterioration and the types of defects anticipated.
      7) Special tools, instruments, test equipment, and ancillary services.
   b. Maintenance schedules shall be provided for preventative maintenance tasks and shall be based on manufacturers' recommendations and other authoritative sources and shall include the following:
      1) Inspections.
      2) Examinations.
      3) Tests.
      4) Adjustments.
      5) Calibration.

6) Lubrication where applicable.
7) Periodic overhaul.

c. Procedures for the logical diagnosis and correction of faults.

9. Modification Information. This section shall include information on permitted plant or system modifications allowed for by the manufacturers or system designers for each system. Space shall be provided in the manual for the recording of all modifications and changes as they occur.
10. Disposal Instructions. This section shall include the following:
    a. Any known dangers likely to arise during the disposal of specific items of systems or equipment, together with the necessary precautions and safety measures.
    b. Methods for safely disposing of or destroying the equipment or any parts thereof, including packaging, insulation, and fluids.
    c. Sources from which further advice on safe disposal can be obtained.
11. Names and Addresses of Manufacturers and Suppliers. This section shall include the following:
    a. Name of each equipment/item.
    b. Name of manufacturer.
    c. Address of manufacturer.
    d. Telephone number and telex/fax number of manufacturer. Include E-Mail address if available.
    e. Name of local supplier/agent.
    f. Address of local supplier/agent.
    g. Telephone number and telex/fax number of local supplier/agent. Include E-Mail address if available.
12. Index of Plans and Drawings. This section shall include the following:
    a. An index shall be provided of all "As Fitted" drawings supplied during the course of the installation work, included by number and title.
    b. The index shall also include a schedule of all drawings issued by each manufacturer and supplier during the course of the installation work; e.g., control panel wiring diagrams.
    c. In addition to manufacturer-prepared documentation and drawings as specified below, the O&M Manual shall contain copies of the Contractor-prepared Coordination Drawings which accurately represent the final as-built condition of the facility/system.

13. Emergency Information. This section shall include the following:
    a. Names, addresses, telephone, and telex/fax numbers of the appropriate contacts in the event of fire, theft, burglary, fuel, gas or electricity failure.
    b. Where applicable, location of fire-fighting equipment, hydrants, and rising mains shall be identified and described.
14. Manufacturers' Literature. This section shall include the following:
    a. A complete set of all manufacturers' literature shall be provided for each of the systems and equipment installed and assembled. As a minimum, the following document types shall be provided:
        1) Product data shall be manufacturers' original printed data (not copies).
        2) Copies of applicable Shop Drawings and Product Data.
        3) Assembly drawings and diagrams required for maintenance.
        4) Wiring diagrams.
        5) Inspection and test procedures.

6) Repair instructions including spare parts listing.
7) Maintenance procedures and schedules.
8) Precautions against improper use and maintenance.
9) Sources of required maintenance materials and related services.
10) Description of the sequence of operation and as-installed control diagrams by the control manufacturer for systems requiring controls.
11) Specially prepared drawings where necessary to supplement manufacturer's printed data to illustrate the relationship of component parts of equipment or systems or to provide control diagrams. Coordinate these drawings with information contained in Project Record Drawings to assure correct illustration of the completed installation.

b. This literature shall provide the following:
1) Description of the product as purchased.
2) The cost and date of purchase.
3) Performance - behavioural characteristics of the equipment in use (e.g., performance curves for pumps).
4) Equipment or system function.
5) Operating characteristics.
6) Limiting conditions.
7) Engineering data and tests.
8) Complete nomenclature and number of replacement parts.
9) Applications - suitability for use.
10) Operation and Maintenance details.
11) Resources of labour, plant, material, and space required.
12) Methods of operation and control.
13) Cleaning and maintenance requirements.
14) Protective measures.
15) Labour safety and welfare associated with the equipment.
16) Public safety considerations.
15. Manufacturers' Guarantees and Warranties. This section shall include copies of each warranty, bond, or service contract in the appropriate manual for the information of the Employer's operating personnel. Provide written data outlining procedures to follow in the event of product failure. List circumstances and conditions that would affect validity of warranty or bond.

25.7 1.6 INSTRUCTIONS AND TRAINING FOR THE EMPLOYER'S PERSONNEL

A. Prior to final inspection, instruct and train the Employer's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Provide instruction at mutually agreed upon times.

1. Use O&M Manual sections for each piece of equipment or system as the basis of training and instruction. Review contents in detail to explain all aspects of operation and maintenance.

نموذج تطابق المواصفات

** **Remarks:**
1. **All** technical specifications and values **shall be filled in** "Proposed items section".
2. Technical Data-sheets for all components units shall be attached to this sheet in the technical offer. Technical Specifications in data-sheets must match the values in this sheet.

BIDDER PRODUCT INFORMATION SHEET

Contractor			
Contractor Name			
Contractor Address			
Contractor Contact			

#	Solar PV Panel	Offered (Filled by the bidder)	Deviation (if present)	Committee evaluation (comply/Not comply)
1	manufacturer			
2	Country of origin			
3	manufactured date			
4	Cell type (mono / poly…)			
5	Module nominal STC power (W)			
6	Temperature coefficient (Pmp)			
7	Maximum Power Voltage (Vmp)			
8	Open circuit voltage (VOC)			

9	Short circuit current (ISC)			
10	Module Efficiency (%)			
11	Number of cells per module (cells)			
12	Modules temperature sensitivity at peak power (°C)			
13	Module warranty (years)			
14	1-year Power loss guarantee (%)			
15	10-year Power loss guarantee (%)			
16	25-year Power loss guarantee (%)			
17	LID loss percentage including first year degradation (%)			
18	Panel Dimensions (cm)			
19	Weight (kg)			
20	Maximum Load (Pa)			
21	Official Product Manufacturer Certification(s) attachment (Y/N)			
22	Attached Manufacturer Data Sheet (Y/N)			
23	PID Resistance (Y/N)			
24	Flash reports of PV (Y/N)			
25	Operating PV temperature ranges (°C)			

26	Module power tolerance			
27	PV junction box IP rating			
28	PY module frame made from anodized aluminum (Y/N)			

#	Solar Inverter	Offered (Filled by the bidder)	Deviation (if present)	Committee evaluation (comply/Not comply)
1	Manufacturer			
2	Country of origin			
3	Manufactured date			
4	Inverter model			
5	Inverter nominal power output **(kW)**			
6	Inverter Max. generator power (Wp at STC)			
7	Inverter Max. input voltage (V)			
8	Inverter Max. operating input current per MPPT (A)			
9	Inverter Output Wave Form			
10	Inverter Output Frequency (Hz)			
11	Inverter MPPT Current (A)			
12	Inverter output Voltage Range (V)			

13	Warranty (years)			
14	Temperature operating range (°C)			
15	Harmonic distortion (%)			
16	Inverter euro efficiency (%)			
17	Cooling type (fans / no fan(s))			
18	SPD protection (DC and AC)			
19	Over current protection (DC and AC)			
20	Installation method (Indoor / outdoor)			
21	IP protection			
22	LCD display (Y/N)			
23	Cosφ (PF)			
24	Peak Efficiency at full load			
25	Self-consumption (W)			
26	Noise emission (typical)			
27	Operating temperature range (°C)			
28	Total harmonic distortion THD (%)			
29	Official Product Manufacturer Certification(s)			

#	Support Structure for PV Array	Offered (Filled by the bidder)	Deviation (if present)	Committee evaluation (comply/Not comply)
1	Manufacturer (Prefabricated or Customized Welding Design)			
2	Country of origin			
3	Manufactured date			
4	Material (Hot Dip Galvanized Steel 2: 80 µm / Aluminum …)			
5	Coating Thickness (µm)			
6	Wind speed resistance (km/h)			
7	Warranty (Years)			
8	Bolts, washers, and nuts Stainless steel (Y/N)			
9	Module clamps Aluminum (Y/N)			
10	Contact between PV frame and No dissimilar metal (Y/N)			
11	Array tilt angle to the horizontal for Tyre-Ras El Ain 33.228091, 35.218617			
12	Resistance to corrosion (Y/N)			
13	Earthed (Y/N)			
14	Minimum clearance of the structure from the ground level (mm)			
15	Concrete Foundation Drawing (Y/N)			

16	Mounting Structure Drawings submission (Y/N)			
17	Attached Manufacturer Data Sheet (Y/N)			

#	Hybrid PV Plant Controller	Offered(Filled by the bidder)	Deviation(if present)	Committee evaluation (comply/Not comply)
1	Manufacturer Brand Name			
2	Country of Origin			
3	Compatible with PV system size (up to …kW)			
4	Max number of generators that can be connected (1,2,3…)			
5	Inverter Brands Communication Compatibility			
6	Communication Type			
7	Official Product Manufacturer Certification(s)			
8	Official Warranty (Years)			
9	Product serial number(s)			
10	Attached Manufacturer Data Sheet (Y/N)			

#	PV DC Cables	Offered (Filled by the bidder)	Deviation (if present)	Committee evaluation (comply/Not comply)
1	Manufacturer			
2	Country of origin			
3	Manufactured date			
4	Cable Material			
5	Type			
6	Cross section (mm2)			
7	Multi-stranded (Y/N)			
8	Insulated and Sheathed (Y/N)			
9	UV stabilized (Y/N			
10	Weather Proof (Y/N)			
11	Single or Multi core Colored			
12	Connections including cables connectors (Y/N)			
13	Warranty (years) 5			
14	TUV certificate (Y/N)			
15	Operation temperature (°C)			
16	UV resistant, flame retardant (Y/N)			

17	Cable color (Red for+ / Black for-)			
18	Solar cable grade			
19	Excellent resistance to heat, cold, water, oil, abrasion (Y/N)			
20	The total voltage drops on the cable segments (%)			
21	Cable routing drawing Submit ion (Y/N)			
22	Cable Labeling During Installation (Y/N)			
23	Attached Manufacturer Data Sheet (Y/N)			

#	PV Junction box	Offered (Filled by the bidder)	Deviation (if present)	Committee evaluation (comply/Not comply)
1	Manufacturer Brand Name			
2	Country of Origin			
3	Enclosure material			
4	Dimensions mm (L*W*D)			
5	Outdoor/Indoor			
6	Protection Class			
7	Waterproof (Y/N)			
8	Dustproof (Y/N)			

9	Rustproof (Y/N)			
10	Number of strings per box			
11	String fuses specifications			
12	Includes appropriate Output cable Glands & Safety Labels (Y/N)			
13	Provided with lockable door			
14	Equipped with touch DC fuse-holders, DC fuses, reverse protection diodes, DC surge arrester and load disconnect switches (Y/N)			
15	Operational Environment Temperature			
16	Circuit diagram drawing of PV combiner box submission (Y/N)			
17	Product serial number(s)			
18	Attached Manufacturer Data Sheet (Y/N)			

#	Control Panel Enclosure	Offered(Filled by the bidder)	Deviation(if present)	Committee evaluation (comply/Not comply)
1	Manufacturer			
2	Country of origin			
3	Manufactured date			
4	Enclosure material			
5	IP protection			
6	Outdoor/Indoor			
7	Dimensions mm (L*W*D)			
8	Product serial number(s)			
9	Attached Manufacturer Data Sheet (Y/N)			
10	Warranty (years) 5			
11	Appropriate sizes for terminals and bus bars (Y/N)			
12	Bus bars material (Tin-coated copper…)			
13	SPD protection (Y/N)			

#	AC Cables	Offered (Filled by the bidder)	Deviation (if present)	Committee evaluation (comply/Not comply)
1	Manufacturer			
2	Country of origin			
3	Manufactured date			
4	Insulation type			
5	Warranty (years) 5			
6	TUV certificate (Y/N)			
7	Trench cable laying (Y/N)			

#	Shop drawing & Training	Offered (Filled by the bidder)	Deviation (if present)	Committee evaluation (comply/Not comply)
1	Provide the manufacturer datasheets for each components need to be installed in the system (Y/N)			
2	Provide the requirement certifications standards (Y/N)			
3	Provide the official required product warranties (Y/N)			
4	Provide call-email technical support on request			
5	The supplier must provide Training of 2 people from the establishment			
6	Training Include Inverter operation			
7	Training Include System maintenance checklist			
8	Training Include System online monitoring procedure			
9	Training Include Fault diagnosis			
10	Training Includes main panel hardcopy drawing beside the panel			
11	Training Include safety and emergency shutdown procedure			
12	Training Include products user manuals Submission			
13	Training Include drawings explanation			

نموذج تطابق شهادات المنتج والمصنع

Service/Product	Minimum Certification	Compliance (Y/N)	Attached (Y/N)
PV Module	ISO 9001		
	ISO 14001		
	IEC 61215		
	IEC 61730		
	UL 1703		
	IEC 61701		
	IEC 62716		
	IEC 60068		
Solar Inverter	IEC 62116		
	IEC 61727		
	IEC 62109		
	IEC 60068		
	EN 50438		
Manufactured products and equipment shall comply, manufactured & design with US or Western European Standards. ISO 9001 certification for main manufactured goods is essential for the following items: PV module, mounting structure, inverters & DC cables. However other goods shall be approved by SLWE Engineer.			

Company Stamp

الجمهورية اللبنانية
وزارة الطاقة والمياه
مؤسسة مياه لبنان الجنوبي

نموذج ضمان الانتاج

أنا الموقع أدناه _____ بصفتي _____ مخولًا بالتوقيع باسم _____ , نؤكد ضمان انتاج مشروع توريد وتركيب وتشغيل نظام طاقة شمسية كهروضوئية لمحطة _____ بقدرة _____ kWp و نضمن توليد _____ (كيلوواط ساعة بالسنة) من الطاقة الشمسية الكهروضوئية.

لذلك ، نحن نضمن Capacity Factor (CF in %) من _____ حيث سيتم قياس وحساب CF لمحطة توليد الطاقة الكهروضوئية المثبتة وفقًا للقواعد التالية:

$$CF_{measured} = \frac{E_{generated\ per\ annum}}{8760 \text{ x Installed Capacity}}$$

Corresponding units:

$E_{generated\ per\ annum}$	Electricity produced by the PV power plant during the first year	kWh
Installed Capacity	Installed Capacity of the PV power plant	kWp

ختم الشركة والتوقيع

طابع مالي 1000 ل.ل

أنا الموقع أدناه _____ بصفتي _____ مخولًا بالتوقيع باسم _____ نيابةً عنه ، نضمن نسبة الأداء -PR Performance ratio- المدرجة في الجدول رقم 1 أدناه. يمثل PR المضمون _____٪ من المحاكاة.

سيتم قياس العلاقات العامة لمحطة توليد الطاقة الكهروضوئية المركبة أثناء التشغيل على مدار سبعة (7) أيام متتالية. في حالة حدوث انقطاع التيار الكهربائي لأي سبب من الأسباب ، يتم استبعاد أيام انقطاع التيار الكهربائي وتمديد فترة اختبار العلاقات العامة للوصول إلى الحد الأدنى لمدة 7 أيام من القياس.

سيتم احتساب نسبة الأداء -PR Performance ratio- وفقًا للقواعد التالية:

$$PR_{commissioning} = \frac{E_{produced\ system\ energy}}{GTI * A_{total\ module\ area} * \eta_{STC\ module}}$$

Corresponding units:

$E_{produced\ system\ energy}$	Electricity produced by the PV power plant [1)]	[kWh]
GTI	Global Tilted Irradiation [2)]	[kWh/ m²]
Atotal module area	Total area of PV modules	[m²]
ηSTC module	Efficiency of the PV module	[%] according to PV module datasheet

1) Produced system energy will be measured during the Test period of seven (7) consecutive days at the connection point.

2) Collected by the tilted pyranometer of a local meteorological measurement station for the Test period of seven (7) consecutive days.

ختم الشركة والتوقيع

طابع مالي 1000 ل.ل

الجدول رقم 1: الحد الأدنى لنسبة الاداء

South, Ras Al Ain		
Month	PR Simulated*	PR Guaranteed (Contractual)
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		
Yearly Average		

* Including AC losses until delivery point

ختم الشركة والتوقيع

طابع مالي 1000 ل.ل

متوسط توليد الطاقة اليومي		
الوقت	كفاءة توليد الطاقة ٪	الطاقة المنتجة kW.h
24:00 - 01:00		
01:00 - 02:00		
02:00 - 03:00		
03:00 - 04:00		
04:00 - 05:00		
05:00 - 06:00		
06:00 - 07:00		
07:00 - 08:00		
08:00 - 09:00		
09:00 - 10:00		
10:00 - 11:00		
11:00 - 12:00		
12:00 - 13:00		
13:00 - 14:00		
14:00 - 15:00		
15:00 - 16:00		
16:00 - 17:00		
17:00 - 18:00		
18:00 - 19:00		
19:00 - 20:00		
20:00 - 21:00		
21:00 - 22:00		
22:00 - 23:00		
23:00 - 24:00		
Total		

ختم الشركة والتوقيع

طابع مالي 1000 ل.ل

معدل الانتاج للمحطة

الشهر	متوسط ساعات العمل اليومي المتوقع لنظام الطاقة الشمسية الكهربائي (ساعة)	متوسط الانتاج الكهربائي اليومي المتوقع لنظام الطاقة الشمسية الكهربائي	الانتاج الكهربائي الشهري المتوقع لنظام الطاقة الشمسية الكهربائي (kWh)	الانتاج الكهربائي السنوي المتوقع لنظام الطاقة الشمسية الكهربائي (kWh)
كانون الثاني				
شباط				
اذار				
نيسان				
أيار				
حزيران				
تموز				
اب				
أيلول				
تشرين أول				
تشرين ثاني				
كانون أول				
متوسط الإجمالي				

أخيرًا ، نؤكد أن الوحدات الكهروضوئية سيتم تصنيعها أقل من ..... أشهر من تاريخ توقيع العقد.

ختم الشركة والتوقيع

طابع مالي 1000 ل.ل

ضمان و كفالة القطع

أنا الموقع أدناه _____ بصفتي _____ مخولًا بالتوقيع باسم _____

نؤكد ضمان وكفالة هيكل الدعم لتثبيت الألواح الشمسية الكهروضوئية لمدة لا تقل عن 10 سنوات بدءا من تاريخ بدء تشغيل النظام (يشمل الضمان جميع مكونات الهيكل).

نؤكد ضمان وكفالة الألواح الشمسية الكهروضوئية للعمل بكفاءة لا تقل عن 97% لمدة 5 سنوات الأولى بعد تاريخ بدء التشغيل وكفاءة لاتقل عن 90 ٪ لمدة 5-15 سنة بعد تاريخ بدء التشغيل وكفاءة 85 ٪ على الأقل لمدة 15 إلى 25 سنة بعد تاريخ بدء التشغيل.

نؤكد ضمان وكفالة المحولات المخصصة للطاقة الشمسية الكهروضوئية – Solar Inverters - للعمل بكفاءة لمدة لا تقل عن 3 سنوات من تاريخ بدء تشغيل النظام (يشمل الضمان جميع مكونات الداخلية للمحول الكهربائي).

نؤكد ضمان وكفالة الكابلات المخصصة لأنظمة الطاقة الشمسية الكهروضوئية – PV Cables - للعمل بكفاءة لمدة لا تقل عن 10 سنوات من تاريخ بدء تشغيل النظام (يشمل الضمان جميع مكونات الداخلية للمحول الكهربائي).

ختم الشركة والتوقيع

طابع مالي 1000 ل.ل