**SCHEDULE OF WORKS**

# INTRODUCTION

The lack of electricity remains one of the key obstacles to the provision of basic services (including health services) to the population. It has been cited as one of the reasons for security and protection concerns for women and children, especially in the new liberated areas in Iraq.

Reconstructing and strengthening the electricity supply system in Iraq is considered one of the national priorities especially in terms of improving the level of access to electricity in remote areas and areas affected by the crisis, and reducing the number of power cuts during the peak times.

Reconstructing the main grid will require relevant amount of resources in terms of funds and time so that there is a need for smart alternatives: decentralized renewable energy solutions can provide effective, affordable quick solutions, which may address the needs of a large part of the population, with low impact on the environment.

This project aims at improving the living conditions of the returnees in newly liberated areas in Iraq through the provision of innovative renewable energy solutions.

In coordination with the relevant authorities in the Iraqi Government, the following six locations were identified for the installation of PV systems:

1. **Al Ramadi Hospital, Ramadi, Anbar Governorate.**

**Coordinates: 33.424039 N, 43.283501 E**

Al Ramadi Hospital is a teaching hospital for maternity and children. It consists of two floors. The ground floor include 5 operation theatres, laboratory, Intensive care, administration section and maintenance section. The first floor includes women and premature wards. The hospital operates 24 hours a day.

The current source of power for the hospital is from either the national electricity and / or existing 4 generators with the capacity of (500 Kva (2 units), 1250 Kva and 1500 Kva).

UNOPS will utilize solar energy by using PV system, this system anticipates to run the operation theatres with 147.9 kWp and Laboratory with 90.78 kWp.

Point of connection will be with the input of the existing Main MCCB 400A of operation theatres and Main MCCB 100A of laboratory, located inside hospital building.

1. **Andalus Health Center, Ramadi, Anbar Governorate.**

**Coordinates: 33.421619 N, 43.297254 E**

Al Andalus Health Center is one floor building. It includes Dental clinic, laboratory, X-ray, Pharmacy, vaccine room, doctor room, women care and administration rooms.

At the back yard of the health center, there is a newly constructed pre-fabricated storage for storing vaccines. The health center operates 8 hours.

The current source of power for the hospital is from either the national electricity and / or existing 2 generators with the capacity of (50Kva and 250 Kva).

UNOPS will utilize solar energy by using PV system, this system anticipates to run the facility with 42.48 Kwp for 8 hours.

Point of connection will be with the input of Existing Main MCCB 630A, located in the main control room of HC.

1. **Audhaim Health Center, Al Audhaim, Diyala Governorate.**

**Coordinates: 34.272184 N, 44.542792 E**

Al Audhaim Health Center is one floor building. It includes Dental clinic, laboratory, X-ray, Pharmacy, vaccine room, doctor room , women care, emergency for men, emergency for women and administration rooms. The health center operates 24 hours.

The current source of power for the hospital is from either the national electricity and / or existing generator with the capacity of (500Kva).

UNOPS will utilize solar energy by using PV system, this system anticipates to run the facility with 91.8 kWp for 8 hours.

Point of connection will be with the input of existing Main MCCB 800A, located in the main control room of HC.

1. **Jalawla’a Health Center, Jalawla, Diyala Governorate.**

**Coordinates: 34.271945 N, 45.163334 E**

Jalawla Health Center consists of two floors. The ground floor includes Dental clinic, laboratory, X-ray, Pharmacy, vaccine room, doctor room, women and administration rooms. The first floor includes women care and vaccine room. The health center operates 8 hours.

The current source of power for the hospital is from either the national electricity and / or existing generator with the capacity of (250Kva).

UNOPS will utilize solar energy by using PV system, this system anticipates to run the facility with 91.8 kWp for 8 hours.

Point of connection will be with the input of existing Main MCCB 630A, located in the main control room of HC.

1. **Ibn Sina Hospital, Left side of Mousel City, Nineveh Governorate.**

**Coordinates: 36.3997620 N, 43.1123954 E**

Ibn Sina Hospital consists of ground floor and 2 stories above. The ground floor include Consulting clinic, emergency, pediatrics, Internal medicine for women, internal medicine for men, Heart Care + Blood Disease, Neurosurgery Surgery and operation theaters. The first floor includes Laboratory and Administration. The second floor includes meeting rooms. The hospital operates 24 hours a day.

The current source of power for the hospital is from either the national electricity and / or existing generator with the capacity of (1250 Kva). There is another generator in the hospital of 1000 Kva but not connected.

UNOPS will utilize solar energy by using PV system, this system anticipates to run the operation theatres and intensive care unit with 214.2 kWp.

Point of connection will be with the input of existing Main MCB 100A of DB.

First DB located in the operation theatres zone and second in the intensive care wards.

1. **Al Mansour Health Center, Right side of Mousel City, Nineveh Governorate.**

**Coordinates: 36.3181803 N, 43.1123954 E**

Al Mansour Health Center consists of two floors. The ground floor includes Dental clinic, laboratory, X-ray, Pharmacy, vaccine room, doctor room, women and administration rooms. The first floor includes women care and vaccine room. The health center operates 8 hours.

The current source of power for the hospital is from either the national electricity and / or existing generator with the capacity of (30Kva).

UNOPS will utilize solar energy by using PV system, this system anticipates to run the facility with 64.26 kWp for 8 hours.

Point of connection will be with the input of existing Main MCCB 1000A, located in the main control room of HC.

1. **Scope of Works:**

The works of the PV systems to be undertaken consists of supplying all material to the sites, shipping, logistics, labour, plant, tools, equipment and all facilities for the satisfactory installation, testing and commissioning, maintaining turnkey Solar PV systems with a minimum total capacity of 750 kWp in the following sites.

|  |  |  |
| --- | --- | --- |
| No. | Facility Name | Rated Capacity[kWp] |
| 1 | Andalus Health Centre- Ramadi | 42.84 |
| 2 | Ramadi Maternity Teaching Hospital-Ramadi (2 PV systems) | 238.68 |
| 3 | Jalawla’a Health Centre- Deyala | 91.8 |
| 4 | Odhaim Health Centre- Deyala | 91.8 |
| 5 | Al-Mansour Centre- Mousel | 64.26 |
| 6 | Ibn Sina Hospital- Mousel (2 PV systems) | 214.2 |

**General Requirements**

* In addition to the requirements stated in the aforementioned ITB and the contract, the following items shall be performed **by the Contractor at his own expense**
1. Bidders are recommended to use high quality products and the latest technology available. Bidder shall submit Catalogues / data sheet of all the offered PV systems equipment with detailed technical specifications for the proposed system and components. The offered PV systems shall be capable of operation in the climatic conditions that prevail at the site locations where systems are to be installed and operated, taking into consideration the system sustainability.
2. The Contractor is responsible for all the logistical matters pertaining to the delivery of all material to the sites, labour, plant, tools, etc.. including the documents needed for the clearances from the governmental authorities.
3. System installation, connection, testing, commissioning and in accordance to the manufacturer operation manual
4. As soon as the sites is handed over to the Contractor, and before commencing of any works, the contractor shall prepare design and shop drawings for the Engineer approval entailed the provided drawings, specifications and BOQs in the aforementioned ITB including but not limited to:
* SLD, PV layout, cables sizes, routing, etc. …
* Photovoltaic arrays, mounting systems which shall withstand a wind load of minimum 120 km/h
* Components required for data monitoring and needed to connect the PV system to the interconnection point
* The shop drawings shall be in AutoCAD. The electrical engineering and design shall meet BS standard and local applicable standards taking into consideration the site condition, obstacles, shadings, etc..
* All grounding and protection equipment throughout the system shall be sized and specified to reduce damage on all components.
1. The contractor shall provide copies of the following studies and reports

1. Shading analysis;

2. Expected energy yield and performance ratio;

3. System design and detailed site layout.

1. Installation of PV systems components shall be done in accordance with manufacturer operation manual, bidders will be required to submit stamped operation and manuals prior commencement of works;
2. Balance the distribution of the existing electrical load in the MBD to function properly with the new PV systems.
3. The Contractor shall install a metallic Signboard with an approximate size of 1.5mX1.2m at each site of the works as per the Engineer instructions.
4. Set a protection system against lightning, any equipment fail due to lightning will be replaced by the contractor and on his own cost;
5. Upon completion of the project, the contractor shall submit detailed As built drawings and Maintenance Service Plan which shall be comprehensive, preventative and corrective for the Engineer approval
6. **Training:** The contractor shall provide training on the operation and maintenance of the PV systems to groups of the end users with technical background (approximately 3) at each of the installation site. The trainings shall include on-site training, provision of manuals, operator handbooks that address operation and maintenance, energy usage and best practice, reporting and troubleshooting, DOs and DON’Ts, etc..
7. **Maintenance and Performance Warranty:** The Contractor shall be responsible for performing all the maintenance and warranty for the installed PV Systems components for a minimum period of one year after the substantial completion and handover. The Contractor must pay important attention to carry out the maintenance, repair of supplies with fast response, and commit to providing rapidly supply of spare parts. The Contractor shall take full responsibility of supplying all labour, spare parts, tools, etc.…that are needed for the PV systems components maintenance at no additional cost. The maintenance service shall comprehensive, preventative and corrective.
8. **Specifications:**

**Solar Modules**

* PV modules shall be constructed with minimum shading effect;
* Cell Type: mono-crystalline or poly-crystalline;
* Module’s maximum system voltage should be not less than 1000 V;
* The modules shall have individual serial numbers and nameplate;
* Certifications and standards: IEC 61215, IEC 61730, conformity to CE;
* All modules must be waterproofed;
* The PV modules junction box shall be IP67;
* All modules must be certified from accredited body;
* PV modules should be procured from tier 1 manufacturers only;
* Protection against partial shading via bypass diodes;
* 72 cells of 340W @ STC modules, 5 busbar design;
* Flash reports shall be provided;
* The product warranty should be at least 10 years.

**Solar off grid inverter/ Charger**

* The inverter unit(s) shall be single phase and can be connected in series or parallel to generate with 3 wave forms (Three phase).
* The inverter shall generate pure sine wave form voltage;
* Designed for indoor IP20 or higher;
* The device should have LED indicator and display;
* The device shall be mounted to a non-flammable wall designed to the inverter load;
* Adjustable system voltage 12/24/48 Volts;
* The inverter shall allow low voltage disconnect feature;
* The inverter shall be vertically mounted, the electrical connections and cable glands shall be oriented down;
* Should have integrated transfer switch;
* Should not be situated directly above the battery or in a cabinet with it;
* Minimum acceptable efficiency is 96 % @ full load;
* Output frequency shall be 50 Hz;
* The device shall allow connection to a backup generator and/or utility grid;
* Protections required: Output short circuit, overload, high battery voltage, over temperature, and reverse polarity;
* The inverter should allow remote monitoring and control when connected to the internet;
* AC input and/or output terminals must be provided with uninterruptable grounding;
* Uninterruptible Power Supply functionality;
* Complaint with the following safety standards: EN-IEC 60335-1 and EN-IEC 60335-2-29;
* Complaint with the Electromagnetic compatibility standards: EN 55014-1 and EN-IEC 61000-3-2;
* Compliant with EN-IEC 61000-3-2 standard for limitation of harmonic currents;
* Victron or Studer or equivalent brand are recommended to be used;
* Parallel and/or serial kits shall be provided when needed with no additional cost;
* Product warranty shall be 5 years.

**PV Charge Controller**

* Maximum Power Point Tracking (MPPT) type;
* Minimum acceptable efficiency is 96%;
* Should allow parallel operation, i.e more than one unit can be connected in parallel;
* Adjustable system voltage 12/24/48 Volts;
* Controller must utilize passive cooling with no fans;
* Protections required: Over-temperature and power derating when temperature is high, PV short circuit, reverse polarity protection, PV reverse current protection;
* Controllers to be certified to meet at the following standards: IEC 62109, UL 1741 and EN 61000-6-3;
* Product warranty shall be 5 years.

**Solar Battery**

* VRLA gel type shall be used for this project;
* Only one technology, one brand can be used for the entire project;
* 2 VDC batteries shall be used; Rated Amps as specified in the BOQ.
* The battery capacity will be calculated @10 hr discharge rate;
* The operating temperature for the battery shall be -20°C to +60 °C;
* To be certified to meet UL1989 safety standard,
* To be certified to meet the following standards: DIN40742 and IEC60896-21
* No. of cycles should be at least 2000 @ 80 % DOD, and 3500 @ 50 % DOD;
* Victron or Ritar brand are recommended to be used;
* Design life should be not less than 10 years;
* Product warranty min. 3 years; certificates shall be provided by the manufacturer.

**Roof and ground mounting structure**

* Module mounting structure should entirely be made from Aluminum parts only;
* All clamps used in the project shall be earthling clamps, test reports from accredited body shall be submitted
* No roof punching will be allowed; the mounting structure shall be fixed using concrete blocks
* The system workshop warranty should be at least 5 years

**Control Room Enclosure**

System components (Batteries, Charge controllers, inverters, DC fuses box(s), AC coupling panel) shall be housed inside container. The bidder’s unit price of the control room shall include the followings:

* **Site preparation:** Provision of materials and machines for grading, levelling and removing top soil of any kind not less than 20cm, install bench marks & control points in two directions at the site. The work includes cutting and filling (with approved materials) to any depth required by location. Clearing and grubbing the sites and removing all debris or objects outside the site boundaries with all requirements of work, laying 20cm sub-base materials with good compaction 90%, and according to specification and instructions of site engineer.
* **Concrete works:** Provision of materials and casting the floor with ordinary concrete class (C) (1:2:4) and strength of (210 kg/cm2)  15 cm thickness, a layer of BRC size 10 mm diameter, laid every 20 cm, both directions, using plastic sheet (nylon) under concrete, using electrical machine (helicopter) for smoothing the surface and using electric machine (Cutter) for expansion joints every (7) m with all necessary works taking into consideration reasonable slope for water according to specification and instructions of site engineer
* Supply and Install standard 40’ or 20’ or both as specified in the BOQ white color standard steel container. Each container shall be insulated using high quality foam material including supplying and installing two units of 2 ton air-conditioning units,  2 wall mounted ventilation fans, 3 X (2X36) FLO lighting fixture, waterproof outdoor lighting fixture 250 Watt, distribution board  6 Kg fire extinguisher. The works include all the needed electrical accessories and connections.
* Supply and connect MCCB and cable required for the connection between the DB of Control room and the existing MDB of the facility.

**DC Junction Box**

The DCJB should be placed close to the PV array and it shall combine group of PV strings to derive one common, and it shall follow below specifications as minimum:

* Wall mounted type;
* Suitable for outdoor installation IP65 or higher and can withstand temperature up to 60 degrees;
* Not less than 10 inputs (10 inputs for negative pole and 10 inputs for positive pole);
* Output switch: DC breaker, rating not less than 60 A;
* Each string shall be fused through (10-15) A fuse;
* Connection: DC bus bar with rating not less than 100 A,
* Material shall be metal;
* Warranty shall be not less than 3 years.

**DC Cables**

* PV cables (Between Modules): Should be made of copper with double insulating material and Jacket, TUV certified, cross section not less than 6 mm2;
* Junction box cable (From JB to Charge Controller): Should be made of copper with double insulating material and Jacket, TUV certified, cross section not less than 35 mm2;
* Battery Jumper (Between Batteries): Shall be stranded type and as short as possible, positive and negative terminals should have equal length, the cross section shall be not less than 50 mm2;
* Battery Bank Cable (Between Batteries and DC fuse Box): Shall be stranded type and as short as possible, positive and negative terminals should have equal length, the cross section shall be not less than 50 mm2;
* Charge Controller Cable (Between CC and DC fuse Box): Shall be stranded type and as short as possible, positive and negative terminals should have equal length, the cross section shall be not less than 35 mm2;
* Inverter Cable: (Between DC fuse Box and Inverters): Shall be stranded type and as short as possible, positive and negative terminals should have equal length, the cross section shall be not less than 70 mm2;
* All cables must be covered and protected inside cable tray
* All cables shall be marked properly according to approved design so that cable can be easily identified and traced

**AC Cables**

* The AC cable shall be XLPE type
* The cable loss in the AC side shall be less than 3 %, the contractor shall submit cable loss calculations
* All cables must be covered and protected inside a galvanized cable tray, underground cables shall be housed inside conduit with 60 cm clearance;

**AC Coupling Panel (ACCP)**

* Metal, Steel cabinet, double door, Suitable for outdoor installation IP65 or higher and can withstand temperature up to 60 degrees
* The ACCP shall be vertically mounted, the electrical connections and cable glands shall be oriented down;
* Internal cables shall be neatly routed;
* Shall be located inside the control room, ACCP shall houses the following as minimum:
* MCCB main breaker adjustable, rating in accordance with SLD, Isc:25 kA;
* RCBO inverter breaker, sensiticity:300 mA;
* Cooper bus-bars/Cables and accessories;
* Indicator lamps and Multimeter;
* Type II Surge arrestor protection device

**DC Fuse Box (DCFB)**

* Shall be made of Metal;
* Shall be located inside the control room, DCFB shall houses the following as minimum:
* Fuses for positive pole, the rating should be calculated @C10;
* DC bus bar, the rating shall be as follows in minimum: Maximum Current @C10 X 1.25;
* Inverter Fuses: In accordance with manufacturer recommended values.

**Change Over Switch and Panel:**

* Metal, Steel cabinet, double door, Suitable for outdoor installation IP65 or higher and can Withstand temperature up to 60 degrees;
* Vertically mounted, the electrical connections and cable glands shall be oriented down;
* Internal cables shall be neatly routed;
* Located inside the existing control room of the facility, Change over panel shall houses the following as minimum:
* Change over switch, operates automatically and manually, rating as Specified in the BOQ.
* MCCB main breaker adjustable, same rating of the transfer switch, Isc:25 kA;
* All electrical components required for the protection of change over switch;
* RCBO inverter breaker, sensitivity: 300 mA;
* Cooper bus-bars/Cables and accessories;
* Indicator lamps, Millimeter and ventilation fan;
* Type II Surge arrestor protection device;
* Sound and lighting alarm system last for 20 seconds at the beginning of PV system operation to be installed inside the facility.

**Solar Water Heater**

1. **General**
* The solar water heater shall be pressurized type.
* The heater shall be flat plate type.
* The heater shall have 250 liters hot water storage tank.
* The inclination angle shall be between 30 – 45o.
* The frame and brackets shall be made of Aluminum.
1. **Storage Tank**
* The tank shall be double jacket with 40-50mm Polyurethane foam insulation.
* The inner sheet of the tank shall be made of stainless steel (minimum 304 stainless steel) with a thickness of 0.5mm or thicker.
* The outer sheet shall be painted steel with a thickness of 0.4mm or thicker.
* The tank shall be fitted with provision for electric heater connection.
* Thermostat, safety and drain valve, isolating valves and steel base.
1. **Flat plate solar thermal collectors with the following minimum specifications:**
* Absorber: Black solar painted aluminum surface with minimum 16 copper tubes (total)
* Fluid volume of absorber: minimum 2.5 liter
* Gross Area for each panel: minimum 1.75 m2
* Front cover: Tempered prismatic glass
* Frame: Electrostatic powder coated aluminum extrusion profiles
* Insulation: Direct – injected mono block polyurethane foam
* All required accessories & fitting to complete the installation
1. **Pipes and Accessories**
* Elevated plastic tank made of three layers of Polyethylene (PE) with UV protection fitted with float valve.
* Steel base for the elevated tank made of painted steel. The steel base size shall be sufficient to hold the weight of the elevated tank filled with water and any additional load due to wind or other climatic conditions.
* Isolation ball valves made of Bronze/Brass body and Chrome plated Brass ball at:
	+ Inlet and outlet of the elevated tank.
	+ Inlet and outlet of the solar water heater.
	+ The connection with the hot water network.
* Galvanized steel pipe:

1. Steel Pipe: ASTM A53 or A120, or ASME B36.10, Schedule 40 black.

2. Fittings: ASTM B16.3, 300 lb. threaded malleable iron, or ASTM A234, forged steel welding type.

3. Finish: Prime and finish paint with industrial enamel.

* Ball valve: Carbon steel construction, two piece body, chrome plated steel ball.
* Insulation with applied Aluminum Jacket: Minimum 25mm elastomeric pipe insulation for hot water pipes with suitable tape for fixation on the pipe according manufacturer’s recommendations.
1. Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular form: ASTM C534; Type I, Tubular form.

 B. Elastomeric Foam Adhesive:

Air dried, contact adhesive, compatible with insulation.

* Check valve: 50 mm and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N teflon disc, solder or threaded ends.
1. **Installation**
* Manufacturer’s instruction for installation shall be strictly followed by the contractor.
* The solar water heater shall be installed facing true south with maximum of 10o variation towards southeast or southwest.
* The heater shall be installed in an area free of shade.
* The heater should be vented to atmosphere at a point higher than the elevated tank.
1. Pump: automatic booster pump, 1 l/s flow and 2 bar head, supplied and installed with required fitting and wiring connections, such as but not limited to two shut off valves, strainer, check valve, flow switch and mounting bases in addition to pressurization vessel to operate when pressure in the hot water network drops below the required operational pressure.

**Solar Street Lights**

* All the components of the solar street lights shall be suitable for full performance, in safe, stable and workable manner around the year under very different climate conditions, ranking from snowing conditions to humid, dry and dusty conditions, and ambient temperatures in excess of 60 degrees C and lower than (– 10) degrees C .
* Power Requirement: 60 W - 12V - Stand-alone street light
* LED lamp with min. 4800 lumen (approx. 40 W)
* Must be able to light min. 12 hours/day (approx. 480 Whr/day)
* All in one integrated unit
* The stand-alone street light comes complete turn-key ready with the following components as listed below:

**PV PANELS**

* PV panels size/output to match daily load requirement and simultaneously to fully charge Power bank/battery
* Type of PV cells, either mono, polycrystalline
* Module capacity 60 W
* PV panels with sturdy aluminium frame and sealed glass cover
* Including brackets, junction box(es), screws, nails, cable clips, etc.

**POWER BANK/BATTERY**

* Deep cycle battery/power bank, maintenance free, to match min. 480 Whr/day
* Type of battery: Lithium ion
* Design day of Autonomy: 2 days
* Maintenance free sealed
* Integrated in the module back;
* Requires maintenance, topping up intervals

**TIMER**

Timer, adjustable 1-24 hours, for light-on and light-off must be integrated in the design

**CHARGE CONTROL**

* The Charge control shall be suitable for the other solar street lights components specified in this table and compatible with bidder’s offer in order to attain full performance of the solar street light.
* Charge control unit with internal fuse system and adequate size,

**LAMP**

* LED with min. 4800 lumen, dust and water tight

**STEEL POLE**

* Min. 4 m long (from ground surface to top) hot dip galvanized steel pole suitable to carry PV panel, lamp and power bank/battery under severe windy conditions up to 120 km/h. Pole must be with a suitable base to be placed in the ground. Lamp must be firmly attached to pool on a min. 1 m long hot dip galvanized pole reaching out from the pole.

lamp “sticking out” of the pole and ready to connect to the pole is acceptable;

**The principle items of work for the installation of the solar street lights shall include but are not limited to the following**

1. Design of the pole foundation taking into consideration the site soil conditions, live loads, wind loads, self-weight, dead loads, material standards and all design parameters. The contractor is responsible to provide onsite shop drawings for getting the final approvals from the engineer before starting the works
2. Performance of all necessary earthwork and shuttering for foundation preparation and furnishing of all necessary material including suitable backfill, base concrete, steel reinforcing, bolts, washers, etc. according the foundation plan and structural drawings.
3. All concrete work in substructure shall be mixed with sulphate resistant cement and shall be coated from all sides and top with two coats of a waterproof asphalt. No splices are allowed in the main reinforcement and welding is not allowed.
4. Assembly of all components; installation, testing, and commissioning of the solar streetlight as per Assembly Instructions of the manufacture.
5. This scope of works is not meant to be a comprehensive definition of works, but merely a guide for the items of work contained within this tender package.
6. **Drawings:** The drawings listed below are attached

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Item No.** | **Site** | **Site No.** | **Drawing Name** | **Drawing No.** |
| 1 | Andalus HC | 1 | PV Layout | 1-1 |
| 2 | Andalus HC | 1 | Control Room  | 1-2 |
| 3 | Andalus HC | 1 | SLD | 1-3 |
| 4 | Ramadi Maternity Hospital | 2 | PV Layout  | 2-1 |
| 5 | Ramadi Maternity Hospital | 2 | Control Room OP | 2-2 A |
| 6 | Ramadi Maternity Hospital | 2 | SLD OP | 2-3 A |
| 7 | Ramadi Maternity Hospital | 2 | Control Room Lab | 2-2 B |
| 8 | Ramadi Maternity Hospital | 2 | SLD Lab | 2-3 B |
| 9 | Jalawla'a HC | 3 | PV Layout | 3-1 |
| 10 | Jalawla'a HC | 3 | Control Room | 3-2 |
| 11 | Jalawla'a HC | 3 | SLD | 3-3 |
| 12 | Udhaim HC | 4 | PV Layout | 4-1 |
| 13 | Udhaim HC | 4 | Control Room | 4-2 |
| 14 | Udhaim HC | 4 | SLD | 4-3 |
| 15 | Mansour HC | 5 | PV Layout | 5-1 |
| 16 | Mansour HC | 5 | Control Room | 5-2 |
| 17 | Mansour HC | 5 | SLD | 5-3 |
| 18 | Ibn Sina Hospital | 6 | PV Layout OP | 6-1 A |
| 19 | Ibn Sina Hospital | 6 | Control Room OP | 6-2 A |
| 20 | Ibn Sina Hospital | 6 | SLD OP | 6-3 A |
| 21 | Ibn Sina Hospital | 6 | PV Layout ICU | 6-1 B |
| 22 | Ibn Sina Hospital | 6 | Control Room ICU | 6-2 B |
| 23 | Ibn Sina Hospital | 6 | SLD ICU | 6-3B |
| 24 | Andalus HC | 1 | Change over connection diagram | 1-4 |
| 25 | Ramadi Maternity Hospital Operation | 2 | Change over connection diagram | 2-4A |
| 26 | Ramadi Maternity Hospital Lab | 2 | Change over connection diagram | 2-4B |
| 27 | Jalawla'a HC | 3 | Change over connection diagram | 3-4 |
| 28 | Udhaim HC | 4 | Change over connection diagram | 4-4 |
| 29 | Mansour HC | 5 | Change over connection diagram | 5-4 |
| 30 | Ibn Sina Hospital Operation  | 6 | Change over connection diagram | 6-4A |
| 31 | Ibn Sina Hospital ICU | 6 | Change over connection diagram | 6-4B |
| 32 | Andalus HC | 1 | Earthing Layout | 1-5 |
| 33 | Ramadi Maternity Hospital | 2 | Earthing Layout | 2-5 |
| 34 | Jalawla'a HC | 3 | Earthing Layout | 3-5 |
| 35 | Udhaim HC | 4 | Earthing Layout | 4-5 |
| 36 | Mansour HC | 5 | Earthing Layout | 5-5 |
| 37 | Ibn Sina Hospital | 6 | Earthing Layout | 6-5 |
| 38 | All Site |   | Control room wiring diagram | 7 |
| 39 | All Site |   | Wiring for DB of control room | 7-1 |
| 40 | All Site |   | Control room drawing | 7-2 |
| 41 | All Site |   | Ground mounting structure detail | 8 |
| 42 | All Site |   | Solar water heater detail | 9 |
| 43 | All Site |   | Automatic booster pump Elec. | 9-1 |
| 44 | Andalus HC | 1 | Cabling | 1-6 |
| 45 | Ramadi Maternity Hospital | 2 | Cabling | 2-6 |
| 46 | Jalawla'a HC | 3 | Cabling | 3-6 |
| 47 | Udhaim HC | 4 | Cabling | 4-6 |
| 48 | Mansour HC | 5 | Cabling | 5-6 |
| 49 | Ibn Sina Hospital | 6 | Cabling | 6-6 |

1. **Standards and procedure*s***

**The Contractor must comply with the following procedures:**

- The local and international standard health and safety and environmental laws

- Quality assurance and quality control requirements

1. **Testing and Certificates:**

The testing procedure shall be carried out in accordance to the local standard engineering and construction practice, parameters should be in line with BS standards

The contractor shall provide all necessary equipment and instrument which will be used in commissioning, such instruments has to be calibrated within less than a year

 **System Testing and Commissioning**

1. Cable insulation and continuity test: such tests should be carried before commending installation
2. Battery
* Ensure that batteries are fully charged by measuring the terminal voltage, if not batteries should be charged before carrying out testing and commissioning,
* Battery Inspection and Cleaning: A visual inspection should be done to assess the general condition of the system’s batteries. Check for any electrolyte leak, cracks in the batteries, or corrosion at the terminals or connectors;
* Terminals and connections: ensure that all terminal and connections are tight, and making sure that the same cross section is used for jumpers, measure the negative and positive pole cable length to ensure that its equal.
1. PV Module

- Checking the cleanness of surface (glass) area of the module as it should be free of any dirt and dust;

PV modules Visual Inspection: A visual inspection of the modules should be done to check for defects in the modules such as cracks, chips, de-lamination, fogged glazing, and discoloration, this should be done for the front glass and back sheet;

PV modules Connector and Cable Inspection: Check the sealing gels of the junction box to ensure it have no crack or crevice;

Ensure that all modules have been tested before shipping by double checking the flash reports;

DC voltage measurement: This can be done either on the modules level or on combiner box level;

1. System earthing ;
* System earthing measuring should be done before performing testing and commissioning procedures to ensure the safety of operators and end users.
* Each array structure of the PV yard should be grounded/ earthed properly as per BS 7430:2011. In addition, the lighting arrester/masts should also be earthed inside each array field. Earth Resistance shall be tested in presence of UNOPS engineer as and when required after earthing by calibrated earth tester. PCU, ACDB and DCDB should also be earthed properly.
* Earth resistance shall not be more than 5 ohms. It shall be ensured that all the earthing points are bonded together to make them at the same potential, earthing system shall include but not limited to the following:

|  |  |
| --- | --- |
| Item | Quantity |
| Copper earth rod of 16 - 50 sq. mm, 2.5 Mtr | 2 pc |
| Earthing Plate | 2 pc |
| Main Copper wire of 25 sq. mm | As required |
| Charcoal &salt | As required |
| Earth pit cover (Cast Iron cover) | 2 pc |
| Standards | In accordance to  BS 7430:2011 |

1. Inverter/Battery Charger and Charge Controller
* Ensuring that all components are free of dust, if not, a dry cloth should be used to wipe away any accumulated dirt/dust;
* A visual inspection should be done to ensure that all the indicators such as LED lights are working and a check on the tightening of the bolts both DC and AC
* Charging: The charge controller should indicate that the system is charging when the sun is up, the charging current should be measured for each string/ array.

If such measurement were taken at noon time, the charging current should be close to the maximum current;

Discharging: checking that the battery is discharging when connected to the load;

* Inverter: Checking the voltage and current balancing in the inverter, measuring the output voltage and frequency.
* Checking the operation of the charger when disconnected from the solar, the batteries should not be fully charged.
1. Wiring, Connections and Electrical Panels: Wiring installations should be checked for any cracks, breaks or deterioration in the insulation/conduits, inspect connections for any corrosion and/or burning. Switches should not spark when turned on or off
2. Combiner Boxes and fuses Box: must check strings fuses using a multimeter (continuity test on each fuse) to insure no blown fuse exist, check the tightening of the bolts of the fuse holders should be checked as per manufacturer manual, visual check of the cables and fuse holders;
3. AC Panels: After switching off loads and inverters, check the functionality of the RCDs and RCBOs by bushing test button and noticing the breaker open, check the tightening of all cables bolts as per manufacturer manual, visual check of all cables and breakers.

**SCHEDULE OF SITE**

The 6 locations for the PV systems shall be supplied, delivered and installed in the following locations in Iraq

1. Ramadi Hospital, Ramadi, Anbar Governorate
2. Andalus Helath Center, Ramadi, Anbar Governorate
3. Al Audhaim Helath Center, Al Audhaim, Diyala Governorate
4. Jalawla Helath Center, Jalawla, Diyala Governorate
5. Ibn Sina Hospital, Mousel City, Nineveh Governorate
6. Al Mansour Health Center, Mousel City, Nineveh Governorate

Google Earth site locations

PV1: Al Ramadi Hospital, Ramadi, Anbar Governorate. Coordinates: 33.424039 N, 43.283501 E

Ramadi Maternity Hospital

Ramadi Maternity Hospital

PV2: Al Andalus Health Center, Ramadi, Anbar Governorate. Coordinates: 33.421619 N, 43.297254 E

Andalus HC

PV3: Al Audhaim Health Center, Al Audhaim, Diyala Governorate. Coordinates: 34.272184 N, 44.542792 E

Udhaim HC

PV4: Jalawla Health Center, Jalawla, Diyala Governorate. Coordinates: 34.271945 N, 45.163334 E

Jalawla’a HC

Jalawla’a HC

PV5: Ibn Sina Hospital, Left side of Mousel City, Nineveh Governorate. Coordinates: 36.3997620 N, 43.1123954 E

Ibn Sina Hospital

Ibn Sina Hospital

PV6: Al Mansour Health Center, Right side of Mousel City, Nineveh Governorate.

Coordinates: 36.3181803 N, 43.1123954 E

Mansour HC