

STATEMENT OF WORK (SOW)

HIGH-PERFORMANCE SOLAR ENERGY SYSTEM

AL-SHAAB HOSPITAL, AL-HASSAKAH CITY

1. EXECUTIVE SUMMARY

This Statement of Work defines the comprehensive scope for the design, supply, installation, testing, and commissioning of a high-performance solar photovoltaic (PV) system with battery energy storage for Al-Shaab Hospital in Al-Hassakah City. The system shall provide reliable, uninterrupted power supply to critical hospital departments including dialysis, blood bank, surgery, baby incubators, and elevators.

1.1 Project Overview

- **Total System Capacity:** 134.5 kW actual load (140 kW design capacity)
- **Solar PV Capacity:** Minimum 180 kW (accounting for 30% losses due to soiling and high temperatures)
- **Battery Storage:** 120 kWh minimum capacity
- **Backup Duration:** 1.5 hours excluding surgery rooms, 1.0 hour including all components
- **Design Standards:** BS 7671 (18th Edition), NEC/NECA, IEC 62305

1.2 System Configuration

- **Group 1:** 62.1 kW (270A, 230V) covering dialysis and blood bank departments
- **Group 2:** 72.4 kW (315A, 230V) covering surgery, baby incubators, and elevators

2. SCOPE OF WORK

2.1 Battery Energy Storage System (Item A.1)

2.1.1 Technical Requirements

Supply and install complete battery rack systems with the following specifications:

Battery Specifications:

- **Type:** High-quality Lithium Iron Phosphate (LiFePO₄) cells

- **Minimum Capacity:** 120 kWh total system capacity
- **Configuration:** High Voltage 48V battery system
- **Battery Management System (BMS):** Integrated smart BMS for optimized performance
- **Depth of Discharge (DOD):** 90% minimum
- **Cycle Life:** ≥6,000 cycles at 25°C at specified DOD
- **Operating Temperature:** -20°C to +55°C (charging/discharging)
- **High-Voltage Box:** HVB750V/100A supporting 120-750 VDC operating range
- **Maximum Current:** 125A charge/discharge capability

Protection Features (per BS 7671 Section 542 & NEC Article 480):

- Overvoltage protection
- Undervoltage protection
- Overcurrent protection
- Short-circuit protection
- Temperature monitoring and protection
- IP20-rated housing minimum
- Built-in status indicators for real-time monitoring

Additional Requirements:

- DOD performance curves must be provided by manufacturer
- Battery production date not older than three (3) months prior to purchase order
- Manufacturer's complete datasheet required (photographs alone not acceptable)
- Supply and installation of rectangular iron battery base with rust-resistant paint and lock
- Base to be sized appropriately for installation location

Quantity: 2 complete systems

2.2 Solar Photovoltaic Modules (Item A.2)

2.2.1 Technical Specifications

Supply and install solar panels meeting the following requirements:

Panel Specifications:

- **Type:** Bifacial dual-glass monocrystalline modules
- **Minimum Power:** 580W per panel
- **Module Efficiency:** >17%, Class A rating
- **Protection:** Minimum IP65 rating (per BS 7671 Section 712.522)
- **Service Life:** Not less than 25 years
- **Junction Box:** Equipped with bypass diodes, cables, and MC4 connectors
- **Certifications:** IEC 61215, IEC 61730 compliance

Warranty Requirements:

- 10-year manufacturing warranty
- 12-year performance guarantee at 90% rated power
- 25-year performance guarantee at 80% rated power

Installation Requirements:

- Total quantity: 342 panels minimum (based on 180 kW requirement with 30% derating)
 - Group 1: panels covering 430 m²
 - Group 2: panels covering 490 m²
- Complete datasheet must be provided (photographs alone not acceptable)
- All mounting structures, frames, bolts, nuts, and fasteners per design drawings
- Installation per BS 7671 Section 712 and NEC Article 690

2.3 Industrial Inverters (Item A.3)

2.3.1 Technical Specifications

Supply and install three-phase industrial inverters:

Inverter Specifications:

- **Minimum Capacity:** 80 kW per unit

- **Battery Voltage Range:** 160-1000 V
- **MPPT Voltage Range:** 150-850 V
- **Solar Panel Inputs:** X14 minimum (each handling 15 panels in series)
- **Rated AC Current:** Input 120A / Output 115A
- **Communication:** RS485/RS232/CAN interfaces
- **Monitoring:** GPRS/WiFi/Bluetooth/4G capabilities
- **Noise Level:** ≤65 dB
- **Warranty:** 5 years minimum

Protection Features (per BS 7671 Section 712.53 & NEC Article 690.9):

- DC reverse polarity protection
- AC output overcurrent protection
- Thermal protection
- AC output overvoltage protection
- AC output short-circuit protection
- DC component monitoring
- Arc-fault circuit breaker (per NEC 690.11)

Quantity: 3 units (1 for Group 1, 2 for Group 2)

2.4 PV Distribution Boards (Item A.4)

Supply and install DC distribution boards per Sheet A2:

Group 1 Configuration:

- 12 × 63A DC MCCB/MCB
- 12 × Class 1 DC SPD (Surge Protection Device)
- Connection using 1×6mm² PV copper cables (per BS 7671 Table 4D4A)

Group 2 Configuration:

- 14 × 63A DC MCCB/MCB
- 14 × Class 1 DC SPD

- Connection using 1×6mm² PV copper cables

String Configuration:

- 15 panels per string (7-8% tolerance)
- V_{mp} (string) = 750V
- V_{oc} (string) = 855V
- String current: 12-16A

Cable Requirements (per NEC Article 690.31):

- 10 AWG copper, 90°C insulation
- PV-rated cable with sunlight-resistant insulation
- DC voltage rating >855V

2.5 AC Distribution Boards (Item A.5)

Supply and install AC distribution boards per Sheet A3:

Group 1 AC DB (Quantity: 1):

- 3 × 100A AC Digital MCB (16-step)
- 3 × 125A AC MCB
- 1 × Class 1 AC SPD, 4P
- 1 × RCB/RCD, 4P (per BS 7671 Section 411.3.3)
- 1 × 200A AC MCCB, 4P

Group 2 AC DB (Quantity: 2): Each containing same configuration as Group 1

Cable Specifications:

- 4 × 25mm² PVC/XLPE cables from inverters to changeover switches

2.6 New Distribution Boards #2 (Item A.6)

Supply and install new distribution boards:

Configuration (3 units total - 1 for Group 1, 2 for Group 2):

- 3 × 100A AC Digital MCB (16-step)
- 3 × 125A AC MCB

- 1 × 250A DC MCCB
- 1 × Class 1 AC SPD, 4P
- 1 × RCB/RCD, 4P
- 1 × 400A AC MCCB, 4P

400A MCCB Specifications:

- Rated Current (In): 400A
- Rated Voltage (Un): 415 VAC, 50/60 Hz
- Number of poles: 4-pole (4P)
- Thermal Protection (Ir): Adjustable $0.7-1.0 \times I_n$ (280-400A)
- Magnetic Protection: Fixed at $12 \times I_n$ (4800A)
- Breaking Capacity (Icu): 50 kA at 415 VAC
- Standards: IEC 60947-1, IEC 60947-2

Cable Requirements:

- 4 × 70mm² PVC/XLPE cables
- 4 × 95mm² PVC/XLPE cables
- 1 × 70mm² PVC/XLPE cables Per Sheet A3 configuration

2.7 Existing Main Distribution Boards & Changeover Switches (Item A.7)

2.7.1 MDB Maintenance

- Maintain existing MDBs at Group 1 and Group 2 control centers
- Cable rerouting as required
- Cleaning and replacement of damaged components
- Ensure safe and reliable operation per BS 7671 Section 132.12

2.7.2 Changeover Switches

Supply and install manual changeover switches:

Specifications:

- Nominal Current: 250A

- Nominal Voltage: 415V AC
- Number of Poles: 4
- Type of Operation: Manual rotary switch
- Safety Features:
 - Handle lock capability for unauthorized operation prevention
 - Door lock in switching positions
 - Position 0 lock capability
- Standards: IEC 60947-3 compliance
- Protection Box: Included

Quantity:

- Group 1: 1 × 250A changeover switch
- Group 2: 2 × 250A changeover switches

2.8 Control Center Maintenance (Item A.8)

Prepare and condition inverter rooms/control centers:

Scope:

- Surface finishing and painting
- Installation of thermal and electrical insulating panels
- Window replacement/repair
- Installation of power outlets (per BS 7671 Section 411)
- Lighting systems installation (per BS 7671 Section 559)
- Complete electrical infrastructure

Locations: Group 1 and Group 2 control centers per Sheet A1

2.9 Air Conditioning Units (Item A.9)

Supply and install inverter air conditioners:

Specifications:

- Capacity: 18,000 BTU

- Voltage: 220V, 50Hz
- Compressor: Rotary inverter type
- Refrigerant: R410A
- Tubing: Copper for indoor and outdoor units
- Climate Rating: T3 (tropical)

Quantity: 2 units

2.10 Earthing System (Item A.10)

Supply and install complete earthing system per BS 7671 Chapter 54 and NEC Article 250:

Configuration:

- Group 1: 3 earth pits minimum
- Group 2: 6 earth pits minimum
- Lightning Protection System: 3 earth pits minimum

Technical Requirements:

- Target Resistance: $\leq 1.0\Omega$ (per BS 7671 Regulation 542.2.4)
- Rod Specifications: 16mm diameter copper-bonded, 3.0m length
- Borehole: 100mm diameter
- Backfill: Charcoal-salt-lime mixture (3:1:1 ratio)
- Conductor: 35mm² copper
- Conduit: 1-inch PVC for conductor protection
- Test Points: Housed in plastic manholes

Installation per Sheet A4:

- Earth pit depth: 150cm
- Connections at two points minimum per rod
- Interconnection between all earth pits
- Full integration with PV array, inverters, batteries, SDPs, and LPS

2.11 Lightning Protection System (Item A.11)

Supply and install Class I LPS per IEC 62305:

Air Terminals:

- Material: Copper or aluminum, 15mm diameter
- Height: Minimum 150cm above highest PV panel point
- Grid: Maximum 5m × 5m spacing
- Support: HSS 80×40×2mm structural steel sections

Mounting:

- Base plate: 10mm thick
- Anchors: 4 × wedge anchor bolts (10mm dia × 75mm length)
- Edge bolts: 4 × Ø10mm, L75mm, @1500mm spacing

Down Conductors:

- 35mm² copper earth cable
- Protected routing to earth pits

2.12 Fire Safety System (Item A.12)

Supply and install fire safety equipment per NFPA standards:

Per Control Center:

- 1 × 6kg ABC dry powder portable extinguisher
- 4 × Automatic fire extinguishing balls positioned above:
 - Inverters
 - Batteries
 - Distribution boards

Installation:

- Appropriate mounting brackets
- Clear labeling and signage
- Compliance with international fire safety standards

2.13 Generator Starting Batteries (Item A.13)

Supply and install generator batteries:

Specifications:

- Type: Dry cell
- Capacity: $\geq 200\text{Ah}$
- Cycle Life: 1,500 cycles at 50% DOD, 25°C
- Nominal Voltage: 12V
- Operating Temperature: -20°C to +65°C
- Clear permanent labeling of technical parameters

Requirements:

- Manufacturer's charge/discharge curves required
- Production date ≤ 4 months from purchase order
- Complete technical datasheet (no photographs only)

Quantity: 10 units

2.14 Generator Maintenance (Item A.14)

Perform preventive and corrective maintenance:

Generators:

- 630 kVA unit
- 220 kVA unit
- 45 kVA unit

Scope:

- Replace all necessary parts and consumables
- Test under rated load conditions
- Ensure full mechanical and electrical readiness
- Handover after one week of operation

2.15 Additional MCCB Requirements

630A MCCB Specifications:

- Rated Current: 630A
- Operating Voltage: 415V AC
- Frequency: 50/60 Hz
- Number of Poles: 4
- Thermal Protection: Adjustable $0.7-1.0 \times I_n$
- Magnetic Protection: Fixed at $10 \times I_n$
- Breaking Capacity: 100 kA
- Standards: IEC 60947-1, IEC 60947-2

3. TECHNICAL STANDARDS AND COMPLIANCE**3.1 Applicable Standards**

All work shall comply with:

- BS 7671:2018 (18th Edition) - Requirements for Electrical Installations
- National Electrical Code (NEC) - NFPA 70
- IEC 62305 - Lightning Protection
- IEC 60947 - Low-voltage Switchgear and Controlgear
- IEC 61215 & IEC 61730 - Photovoltaic Modules
- NECA Standards for electrical construction

3.2 Specific Code Requirements**BS 7671 Compliance:**

- Section 132.12 - Design and installation quality
- Section 411 - Protection against electric shock
- Section 542 - Earthing arrangements and protective conductors
- Section 559 - Luminaires and lighting installations
- Section 712 - Solar photovoltaic (PV) power supply systems

- Chapter 54 - Earthing arrangements and protective conductors

NEC Compliance:

- Article 250 - Grounding and Bonding
- Article 480 - Storage Batteries
- Article 690 - Solar Photovoltaic (PV) Systems
- Article 690.9 - Overcurrent Protection
- Article 690.11 - Arc-Fault Circuit Protection
- Article 690.31 - Methods Permitted (Wiring)

4. QUALITY ASSURANCE & CONTROL

4.1 Documentation Requirements

- Complete technical datasheets for all equipment
- Manufacturer warranties and certificates
- As-built drawings
- Operation and maintenance manuals
- Test certificates and commissioning reports

4.2 Testing & Commissioning

- Insulation resistance testing per BS 7671 Section 643
- Earth resistance testing $\leq 1.0\Omega$
- Functional testing of all protection devices
- Load testing at rated capacity
- 7-day operational test period before final handover

4.3 Supervision

All works shall be executed under the supervision and instructions of the site engineer, with compliance to:

- Approved design drawings (Sheets A1-A4)

- Contract specifications
- International safety standards

5. PROJECT DELIVERABLES

5.1 System Performance

- Minimum 180 kW solar power generation capacity
- 134.5 kW continuous power delivery to critical loads
- 1-1.5 hours battery backup depending on load configuration
- System efficiency $\geq 96\%$

5.2 Documentation Package

- Complete as-built drawings
- Equipment operation manuals
- Maintenance schedules and procedures
- Warranty documentation
- Training materials for hospital staff

5.3 Training

- Comprehensive operator training for hospital maintenance staff
- System operation procedures
- Emergency response procedures
- Basic troubleshooting guide

6. WARRANTY AND MAINTENANCE

6.1 System Warranties

- Solar panels: 25-year performance warranty
- Inverters: 5-year warranty minimum
- Batteries: Per manufacturer specifications

- Installation workmanship: 2-year minimum

6.2 Maintenance Requirements

- Preventive maintenance schedule
- Spare parts list
- Emergency contact procedures
- Remote monitoring setup where applicable

7. SAFETY REQUIREMENTS

7.1 Installation Safety

- Compliance with all local and international safety standards
- Proper PPE for all installation personnel
- Safe work method statements for all high-risk activities
- Daily safety briefings

7.2 Operational Safety

- Clear labeling of all equipment (per BS 7671 Section 514)
- Warning signs for high voltage areas
- Emergency shutdown procedures
- Arc flash protection where required (per NEC Article 690.11)

7. ACCEPTANCE CRITERIA

The system shall be considered complete and acceptable when:

1. All equipment is installed per approved drawings and specifications
2. System generates minimum 180 kW under standard test conditions
3. Battery backup provides specified duration at full load
4. Earth resistance measures $\leq 1.0\Omega$ at all points
5. All protection systems function correctly

6. Documentation package is complete
7. Training has been provided to hospital staff
8. 7-day operational test completed successfully
9. All punch list items resolved
10. Final inspection approved by supervising engineer