

Supply, Installation, Commissioning & Maintenance of Solar Systems to YEMAC office in Dar Sa'ad, Aden city

Annex 1 → LOT 2

Table of Quantities

No.	Item	Description	Quantities
1	3.7KW Solar system	<p>Integrated solar solution with a capacity of 3780W, including:</p> <ol style="list-style-type: none"> 1- Solar panels 12PV*315 2- 5KW ON/OFF Grid Solar inverter Built-in MPPT per one Solar System 3- 200AH-12V Battery, 8 Batteries per one Solar System 4- PV Panels Mounting structures, solar inverter (With controller), batteries, DC and AC junction's boxes and cables. 5- Supply, delivery to site, installation, operation and maintenance. <p>Which required successful operation of electric loads for sites within the specified power consumption plans of the site (Please see attached Annex 2</p>	1 full solar system

Scope of Works:

- Supply, installation, commissioning and comprehensive maintenance for number of Solar Photovoltaic Systems power solutions with battery backup.
- Ensure each & every piece of electrical equipment & apparatus shall be connected to the main earth bus by means of branch main connection of earth continuity conductors.
- Ensure all electrical equipment, except those operating at extra low voltages will be provided with an earth terminal.

Note	Catalogue should be provided for the specifications which offered
------	---

General Description

ON/OFF Grid Photovoltaic power system with backup battery consists of PV array, module mounting structure, ON/OFF Grid Solar Inverter with built-in MPPT Controller/s, Backup Batteries & Protections, Cables and Switches etc.

PV array is mounted on a suitable structure. ON/OFF SOLAR Hyper Inverter PV system is working with/without batteries (Grid-Tie with backup battery) and should be supply directly the power generated by PV to the load grid and charge the batteries to be used in night.

All components and parts used in the PV power systems should conform to the IEC standards or equivalent.

Technical Requirements

Solar PV system shall consists of following equipment/components:

- **Solar PV modules consisting of required number of Crystalline PV modules;**
- **SOLAR Hyper Inverter (with built in MPPT controller)**
- **Storage Batteries consisting of required capacity of AH;**
- **Mounting structures suitable for number of PV panels;**
- **IR/UV protected cables, pipes and accessories;**
- **Interconnects, connectors and protection devices;**
- **Box/Rack or container for inverter and batteries.**

Technical Specifications

Detail specifications for complete system

No.	Solar panels Technical Specifications
1	<p><u>(12) Solar Panels.</u></p> <p><u>Photovoltaic modules (STC):</u></p> <ul style="list-style-type: none"> - Solar Panel Wattage at STC: Shall be $\geq 300\text{Wp}$ (Bigger watt size Solar PV module will be preferred, recommend Wp). - Total Wattage of solar PV Array: Must be not less than 3600 Watt p. - Type of PV Module: Higher cell efficiency or POLY Crystalline - Module efficiency: $\geq 15.2\%$ - Open Circuit Voltage of each panel: $\geq 44.5\text{VDC}$ - Max MPPT Voltage of each panel: $\geq 36\text{VDC}$ - Short Circuit Current (A): $\geq 8.75\text{ A}$ - MPP current (A): $\geq 8\text{ A}$. - No of cells in each panel: 60/72 per panel. - Operating Temperature (C°) : $-40^{\circ} \sim +90^{\circ}$ - Thermal coefficient of Power: Less than $-0.42\%/^{\circ}\text{C}$. - Tolerance of maximum power rating: $\pm 5\%$ - Min. system voltage: $\geq 1000\text{V}$ - Warranty: Nominal power output 90% for 10 years, 80% for 25years. - Conform to IEC 61215, IEC 61730 and CE or equivalent - PV modules to be used in a highly corrosive atmosphere must qualify Salt Mist Corrosion Testing IEC 61701 - Weather proof DC rated PINs-MC4 connector. Fully Secured, not allowing for any loose connections. - Temperature coefficient: Less than $-0.2\%/^{\circ}\text{C}$ - Good tab thickness, heavy duty frame - Resistant of water, abrasion, hail impact, humidity& other harsh environmental factors for the worst situation at site and water drainage structure - Suitable encapsulation and sealing arrangements to protect the silicon cells from the harsh environmental conditions
2	<p><u>Mounting Structure For PV Panels:</u></p> <p>The PV modules shall be mounted on fixed metallic structures having adequate strength and appropriate design, which can withstand the load of the modules and high wind velocities. The support structure shall be hot dip galvanized steel.</p> <ul style="list-style-type: none"> - Access for panel cleaning and maintenance: All solar panels must be accessible from the top for

	<p>cleaning and from the bottom for access to the module-junction box.</p> <ul style="list-style-type: none"> - Quantity : to be determined by the bidder based on the Total No of panels and capacity of the system. <p>The prospective Installer shall specify installation details of the solar PV modules and the support structures with lay-out drawings and array connection diagrams. The work shall be carried out as per the designs</p>
3	<p><u>(1) ON/OFF Grid Hybrid Solar Inverters (Built-in MPPT Solar controller).</u> INVERTER with built-in MPPT solar controller</p> <ul style="list-style-type: none"> - Type: ON/Off Grid hybrid Solar Inverter 1 Phase with isolated transformer or transformer less High frequency output. - Pure sine wave output - Low Self-consumption. - Hybrid Support main/generator input. - Directly power from PV to loads. - Intelligent battery management. - Programmable supply priority for PV, Battery or electrical grid - Programmable multiple operation mode: OFF-Grid, ON-Grid (Grid-Tie), ON-Grid (Grid-Tie) with backup battery. - Rated output power = 5000W - Output Voltage: 2line (230VAc\pm5%). - Output Frequency: 50Hz \pm3. - Input AC Voltage: 2line (230VAc\pm5%). - Input Frequency: 50Hz \pm3. - Maximum AC charging current: \geq 60A, - Power factor \geq0.9 - Efficiency (DC to AC) \geq 90% - MPP Voltage Range (Vdc):As system design required. - Maximum MPP charging current \geq 60A, As system design required. - Max solar input power (Wp): Not less than 10,000W. - Display: LCD display + LED status indicator. - Display content: PV status (Current, Voltage, Power, Energy), battery capacity, AC input voltage, AC output voltage, Load, etc. - Perfect Protection: DC&AC Overload, Under-Voltage, SPD, Short-Circuit,Overcharge, Over Discharge, Over-Temperature .etc.
4	<p><u>(8) Batteries.</u> <u>Battery modules:</u></p> <ul style="list-style-type: none"> - Deep Cycle AGM range for Solar - Voltage = 12volt - Capacity (AH)=200AH - Capacity of batteries bank (WH): 8 Batteries \times 200AH \times 12Vdc = 19,200 Wh. - Manufacture date : Not more than 6months - Warranty : Not less on one year . - Low self-discharge: less than 5% per month.

	<ul style="list-style-type: none"> - Cycle performance: Not less than 1500 Cycle at 50% DoD. - applicable Operating Temperature Range (-20C⁰ ≈ +70C⁰). - Suitable Charging/Discharging Current rate (according to solar PV Array & Loads (Inverter Capacity)). - High specific power/energy: (30-50Wh/Kg), capable of high discharge currents. - Outstanding performance and long battery life - Terminations: Screw Type. - Applications: Solar system applications. - Temperature coefficient: Less than (-3mV/C⁰/Cell), 25C⁰. - Service life (Long shelf life): Not less than 4 years. - Standards: Conforms to IEC 60896, IEC 60079, CE, and all standards & certificates & Success stories (or previous projects where this product was used) which related. - Container & Cover: Acid-resistant ABS resin.
5	<p><u>Inverters & Batteries Racks:</u></p> <p>-Battery metal rack: Suitable for 8 battery 200AH Ironsteel, with coating paint resistant of corrosion.</p> <p>-Inverter rack: Suitable for inverter size, with coating paint resistant of corrosion.</p> <ul style="list-style-type: none"> • Standard ventilation holes are punctured on all sides including floors of shelves. • Enclosure Dimensions: suitable for all system batteries bank. • Provide adequate ceiling clearance for ventilation and maintenance. • Should be closed type cabinets to use for placing batteries and solar inverter in an efficient manner.

6 Cables:

Sections of cables between array interconnections, to inverter, inverter to batteries, batteries interconnections, inverter to ACDB, etc. shall be well selected to keep the voltage drop (power loss) of the entire solar system to the minimum:

- For DC cables, the maximum drop should be limited to 3%;
- For AC cables, the maximum drop should be limited to 2%.

Cables of appropriate size to be used in the system should have the following characteristics:

- Temp. Range: -10°C to $+80^{\circ}\text{C}$;
- Voltage rating 500/1000V;
- Excellent resistance to heat, water, oil, abrasion, UV radiation;
- Cables should be Flexible;

Sizing and length of cables:

Item	Descriptions	Type	Length	Size (mm ²)	Note
Between PV array interconnections	DC cabling; <ul style="list-style-type: none"> • PVC. • Insulated and sheathed. • UV-stabilized. • Multi-stranded flexible copper. • Weather proof. 	single/Multi core Colored	10 m	6mm ²	Outdoor
Array to DCDB (combiner boxes)		Multi-core Colored	10m	2x6 mm ²	Per String, Outdoor
DCDB (Combiner boxes) to MPPT			35m	2x16 mm ²	Outdoor
Inverter to batteries		Single –core	4 m	35mm ²	Indoor , Black color
Batteries interconnections		Single –core	4 m		Indoor , Red color
		Single –core Colored	8 m		Indoor, with Heat resist.
Inverter to ACDBs	AC cabling; <ul style="list-style-type: none"> • PVC. • Insulated and sheathed. • UV-stabilized. • Multi-stranded flexible copper. • Weather proof. 	Multi-core Colored	15m	4x6 mm ²	Outdoor
DB to water cooler			60m	3x2.5 mm ²	

7 Wiring Pipes.

PVC pipe minimum 50mm diameter (or as required) and above depending on No. of wires to be drawn, HMS grade (1 - 2mm thick), accessories for PVC pipes of the same make that of pipe; such as Spacers & Saddles, Couplers, Bends, inspection or non-inspection type Elbows, Tees, Junction boxes of required ways and resin / adhesive to make all joints rigid.

	<p>Black pipe shall not be used for surface type wiring.</p> <ul style="list-style-type: none"> • Pipe type: Rigid PVC conduits. • Thickness: 1.3mm to 2.0mm. • Color: white. • Size: 50 /70mm dia. / as required. • Smooth inner surface for easy wiring. • Flexibility for long radius bending. • Non Conductor of Electricity and prevent Electrical shocks. • High mechanical strength for buried and open application. • Non corrosive in nature and are immune to Chemical and Galvanic corrosion. • Do not support combustion and are self-extinguishing. • Light weight to handle, install and Transport.
--	--

8

AC Distribution Board (ACDB)

The inverter output will be connected to the existing AC Distribution Board (DB). The contractor will verify the compliance of the existing AC DB with EU standards and if needed adapt the ACDB for integration of the solar system.

All switches and the circuit breakers, connectors should conform to **IEC 60947, part I, II and III.**

All **indoor** equipment will have protection of **IP52 or better**. All **outdoor** panels will have protection of **IP65** or better.

All the devices / equipment like change over, circuit breakers, etc., mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under harsh environmental conditions.

The AC Distribution board shall consist of the following items:

Item	Description	Cutoff Current	Quantity	
Main AC Circuit Breaker	<ul style="list-style-type: none"> - MCB type. - Voltage: 220 VAC. - Rated frequency: 50 Hz - Cutoff Current: It must be cutoff at 5,000W within less than 3 seconds. - Opening Time: 40-60 ms - Closing Time: 60-80 ms - Suitable Isolation: Yes - Utilization Category: B - No. of Poles: 2poles. - Mechanical Life: at least 15000. - Rated duration of Short Circuit Current: less than 3Sec. - Ambient Temperature: 50C° 	It must be cutoff at 5,000W within less than 3 seconds.	1	For AC output
AC Circuit Breaker	<ul style="list-style-type: none"> - MCB type. - Voltage: 220 VAC. - Rated frequency: 50 Hz - Opening Time: 40-60 ms - Closing Time: 60-80 ms - Suitable Isolation: Yes - Utilization Category: B 	16A	1	For AC input

	<ul style="list-style-type: none"> - No. of Poles: 2 poles. - Mechanical Life: at least 15000. - Rated duration of Short Circuit Current: less than 3Sec. - Ambient Temperature: 50C° 				
Manual Change Over	<ul style="list-style-type: none"> - MCB type. - Voltage: 380 VAC – 420VAC. - Cutoff Current: at least 100 Amp. - Rated frequency: 50 Hz. - No. of Poles: at least: 6 poles.2 poles for load output, 2 poles for 1st input (Solar System) and last 2 poles for 2nd input (Generator/Main network). For 3PH. - Ambient Temperature: 50C° - Mechanical Life: at least 15000. 	at least 60 Amp.	1		

The MCB shall be provided with a quick make- quick break type of switching mechanism which a definite speed of travel of moving contacts is ensured.

All internal wiring shall be carried out with PVC insulated, stranded copper conductor, single core, **6-10 sq. mm.** or larger stranded copper wires.

The enclosure shall be dust & vermin proof, Rust proof and Corrosion resistance with a degree of protection of **IP-52.**

9 (2)DC Distributions/Junction Boxes (DCDB) / (PV Combiner Boxes)

These combiner boxes are equipped with **touch DC fuse-holders, DC fuses, reverse protection diodes, lightning induced DC surge arresters and load disconnect switches.**

Combiner boxes are installed near their PV arrays (that is, in the weather), and require appropriate outdoor ratings. 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, durability, reliability, lockable door, Longer service life, Sun shields (Available for top, sides, and door).

- **5 String Solar Power Combiner.6-String PV Enclosure.**
- Each String Continuous Duty Rated up to **500Vdc.**
- High-Voltage Protection: Each String with **high-voltage fuses, over-voltage & over-current protection.**
- Anti-backflow **diodes &anti-reverse protection.**
- **Circuit breaker output control: ≥60 Amp Circuit Breakers**
- Protection class **IP65** for outdoor with **waterproof, dustproof, rustproof, salt fog proof.**
- Includes Output cable Glands &**Safety Labels.**
- Includes **SPD Lightning/Surge Protection Module (500V).** **Lightning arrester** for both poles.
- Max Input/ Output Voltage Rating: up to **500Vdc.**
- Operational Environment Temperature: **-30 C° ~ +60C°.**
- Cooling Method: **Natural Cooling.**
- Dimension: **as required.**
- Double Flanged Door Opening, Rain Drip Lip, Back Panel and Mounting Tab ...etc.

10 (2)Earthing& Grounding System:

The contractor shall provide the complete bonding & earthing of the neutral point of power system & non-current carrying metal parts of all electrical equipment & apparatus.

Each & every piece of electrical equipment & apparatus shall be connected to the main earth bus by means of branch main connection of earth continuity conductors.

All electrical equipment, except those operating at extra low voltages shall be provided with an earth terminal.

EARTH PIT DETAILS:

Copper earth rod of 35/50 sq. mm x 1000 mm buried in specifically prepared earth pit of 1.2 meters below ground level with **20 kg charcoal & salt** with alternate layers of charcoal & salt with 2 number of **50 mm dia. C class GI pipe** with funnel with wire mesh for watering & **brick masonry block** cover, heavy duty **cast iron cover** complete as per IS : 3043.

Necessary connections shall be done using **copper wire of 25 sq. mm** copper wire as per instructions of inspector connected to nearest switch gears as directed & duly tested by earth tester.

Pipe electrode shall be of 1.5 M long 50 mm dia. class C GI pipe. The GI pipes shall be provided with holes at regular intervals as per IS : 3043.

Each array structure and all metal casings of the panel etc. shall be earthed properly. And connected to ground hole including pure copper rod 50 sq.mm and adding salts and carbon.

RESISTANCE TO EARTH

The resistance of earthing system shall not exceed 1.0 ohm.

MATERIALS:

Item	Quantity
Copper earth rod of 16 sq. mm	1 meter
Charcoal & salt	15Kg
Copper wire of 25 sq. mm	As per system requirement.
C class GI pipe 50 mm dia.	1 × 1 meter
Funnel	1
Cast Iron cover	1
Brick Masonry Block	Suitable for earth pit

