LEBANESE REPUBLIC
GENERAL DIRECTORATE OF THE PRESIDENCY
PRESIDENTIAL PALACE COMPOUND- BAABDA

Provision of services related to the Design and Preparation of Complete Tender Documents for Solar P.V System for the Presidential Palace Compound

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TENDER DOCUMENTS

VOLUME 2

TECHNICAL SPECIFICATIONS

ELECTRICAL ENGINEERING SERVICES- R5

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VOLUME 2 : TECHNICAL SPECIFICATION

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SECTION 260500
COMMON WORKS RESULTS FOR ELECTRICAL

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Basic electrical materials and methods requirements. The work of this section is integral with the whole of the contract documents and is not intended to be interpreted outside that context.

Part 2 - PRODUCTS

2.01 MATERIALS

A. All equipment and materials used in the for solar system work shall be new and of the highest quality to the best modern practices. All materials shall be approved types, supplied by approved manufacturers and shall be fully suitable for use in the climatic conditions stated and on standard frequency and voltage of Lebanon.

All electrical materials and equipment shall comply in all respects (design, properties, qualities, testing, etc.) as a minimum with the latest International Electro technical Commission (I.E.C.) recommendations (as applicable), EDL.

B. All materials brought to site for use on the project shall be offered for inspection by the Engineer. The Engineer reserves the right to inspect materials on site at reasonable times and to reject any materials not complying with the specifications.

C. The cost of dismantling and re-erection of the installation occasioned by the removal of the rejected materials shall be at the Contractor's expense.

D. Component parts of similar use and rating shall be interchangeable with each other.

E. All manufactured items shall be the product of manufacturers regularly engaged in producing works of the types specified and be constructed and finished by the same manufacturer.

F. All manufactured items shall be free from imperfections and defects which affect their appearance or may impair their durability or serviceability.

2.02 ORDERING OF MATERIALS

A. The detail of equipment and materials shall include the following:
   1. Full Technical Specifications of equipment including construction, materials, degree of protection, characteristics, curves, diagrams, ratings, dimensions, fixing details, etc.
   2. Relevant sheets of manufacturer's catalogues, specifications, technical data, etc.
   3. Confirmation that equipment and materials offered complies fully with relevant clauses of the Specification and, in case of deviation from the Specification, a schedule of deviations listing all points not conforming to the Specification shall be submitted for the Engineer's approval.

B. Manufacturers specified by name are not relieved of the responsibility for compliance with the Specification.

Part 3 - EXECUTION

3.01 FIXING

A. General
   1. Unless indicated elsewhere in the Specification or on the drawings, the Contractor shall provide and make all fixings to the solar system, PV. Panels, inverters and DC and A.C panels.

B. All metal fixing devices shall be zinc or cadmium plated, sheradized or hot dipped galvanized including any expansion shields, plugs, nuts, washers, etc., associated with the fixing devices.

C. The Contractor shall carry out any drilling for screw fixings of, cable trunking, ducting, wiring, conduit fittings, accessories and finishing trims supplied under this Contract.

D. Purpose made fixing clips and brackets may be necessary in certain areas and the Contractor shall be deemed to be aware of this at the time of tendering and to have included for the supply and fixing of same in this Tender Bid.

E. Details of proposed clips and/or brackets shall be submitted to the Engineer for approval, prior to the manufacture of same being commenced.

F. Holes shall not be drilled in any structural steel work without first obtaining the approval of the Engineer.

G. All supports or mountings described above, shall be steel, hot dipped galvanized after fabrication wherever practicable. In cases where the Engineer agrees that it is not practical to provide galvanized steel, supports and mountings shall have at least two coats of rust resistant paint applied.

H. For the structure works related to PV panels refer to the technical specifications in the structure section.

SECTION 260510
BASIC ELECTRICAL REQUIREMENTS

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: The functional and technical requirements for designing, engineering, supplying, installing, testing and commissioning of all solar system and electrical works complete in accordance with the requirements of the Contract Documents, which shall include, but not be limited to the following:
   1. Main low-tension switchboards.
   2. Earthing system.
   3. Cable trays, cable trunking and conduits.
   4. Main feeders and bus ducts.
   5. Lightning protection system.
   6. Solar system
   7. Medium low voltage oil type transformers (kiosk package).

B. Related work specified elsewhere: The services installations are mentioned above the Contractor shall coordinate these works with the existing Electrical Installations and with all other Works.

C. Contractor should employ approved MEP design consultant to design the system and submit drawings in hard copy and soft copy in AUTOCAD latest format for Client review and approval.

1.02 REFERENCES & STANDARDS

The minimum standards for products specified in this section shall be latest relevant IEC standards (as applicable) including but not limited to the following. Except as otherwise specified herein, perform work in accordance with specification codes and standards cited therein and to latest applicable addenda and supplements.

1. Relevant IEC Standards.
2. Regulations issued by EDL.
3. Lebanon Civil Defense requirements.
4. Other Local Authority/Baadba Municipality
5. The requirements of the specifications are based on the conformance with B.S or US. Codes and standards

5-1 Low voltage electrical insulation; protection against voltage disturbances EEC-60364-44:

- Circuit breakers for overcurrent protection, circuit breakers for A.C and D.C operation IEC 60898-2
- Low voltage switchgear & control gear- circuit breakers. IEC 60947-2-
- Low voltage switchgear and control gear assemblies IEC 61439

5-2
- Photovoltaic devices, measurement of photovoltaic current voltage characteristics IEC 60904-1
- Requirements for reference solar devices. IEC 60904-2
- Measurement of spectral response of photovoltaic (PV) device IEC 60904-8
- PV-power generating system, design, qualification; general and guide- IEC-61215 and 61277
- PV. Power conditioners, procedure for measuring efficiency IEC-61683
- PV system performance monitoring, guidelines for measurement, data exchange and analysis IEC (61721; 61724; 61727)
- PV. array measuring of LV characteristics and requirements for construction and testing and safety qualification IEC (61730; 61829)
- Balance of system components for PV. system design qualification natural environments. IEC-62093

5-3 Inverters:

- Safety of power converters for use in PV power system (general requirements; and particular requirements). IEC (62109-1 and 62109-2) & EN 62116
- Instrument inverters, converter; controllers and interconnection system equipment for use with distributed energy resources NFPA-70

5-4
- Grid connected PV. Systems minimum requirements for commissioning tests and inspection IEC-62446

- Interconnecting distributed resources with electric power systems IEEE-1547

5-5 - Standards test methods:
ASTM E-(1036; 1171; 1799; 1802; 1830 and 2047)

5-6 The cable installation shall comply with EDL regulations or the following International Standards (as applicable):

- Specification for Pressure-Sensitive Adhesive Tapes for Electrical Insulating Purposes (BS 3924)
- Specification for Armoured Cables with Thermosetting + IEC 502 Insulation for Electricity Supply (BS 5467)
- Specification for XLPE Cables (BS 5468)
- Specification for PVC-Insulated Cables (non-armoured) for + IEC 227 Electric Power and Lighting (BS 6004)
- Specification for Mechanical Cable for Elastomer and Plastics Insulated Cables (BS 6121)
- Specification for PVC-Insulated Cables for Electricity Supply (BS 6346)
- Specification for High Conductivity Plain Annealed Stranded Copper Conductor (BS 6360)
- Requirements for Electrical Installations (BS 7671)
- Code of Practice for Selection, Installation and Inspection of Cable Glands used in Electrical Installations (BS 6121)

5-7 The installation for low voltage switchgear and switch boards shall comply with the following Standards, including all amendments:

- Switchgear & Control Gear Assemblies-General rules (IEC 61439-1 LV)
- LV Switchgear & Control Gear Assemblies - Power Switchgear and Control gear Assemblies (IEC 61439-2)
- Enclosed LV Switchgear & Control Gear Assemblies Guide for testing under conditions of arcing due to internal fault (IEC 61641)
- LV Switchgear & Control Gear - General rules (IEC 60947-1)
- Circuit breakers (IEC 60947-2)
- Specification for Cartridge Fuses for voltage up to and (Part 1 to 4), including 1000V A.C. and 1500V D.C. BS 88 (IEC 60269)
- Direct Acting Indicating Analog Electrical (1 to 9 parts) Measuring Instrument & their accessories (IEC 60051)
- Environmental Testing (IEC 60068)

1.03 SYSTEM DESCRIPTION

A. System Parameters:

1. All equipment and materials used in the electrical installation work shall be so designed and constructed that they shall provide satisfactory service without any harmful effects for prolonged and continuous periods in the worst climatic conditions prevailing in Lebanon as stated hereunder:
    a. 40 Deg. C if installed within buildings having good heat insulating properties and adequate ventilation.
2. The temperatures quoted above make no allowance for heat generated from the equipment itself or from any other equipment installed in the vicinity.
3. The capacity and rating of all electrical equipment and materials given are, unless otherwise indicated, Lebanon rating i.e. rating when equipment are operating under Lebanon Climatic Conditions. Provide the basis of the normal rating and the de-rating factors applied in each case.
4. Where specific sizes are indicated e.g. cable sizes, due allowances have been made in the design for the climatic conditions of Lebanon and de-rating has been applied.
5. During stoppage of air-conditioning for extended periods, equipment shall withstand and work satisfactorily in temperature and humidity conditions specified in the previous paragraph.
6. Special attention shall be given to high dust content in the atmosphere from time to time and special steps to prevent the ingress of dust shall be provided.
7. The Contractor shall state the environmental conditions which apply to the reliable working of the system offered, especially for the transistors, integrated circuits, central processing equipment and memories, etc.

B. System Performance:

1. The performance of various systems and equipment shall be as specified separately in each concerned section of this specification. The results and readings obtained shall be equal or better than the requirements of the IEE, EDL, Civil Defense and with the relevant standards.
2. The Contractor shall guarantee that all elements of the systems are of sufficient capacity to meet the performance requirements stipulated in or implied by the Contract Documents.

C. Design Requirements:

1. All electrical equipment, accessories and fittings shall be designed and manufactured to operate continuously in the electricity supply system having the following characteristics:

a. Voltage : 380/220V ,3 phase, 4 wire.
b. Frequency : 50 Hz.

2. Substantial completion certificate will be issued only after testing and commissioning of all equipment with EDL permanent power supply.
3. Contractor shall be responsible for designing the whole system and taking approval from EDL, Civil Defense and other related local authorities having jurisdiction.

1.04 SUBMITTALS

A. General: All submissions for approval shall be submitted sufficiently in advance of requirements to allow the Engineer ample times for checking and approving in accordance with Contract Documents.

B. Product Data:
1. Manufacturer's Data: Prior to the submission of shop drawings, submit to the Engineer full design drawings, details, specifications, installation instructions, etc., of all materials and equipment proposed for use but in all cases no such materials/equipment shall be ordered, delivered or installed without the prior written approval of the Engineer to the Contractor's shop drawings incorporating the said materials/equipment. Any material or equipment which is not approved but installed shall be removed and replaced at the Contractor's expense.
2. The details of materials and equipment shall include the following:
   a. Full technical specifications of equipment including construction, materials, degree of protection, characteristic curves, diagrams, capacities, rating, dimensions, fixing details, etc.
   b. Relevant sheets of manufacturers' catalogues, specifications, technical data, etc.
   c. The estimated current consumption and heat dissipation of any equipment proposed.
   d. Time current characteristic curves for all circuit breakers and fuses
   e. Detailed short circuit calculations; include all components shown on schematic diagrams and discrimination level for up-stream and down-stream breakers and busbars.
   f. Maintenance and supervisory statistics as approved by others for similar systems.
3. At the time of providing the above details submit a statement from manufacturer to the effect that the proposed materials, equipment and systems' performance and functions comply fully with the relevant Clauses of the Specification and, in case of deviation from the Specification, submit a schedule of deviations listing all points not conforming to the Specification.

4. At the same time submit a preliminary time schedule to indicate all logistical elements (i.e. design, submission for approval, ordering, shipping, delivery, installation, etc.).

C. Shop Drawings:

1. General:
    a. The Electrical Drawings are intended to show the general arrangement of work and the approximate location of equipment.
    b. Refer to all Contract Drawings to verify all spaces and conditions affecting the electrical work and to ascertain the location and routes of all services.
2. In accordance with the Contract Documents prepare and submit for approval before commencing any portion of the Contract work, shop drawings for the following systems:
    a. Distribution boards.
    b. D.C combiner and A.C combiner
    c. P.V panels installation.
    d. Power distribution system.
    e. Earthing system.
    f. Lightning protection system.
    g. Cable trays and ladder, raceways and boxes, electrical identification.
3. Shop drawings shall show, but not be limited to the following:
    a. Exact routing of cables including sizes.
    b. Cable trays, including routing, sizes, invert level of the trays and details of supports and hangers, covers, sleeves, etc.
    c. Exact runs of conduits and trunking
    d. Switchboards and distribution boards panels including location, layout, dimensions, fixing details, rating of different components, cabling and final connection arrangement.
    e. Schedule of electrical board indicating type, rating, frame size and trip setting for all circuit breakers and relevant instruments.
    f. Proposed supports and hangers for cable trays, conduits, cables, etc., including details of materials, finish, sizes and method of fixing to structure.
    g. Exact routing of main earthing conductors, down conductors include location and dimensions of earth pits, number of earth rods and details of clamps, connectors and test boxes.
    h. Main power schematic diagram and panel board wiring of various distribution boards, main distribution boards, busbar risers to the main switch boards along with frame size of all breakers, rating and size of busbars and rating/range of control and indicating instruments.
    i. Schematics and block diagrams of equipment configurations and installation of various equipment for solar systems.
    j. Outline drawings for various systems showing the physical system elements:
        i) General layout.
        ii) Outline dimensions of the equipment
        iii) Relations, connections and interfaces between all remote equipment and devices.

iv) Relations and connections at existing main panel boards.

4. Design and shop drawings shall be drawn to a scale approved by the Engineer and shall not be less than 1/100, and 1/50 scale for main electrical inverters and batteries rooms.

D. Cabling Routing Shop Drawings:
Provide complete shop drawings showing the cables routing with road crossing from inverters rooms to main electrical room.

E. Progress Record Drawings:
1. Furnish and keep on the job site at all times one complete and separate set of blackline prints of the electrical work on which shall be clearly, neatly and accurately noted, promptly as the work progresses, all electrical changes, revisions and additions to work as actually installed. Wherever work is installed other than as shown on the Drawings, such changes shall be noted.
2. Indicate daily progress on progress prints by colouring in the various parts of the Works as they are erected.
3. No approval for payment of work installed will be given unless supported by coloured up record prints as required above.

F. "As-built" Drawings:
1. At the conclusion of work, prepare and submit "as-built" Drawings prepared from the latest progress prints.
2. Contractor shall prepare as-built drawings.
Necessary follow-up, calculations shall be submitted by the Contractor.
3. In addition, submit sets of compact discs (CD) in AutoCAD (DXF or DWG) format of all "as-built" drawings.

G. Operation and Maintenance Instruction Manuals
1. At the time of submitting "as-built" drawings, provide the Engineer with three properly printed and bound copies of operation and maintenance instruction manuals for each equipment related to solar system to describe in the fullest detail to facilitate the proper operation, maintenance, replacement of parts and awareness of system characteristics. Such manuals shall include the following:

a. Index of as-built drawings.
b. General description of systems.
c. Manufacturers' technical catalogues, dimensional drawings and wiring diagrams for each and every type of equipment of the solar systems installed.
d. Operating instructions for various equipment and systems included in the installation work.
e. Maintenance manuals for all equipment and PV. panels included in the installation work which need regular and specialised maintenance.
f. Hardware and software facilities, functions and principles of particular systems.
g. Spare parts list with part numbers of various components of all equipment used in the solar system of the installation work.

2. Bind the manuals in A4 size plastic covered loose leaf ring binders with hard covers. Fold drawings larger than A4 and accommodate in the binder so that they may be unfolded without being in any way detached from the rings.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: The electrical and communications materials and installation shall be in compliance with the latest relevant BS, IEC and IEE, EDL, Civil Defense and Baabda Municipality.

B. Quality of Materials
1. It is not the intention of this Specification to provide all details of design and fabrication. The Contractor shall ensure that the equipment has been designed and fabricated to good and prevailing commercial practice in accordance with applicable Engineering Codes and Standards. When specific requirements are stated in the Specification that exceed and/or overlap requirements of the codes and standards the Specification shall govern.
2. Design, material, fabrication, examination, testing, inspection, certification, documentation, and operation shall conform to the following or any other equivalent codes, regulations, standards, specifications, and addenda, as applicable.
a. Regulations for EDL, Lebanon and latest amendments.
b. Regulations for Electrical Installations, 17th Edition, issued by the Institution of Electrical Engineers, London.
c. IEC Standards, issued by the International Electro-technical Commission.
d. Relevant British Standards for Electrical Equipment and Materials.
e. Relevant British Standards Codes of Practice (BSCP).
f. International Commission for Conformity Certification of Electrical Equipment (CEE).
g. National Fire Protection Association (NFPA).

3. In the event of conflicting requirements between the authorities cited above or between authorities cited and those specified, such conflicts will be resolved by the Engineer under the terms of the Contract.

C. Quality of Workmanship
   1. Equipment of the solar system and electrical of Works shall be installed in such a manner that equipment, operating and control devices, etc., are readily accessible for service and that adequate access spaces are maintained.
   2. Obtain detailed information from the manufacturers of the equipment as to the proper method of installation and connection of their equipment.
   3. Should any portion of the works which should reasonably be inferred as necessary for the complete, safe and satisfactory operation of any system of the Electrical Work as a whole, be not expressly described or specified, provide and execute such works as a part of this work at no extra cost to the Employer.

D. Approval by Public Authorities:
   1. Ensure that, where applicable, the work and any materials used in the execution of the work in accordance with the Contract, comply with the requirements of the particular Public Authority having jurisdiction.
   2. Where necessary to comply with regulations, inform the Public Authority of the proposed work and obtain from them any written approval that may be required.
   3. Submit to the Public Authority any materials for testing that the Authority may require.
      Provide the Engineer with a copy of all correspondence, test certificates, etc., in connection with the works.

1.06 DELIVERY, STORAGE AND HANDLING

A. During transportation or storage, all equipment and materials must not be subject to damage even from temperatures ranging from -10ºC to 60ºC, relative humidity from 10% to 95% and high dust content in the atmosphere.

1.07 WARRANTY

A. Manufacturers shall provide their standard warranties for unless Special Project Warranties are required.

1.08 MAINTENANCE

A. Operation and Maintenance:

1. Include for Operation and Routine Maintenance including Preventive Maintenance commencing from date of testing and commissioning requirements of the Contract Documents as follows:
    a. Defect liability/breakdown maintenance, inclusive of replacement parts.
    b. Submit the schedule of the routine Operational and preventive maintenance of all solar systems with all equipment for the Employer's/Engineer approval.
    c. Preventive maintenance as scheduled, inclusive of replacement parts and consumables.
    d. Attending to emergency situations, which may damage property or endanger lives, even outside normal working hours.
    e. Provide a written monthly report to the Employer, detailing the maintenance work performed; including dates, parts replaced etc.
    f. The Employer's personnel shall be allowed to witness or participate (without damages interference) in the above activities.
2. Provide all necessary maintenance staff experienced in both mechanical and electrical work such as engineers, foremen, mechanics, electricians, helpers, for effective maintenance of all solar systems. Submit to the Engineer for approval qualification details of all maintenance staff.
3. The Contractor shall note that during the Defect's Liability Period, rapid response to calls for attendance on-site may be necessary. It may, therefore, be necessary, at times, for the Contractor to undertake repairs to defective Contract Works outside normal working hours. Include all routine and preventive scheduled maintenance as recommended by the equipment manufacturers to keep all electrical and solar systems installation in perfect operating condition.
4. During the Defect's Liability Period, maintain, replace and repair any part of equipment or material within the systems which may prove defective due to Contractor's design, erection, operation, performance or workmanship, or prove defective from any act or omission that may develop from use in the Works or any section thereof.
5. Submit a detailed maintenance schedule for PV. panels which shall cover but not be limited to the following:
    a. At least every three (6) months remove all dust, etc., from the PV. panels
    b. Check all the connection and wiring for correct operation of the PV. Panels
    c. Check the earth connection at least every 12 months.
6. Keep all records, log books, log sheets, maintenance job cards, etc., in neat order to the satisfaction of the Engineer. All records, log books, and log sheets, charts, maintenance job cards, etc., shall become the property of the Employer.

7. Provide all spare parts for replacements made necessary due to wear and tear of equipment and all tools and maintenance equipment required for proper operation and complete maintenance of the Works.
8. Provide all routine operational maintenance and full preventive maintenance as recommended by the equipment manufacturers to keep equipment and systems in proper operating condition.
9. Allow for maintaining adequate stocks of all manufacturer's recommended spare parts and consumables as necessary to guarantee that all equipment and systems can be immediately repaired and properly maintained in satisfactory operating condition at all times throughout the Contract Defect's Liability Period.
10. The routine operational maintenance activities and full preventive maintenance procedures relating to the systems specified herein shall be incorporated in the Maintenance Management Program.
11. The afore going Clauses are in addition to and in no way relieve the Contractor of his liabilities and obligations under the Contract.

B. Spare Parts, Tools and Maintenance Equipment

1. In addition to the spare parts, tools and maintenance equipment provided by the Contractor pursuant to his obligations to operate and maintain the systems specified herein throughout the Contract Defect's Liability Period, the Contractor shall, prior to completion of the Works, supply the spare parts, tools and maintenance equipment specified herein for use after the expiry of such Defect's Liability Period, and store the same in a location in the building designated by the Engineer. Such specified spare parts, tools and maintenance equipment shall not be used by the Contractor during the period of maintenance unless in an emergency and as expressly authorized by the Engineer.

2. All spare parts, tools and maintenance equipment shall be provided in original packing, clearly labelled and referenced. Provide complete schedules of spare parts and maintenance equipment clearly cross referenced with the "as-built" record drawings and with operation and maintenance instructions manuals.
3. All spare parts, tools and maintenance equipment shall be as recommended by the equipment manufacturer and shall be subject to the final approval of the Engineer.
4. Supply two new complete sets of tools complete with lockable tool boxes for the proper operation, routine maintenance and adjustment of all components and equipment.
5. Spare parts, tools, etc., required include but are not necessarily limited to those listed below. Where quantities are not shown, provide the quantities for each item of equipment as recommended by the manufacturer.

C. Minimum Staff / Servicemen Required For Maintenance during the Defect's Liability Period:
   1. The Contractor shall keep permanently on the Site sufficient number of Maintenance staff to fulfill the obligations of the Contract.

Part 2 - EXECUTION.

2.01 TESTING AND COMMISSIONING

A. On completion of the entire solar systems and electrical installation work or any separate system or distinct part thereof, notify the Engineer, in writing, that the completed part of the electrical work is ready for inspection. Before doing so, perform initial trial tests, and correct, adjust, calibrate, balance, regulate, etc., the system concerned as necessary until the specified and required performance conditions are obtained.

B. The inspection of the Contract work shall be carried out by the Engineer in accordance with the requirements of Section Seven (7) of the IEE 'Regulations for Electrical installations 17th Edition and EDL requirements.

C. The Operation tests of the solar and electrical systems shall be as specified separately in each concerned section of this specification. The results and readings obtained shall be equal or better than the requirements of the IEE and the EDL regulations and these shall be recorded on forms similar to the ones described in the IEE regulations.

D. Supply all labour, materials, instruments, tools and equipment required for carrying out the tests.

E. When the results of the above mentioned tests prove satisfactory and no errors or faults are present in the installations, submit the necessary test forms, duly filled, to the consultant and repeat the tests in the presence of owner's representative.

F. Follow-up and make all necessary arrangements with the EDL.

G. After the connection of the permanent power supply, commission all parts of the solar systems and the electrical installations covered by this Specification and demonstrate to the Engineer that the entire electrical installations are in perfect working order.

H. When equipment or services of a specialised nature are involved, provide the services of a specialist from the manufacturer who shall be present at the time of testing and commissioning of their equipment. Include for all expenses incurred in this respect as no claim for additional payment will be entertained.

I. Submit to the Engineer test reports, which shall include all records of test procedures, readings and results obtained.

J. The Contractor shall allow for early start and maintenance of solar systems and electrical equipment prior to substantial completion.

Part 3 - <u>Alternative Solution:</u>

- The bidder can submit another solution that relies on installing low voltage cables to transmit the solar power from A.C combiner to MDB-Z-2,

  The proposed will be accepted and taken into consideration, in condition that the offer will be competitive with other bidders and within the project budget.

- The low voltage cables which will be suggested for the alternative solution will be 4 cables 4c x 240 mm^2 XLPE/SWA/PVC

- The bidders will provide only one offer based on the design drawings and BOQ or for the alternative solution considering the low voltage cables instead of step up and step down transformers with the related medium voltage cables.

SECTION 260519
LOW VOLTAGE & MEDIUM VOLTAGE ELECTRICAL POWER CABLES

A- GENERAL

1.01 SUMMARY

A. Section Includes: Design, engineering, procurement, installation, testing and commissioning of all electrical conductors and cables as indicated on the drawings, and/or specified herein and in accordance with the Contract Documents. Work includes but is not limited to the following:
   1. Electrical power distribution cables.
   2. Wires.
   3. Accessories.

1.02 REFERENCES

A. The cable installation shall comply with EDL and local regulations or the following International Standards (as applicable):

1	BS 3924	Specification for Pressure-Sensitive Adhesive Tapes for Electrical Insulating Purposes
2	BS 5467	Specification for Armoured Cables with Thermosetting + IEC 502 Insulation for Electricity Supply
3	BS 5468	Specification for XLPE Cables
4	BS 6004	Specification for PVC-Insulated Cables (non-armoured) for + IEC 227 Electric Power and Lighting
5	BS 6121	Specification for Mechanical Cable for Elastomer and Plastics Insulated Cables
6	BS 6346	Specification for PVC-Insulated Cables for Electricity Supply
7	BS 6360	Specification for High Conductivity Plain Annealed Stranded Copper Conductor
8	BS 7671	Requirements for Electrical Installations
9	BS 4121	Mechanical Cable Glands
11	BS 6121	Code of Practice for Selection, Installation and Inspection of Cable Glands used in Electrical Installations
12	IEC or an equivalent international standards	

1.03 SUBMITTALS

A. Refer to Section 16010 “Basic Electrical Requirements”.

Part 2 - PRODUCTS

2.01 GENERAL

A. Provide as described herein all cables and wires, cable glands, lugs and all accessories which are required for proper installation and termination of the cables and wires.

B. Cables Manufacturer:
   1. Liban Cables
   2. Or approved equal

C. The products and manufacturers specified herein, are specified for the purpose of establishing minimum quality standards. Products equal in quality to, or better than those specified, will be acceptable. The decision of acceptability rests with the Engineer.

2.02 CABLES

A. General
   1. Provide cables complete with all necessary jointing, termination materials and other accessories of size and type as indicated in the Specifications and on the drawings.
   2. All cables shall have stranded copper conductors. Multicore armoured cables shall be armoured with a single layer of helically wound galvanized steel wires and protected overall with an extruded PVC over sheath.
   3. Unless otherwise indicated on the Drawings all cable over sheaths shall be black for low voltage cables suitable for use on a 3 phase, 50 Hz alternating current system. All cables shall be of a voltage grade appropriate to the voltage of the system to which they are to be connected.
   4. The Contractor shall be responsible for making accurate measurements regarding cable lengths on site after agreement of actual cable routes with the Engineer and for adding whatever allowances are necessary to cover cutting, snaking in trenches allowance for prescribed bending radius over linear lengths and wastage.
   5. Immediately after testing to the Engineer’s satisfaction, both ends of every cable length shall be sealed. Plastic cables shall be sealed by means of a plastic cap embracing the armour wires and the outer sheath. Cable ends shall be marked in accordance with the relevant

British Standard. Where necessary, pulling eyes may be fitted to cables at the manufacturers' Works provided that the approval of the Engineer is first obtained. Copper conductors for mains cables shall comply with BS 6360.

6. Proper cable glands to BS 6121 of brass material shall be used for cable entries into distribution boards and equipment. Such glands shall be covered with purpose made rubber sleeves.
7. Cables shall be of the following types with sizes as indicated on the Drawings:
    a. PVC/PVC Cables: PVC insulated PVC sheathed cables shall be 600/1000V, single or multi-core conforming to BS 6346 or equivalent standards with high conductivity plain annealed stranded copper conductors to BS 6360, PVC insulated with an extruded layer of PVC bedding and a final outer extruded PVC sheath. The insulation and sheath shall be to BS 6746 with insulation coloured to identify phases and neutral in accordance with BS 6746C.
    b. PVC/SWA/PVC Cables: PVC insulated single wire armoured and PVC sheathed cables shall be 600/1000V, multi-core conforming to BS 6346 with high conductivity plain annealed stranded copper conductors to BS 6360, PVC insulated with an extruded layer of PVC bedding having a single layer of galvanized steel wires armoured for multi-core cables and aluminum wires BS 1442 or tape BS 2897 for single core cables and a final outer extruded PVC sheath. The insulation and sheath shall be to BS 6746 with insulation coloured to identify phases and neutral in accordance with BS 6746C.
    c. XLPE/SWA/PVC and XLPE/PVC Cables: XLPE insulated single wire armoured and PVC sheathed cables shall be single core or multi-core cables, 600/1000V con-forming to BS 5467 with high conductivity plain annealed stranded copper conductors to BS 6360, insulated with cross linked polyethylene (XLPE) to BS 5468 applied by a combined extrusion and vulcanization process to form a compact homogeneous layer, cables bedded and overall sheathed by a black PVC layer to BS 6746. Armoured cables shall have a single layer of galvanized steel wires BS 1442 for multi-core cables and aluminum wire or tape BS 2897 for single core cables.
    d. All D.C cables must be 1.5 KV, and shall be installed at cable trays and appropriate conduits between the PV. Panels and the D.C combiner boxes.
    e. All D.C cables to be installed in the correct routing between the D.C combiner boxes and the related inverters using the PVC conduits and the necessary manholes.

B- Medium Voltage cables:

1. **General:**

1.01: Works covered by the contract
a.15 KV cable with the related accessories

1.02: Standards and References
a. BS-6360: Insulated copper conductors cables and wires
b. IEC-502: rigid insulated power cables
c. IEC-228
d. IEC-287

1.03: Definitions & Submissions:
a. Providing all data sheet from the factory regarding the size and type of medium voltage cables that will be used on the site.
b. Providing test certificate concerning the MV. Cables
c. Providing connection detail for the medium voltage cables, at the transformer of the medium voltage switchgear.
d. XLPE red color PVC for cables 3 × 50 mm^2 and 3 x 70 mm^2 to be used respectively for Lot 1 and Lot 2 as per the drawing
e. The medium voltage cable must be installed under ground between the step up transformer and the step down transformer.

SECTION 260526
GROUNDING AND BONDING

1. GENERAL

1.1 SUMMARY

A. Section Includes: Design, procurement, installation, testing and commissioning of complete earthing system, all as indicated on the drawings and/or as specified herein and in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
   - Earth Pits
   - Earth Electrodes (Rods, Tapes etc)
   - Earthing Conductors
   - Main Earthing terminals or bars.
   - Accessories and termination fittings, bonding, welding kits and other materials.

1.2 SUBMITTALS

A. Product Data: Submit to the Engineer for information only in accordance with the requirements of the Contract Documents, copies of manufacturer's specifications and installation instructions and other data to show compliance with these Specifications.

B. Shop Drawings: Submit shop drawings for all components for review by the Engineer. Include complete earthing systems, other accessories required, exact routing main earth conductors, location, dimension of earth pits, number of earth rods, and details of clamps, etc.

C. Sample: Submit to the Engineer in accordance with the requirements of the Contract sets of samples for earth materials for approval.

2. PRODUCTS

3-1 EARTHING SYSTEM

A. Provide complete earthing system in strict accordance with EDL and IEE requirements. Generally, all PV. Panels frames metal and structures and of the solar installation and of power-consuming equipment shall be connected to the earthing system.

B. Earthing Materials:

- Furse, U.K.
- A.N. Wallis & Co., U.K.
- Kingsmill UK.
- Approved equal.
- The products and manufacturers specified herein, are specified for the purpose of establishing minimum quality standards. Products equal in quality to, or better than those specified, will be acceptable. The decision of acceptability rests with the Engineer.
- Earthing system for each zone must be installed in order to connect all solar panel frames and all steel structures.

3-2 MATERIALS

A. The main earth bars shall be constructed of high conductivity copper, tape of size 25 x 3mm (minimum) or 70 mm^2 coper conductor to BS 1432 and fixed as detailed on the Drawings.

B. Unless specified otherwise, the cross sectional area of protective conductors shall be in accordance with the relevant IEC and BSI standards and EDL Regulations.

3-3 EARTH ELECTRODES

A. Earth electrodes shall be copper clad steel rods of not less than 19 mm diameter, minimum 3.6 meters long or in 3 sections coupled. The earth rods shall be manufactured by fusion weld process resulting in an electrolytic copper sheath homogeneously welded to an inner steel core. The thickness of the copper sheath shall be approximately 10% of the overall rod diameter. Copper electroplated steel is not acceptable.

B. One end of the rod shall be pointed without application of heat and with driving head at other end. The sectional rods shall be coupled with strong bronze couplers. The coupler shall be threaded to fit the rod section. For driving the rod into the ground threaded steel shall be used.

C. A brass clamp of suitable size shall be provided for clamping the earth copper tape to earth rod. The rod shall be driven into the earth by means of a power hammer. The top of the earth electrode shall be housed in appropriate brick lined pit with removable medium duty cast iron cover for periodical testing of the electrode.

D. Earth pits shall be reinforced concrete construction of size 320 x 320mm to the depth of 300mm minimum or as approved by EDL. Earth pit cover shall be embossed with “Earth Sign”.

3. EXECUTION

3-1 EARTHING

A. All metallic equipment enclosures, steel structure system, PV. Panels structre, all non-current carrying metal parts of the electrical systems and any other equipment or system components required by EDL, and IEE regulations shall be earthed in an approved manner.
B. All earth continuity conductors shall terminate finally at the main earth bus bar.

C. The earthing system of the solar systems shall be an independent system connected to the earth bus on the main low tension switchboard and to the steel structure for PV. Panels. The neutral shall not be used for earthing and shall be connected to the earth only at the main low tension switchboard
D. The earth wires shall be covered with PVC and distinguished by Green color.
E. The earth tape shall be connected to the low tension switchboard earth bus.
F. All distribution boards, A.C or D.C combiners shall be provided with an earth bus or earth terminal.

3-2 CONNECTIONS

A. Connection between earth bars and equipment frames and stranded copper cables shall be made with appropriate compression lugs, bolts, nuts and lock washers. Contact surfaces shall be thoroughly cleaned and tinned or thermo welded connections can be used.

B. Lugs, bolts, nuts, washers, screws, clamps, cleats and other items which come into direct contact with copper earth bars, tapes, cables, etc., shall be non-ferrous and manufactured from brass, bronze or other suitable conducting material which will not cause electrolytic corrosion. Connection between copper and galvanized structures shall additionally be tinned.

C. Earthing tapes shall be of continuous unbroken lengths. If jointing becomes absolutely necessary, then, after obtaining approval of the

Engineer the tapes shall be joined by fusion welding 'Themoweld' or similar process.

D. The earth bus in the main switchboard shall be connected.
E. The maximum overall earth resistance between any point on the earth installation and general mass of the earth shall be less than 3 ohm in accordance with EDL regulations. If this resistance cannot be obtained with two earth rods, additional earth rods or sectional earth rods shall be used to obtain the required resistance. Parallel connected earth rods shall be spaced at a distance of not less than the rod lengths and connected by 70 mm^2 copper cables. If approved by the Engineer, earth plates or other earthing means may be used instead of the additional earth rods.
F. Measurement of earth resistance shall not be made within 48 hours after rainfall. The panel room earth bus may be connected to the metallic water service of the building provided this is approved by EDL.
G. The connection between earth conductors and earth rods shall be made by means of high strength corrosion resistant copper alloy connector clamps and brazed.
H. The tops of the electrodes shall be protected from any damage and shall be easily accessible being enclosed in pits equipped with covers. The presence of the electrode shall be indicated in English.

SECTION 260536
CABLE TRAYS FOR ELECTRICAL SYSTEM

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Design, engineering, procurement and installation of all cable trays and ladders complete with all accessories, fittings etc., as indicated on the drawings and/or as specified herein and in accordance with the requirements of the Contract Documents.

1.02 REFERENCES

A. The installations shall comply with the EDL or the following International Standards:
   1. BS 1449 : "Steel Plate, Sheet and Strip"
   2. BS 4360 : "Specification for Weldable Structural Steels"
   3. BS 7671 : "Requirements for Electrical Installations"
   4. BS 2989 : "Hot-Dip Zinc Coated Steel"
   5. BS EN 1461 : "Hot-Dip Galvanized after Manufacture"

1.03 SUBMITTALS

A. Refer to Section 16010 - "Basic Electrical Requirements".

Part 2 - PRODUCTS

2.01 MANUFACTURERS

1. B-Line Systems, Inc
2. Niedax (Germany)
3. Swifts (U.K.)
4. OBO Bettermann (Germany)

Or approved equal.

A. The products and manufacturers specified herein, are specified for the purpose of establishing minimum quality standards. Products equal in quality to or better than those specified will be acceptable. The decision of acceptability shall rest with the Engineer.

2.02 CABLE TRAYS AND LADDERS

A. General

1. Provide complete cable tray system including all necessary fittings, supports, accessories and hardware, whether or not indicated on the drawings or defined in detail in these specifications.

B. Perforated Trays

1. Cable trays shall be heavy duty, return flange, perforated type formed from sheet steel to BS 1449 - Part 1 and hot-dip galvanized after fabrication in accordance with BS EN 1461.
2. Cable trays shall have a minimum thickness of 1.5mm for trays up to 450mm and 2mm for wider trays.
3. Cable trays shall be assembled complete with couplers, bends, tees, risers, reducers and all other accessories as required and these accessories shall be of the same material, thickness and finish as the trays. Manufacturer's standard accessories shall be used and site fabrication shall only be allowed where special sections are required subject to the approval of the Engineer.
4. Mushroom head steel roofing bolts and nuts to BS 1494 Part 1 shall be used to fix adjacent sections of cable trays and/or accessories. Holes cut in trays for passage of cables shall be provided with grommets to BS 1767; otherwise they shall be bushed or lined.
5. All hangers, brackets and supports shall be hot-dip galvanized.
6. All horizontal cable tray run shall be of Perforated Type.
7. Cable trays shall be provided with a canopy cover when run exposed to open atmospheric conditions i.e. especially sun radiation and rain. This cover shall be fabricated from higher gauge galvanized sheet steel for sound mechanical endurance.
8. To carry the maximum load of cables with a factor of safety 300%.

C. Ladder Racks

1. Cable ladders shall be H-type made from 2mm mild steel with 3mm coupling plates. Side channels shall be strengthened by reinforcing inserts or other means to increase torsional rigidity. Rungs shall be slotted type and spaced at maximum 300mm. Cable ladders shall be hot-dip galvanized and shall be complete with coupling pieces, bends, tees, reducers, risers, drop-outs, intersections and all other accessories as required and these shall be of the same material, thickness and finish as the ladders.
2. All vertical cable tray run shall be of Ladder Type.

Part 3 - EXECUTION

3.01 CABLE TRAYS/LADDERS

A. Cable trays/ladders less than 3° between fixed points and shall be fixed by support channels and hanger rods, or by cantilever brackets to walls or columns. Fixings shall be disposed at regular intervals not exceeding 1.0 m. Joints shall be positioned as close as practicable to the tray fixing or support. Mid-span joints shall be avoided. All screws bolts and nuts used for fixing shall be zinc plated to BS 1706 - Class B coatings. A minimum clear space of 25 mm shall be maintained between any cable tray or support and the finished wall surface.
B. Cables shall be installed on trays in a single layer except where specified otherwise, leaving 25% of the tray width space for future use. Spacing between two adjacent cables shall be according to EDL Regulations.
C. Cable trays shall be cut only along a line of plain metal and not through perforations. All cut edges of trays shall be prepared with burrs and sharp edges removed prior to installation and any cutting and/or damage made good with rust proofing agent and zinc rich epoxy paint.
D. Where cable trays pass through walls, non-combustible, non-metallic fire barriers shall be installed and the whole fireproofed as specified hereinbefore.
E. Cable trays shall be adequately supported to prevent sagging.
F. Cable trays shall be earthed according to EDL Regulations.

3.02 FIELD QUALITY CONTROL

A. Grounding: Test cable trays to ensure electrical continuity of bonding and grounding connections.
B. Grounding: Do not use metal trays as earth continuity conductor. Connect trays by flexible tinned copper straps to nearest bare earthing conductor and at maximum 30-m spacing.
C. Anchorage: Test Pullout resistance for toggle bolts and powder-driven threaded studs for each type and size of anchorage material.

    1. Furnish equipment, including jacks, jigs, fixtures, and calibrated indicating scales, required for reliable testing.
    2. Obtain Employer’s approval before transmitting load to the structure. Test to 90 percent of rated proof load for fastener.

D. Replace malfunctioning units.

3.03 CLEANING

A. On completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches, and abrasions.

3.04 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure cable tray is without damage or deterioration at the time of substantial completion.

1. Repair damaged to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

SECTION 260569
Medium Low Voltage Oil Transformers (11kV-400V)

Part 1 - GENERAL

1.01 Section Includes

The outdoor package oil-type secondary substation transformer suitable for step up located near to inverter rooms and step down transformers near to the existing main electrical room

1.02 References

The ventilated oil-type transformers and protection devices in this specification are designed and manufactured according to latest revision of the following standards (unless otherwise noted).

IEC 60076-1 to 60076-5
IEC 60076-11 (2004)
IEC 60905
IEC214-Unload tap changer
CENELEC (European Committee for Electro-technical standardization)

1.03 Definitions

A) The transformer shall be totally enclosed of IP43 protection class step down transformer from 11kV (as applicable) to 380 volts, Copper wound and of approved make. It shall be with Delta connections on MV side and star on low tension side. The arrangement of the winding shall be such that there is electrical and magnetic balance under all conditions of operation. The design, treatment and construction of the transformer and bracings of the winding shall be such as to withstand the heavy mechanical and thermal stresses which may be experienced under conditions of daily cycles of heating and cooling due to fluctuations in loads and of dead short circuits on either side of the transformer. The interturns and end-turns of the MV and LV winding shall be insulated for protection against surges and transients. The insulations shall be of class F. The winding insulation shall be suitable for earthed 11 kV system. The rated frequency shall be 50Hz and the transformer shall be designed with the frequency varying by 3% above or below 50Hz. The desired impedance shall be 6% at normal tap and 75°C temperature. All components, frame etc. shall be suitably earthed. Vector group shall be Dyn 11.

B- The Outdoor package Envelope:

1. Single integrated metal housing, comprising three compartments accommodating:
   - MV Switchgear(Protection degree of this compartment IP 53)
   - Transformer(Protection degree of this compartment IP 43)
   - LV Switchgear(Protection degree of this compartment IP 53)

2. The package is designed and constructed for shipping, lifting and handling as one piece. It is manufactured from electro-galvanized sheet steel.
3. Double roof, thermally insulated. The external (except those of the transformer compartment) are sandwich panels, thermally insulated.
   The panels of the transformer compartment are equipped with louvers which permit the natural circulation of air (Natural ventilation transformer) .
4. A lockable doubles wing door give access to the MV compartment
   A lockable doubles wing door give access to the transformer compartment
   A lockable doubles wing door give access to the LV compartment
5. The package dimensions are approximately as follows :
   Approx. Length : 3270 mm
   Approx. Width : 1920 mm
   Approx. Height : 2350 mm
6. Each package substation includes the followings equipment:
   A MV Switchgear
   Metal enclosed switchgear
   Each MV switchgear includes the following MV cubicles:

   A-1: Incoming Cubicle
   Consisting of:
   - Air insulated, three phase bus bars each made of copper, 630A, 12KV, 25KA
   - Manually operated, fixed type, SF6 switch and earthing switch (630A-12KV)
   - Capacitive voltage dividers + Neon voltage indicators
   - Heating element
   - A short circuit and earth fault indicator
   - Cable gland for a three- core cable 3*70 mm^2 for Lot 2 , and cable gland for a three core cable 3 x 50mm^2 for Lot 1

   A-2: Transformer Protection Cubicle
   Consisting of:
   - Air insulated, three phase bus bars each made of copper, 630A, 12KV, 25KA
   - Manually operated, fixed type, SF6 switch and earthing switch (200A-12KV) with a shunt trip release 220 V AC
   - Three MV fuses (DIN)
   - Capacitive voltage dividers + neon voltage indicators
   - Heating Element
   - Cable termination for the single core cable connecting this MV cubicle to the transformer

B- Transformer 630 or 1000 KVA:

Three – phase, ONAN type, hermetically sealed, completely filled (with mineral oil) transformer in a corrugated tank:

Standard: IEC 60076
Winding: Copper
Magnetic cover: Made of grain oriented, cold rolled, silicon steel strips
High Voltage: 11 KV
Withstand voltage- MV winding:

- 50 Hz withstand: 28 KV
- Impulse withstand voltage: 75 KV

Frequency: 50 Hz
Tappings: +/- 2.5% +/- 5% by an off-loaf tap changer
System highest voltage: 12 KV at the HV side
No-load low voltage: 400 V
Withstand voltage LV winding: 3 KV at 50 Hz
Top oil temperature rise: 45°C
Winding temperature rise: 50°C
Vector group: Dynll
MV bushings Porcelain 10 NF/250- insulation level 12 KV according to DIN 42531
LV Bushings: Porcelain 1 KV-according to DIN 425302
Oil: Mineral according to IEC 60296- Clas 1
Painting: As per international standard procedure
Accessories (ref Section 6):

- Thermometer with 2 contacts
- Pressure relief valve (without contacts)
- Oil filling valve
- Oil draining device
- Earthing terminal
- Skids
- Lifting lugs
- Rating plate
- Terminal marking plate

Losses table:

Rating	Impedance voltage	No-load losses	Load Losses
KVA	**%**	**W**	**W**
630	4.0	1300	8400
1000	5.5	1728	8800

The transformers must be matching with the inverters operation in both lots (1) and (2)

C- LV panel Board for a 630 KVA Transformer:

The LV panel Board is manufacturer from sheet steel (thickness 1.5 to 2 mm), designed for a 50 degree C ambient temperature. The panel is modular, dead front, freestanding, floor mounted and comprises the following equipment according to the tender book:

- Copper bus bar
- 4-pole main circuit breaker, rated 1000 A
- 1 voltmeter + selector switch
- 1 ammeter +selector switch
- 3 current transformers 1000/5A
- 1 test terminal blocks for VTs and Cts
- Set of auxiliary circuit breakers for substation internal lighting

D- LV Panel Board for a 1000 KVA transformer

The LV panel board is manufactured from sheet steel (thickness 1.5 to 2 mm), designed for a 50 degree C ambient temperature. The panel is modular, dead front, freestanding, floor mounted and comprises the following equipment according to the tender look:

- Copper bus bar
- 1 manually operated, 4- pole main circuit breakers 1600A
- 1 voltmeter + selector switch
- 1 ammeter + selector switch
- 1 current transformer 1500/5A

Circuit breakers must be from reputable brand name **with Icu = 35 KA**.

Remark: the connections by cables, between:

- MV protection cubicle and the MV bushings of the transformer
- LV bushings of the transformer and the bus bars of the LV panel must be made at the factory

1.04 Submittals

Manufacturer shall provide copies of following documents to owner for review and evaluation.

1. Product data and spare parts list;
2. Outline, nameplate, connection diagrams and other shop drawings on transformer;
3. Installation and operating instructions, maintenance, troubleshooting and repair procedures and technical literature pertaining to all components or instruments provided.
4. A certified test report containing minimum information per IEEE C57.12.91 Appendix.

1.05 Project Record Documents

A. Maintain an up-to-date set of Contract documents. Note any and all revisions and deviations that are made during the course of the project.

1.06 Operation and Maintenance Data

A. Manufacturer shall provide copies of installation, operation and maintenance procedures to owner.

B. Submit operation and maintenance data based on factory and field testing, operation and maintenance of specified product.

1.07 Quality Assurance (Qualifications)

A. Manufacturer shall have specialized in the manufacture and assembly of ventilated oil-type secondary substation transformers for (20) years.

B. Manufacturers: Firms regularly engaged in manufacture of oil type transformer of types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall be given to local manufacturers and agents/suppliers.

C. Installer: Firms regularly engaged and qualified with at least 10 years of successful installation experience on projects with electrical installation work similar to that required for the project.

1.08 Delivery, Storage and Handling

A. Deliver, store, protect, and handle products in accordance with recommended practices listed in manufacturer's installation and Maintenance Manuals.

B. Deliver each transformer on individual shipping skids for ease of handling. Each transformer shall be wrapped for protection.

C. Inspect and report concealed damage to carrier within specified time.

D. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. (Heat enclosures to prevent condensation).

E. Handle in accordance with manufacturer's written instructions to avoid damaging equipment, installed devices, and finish.

1.09 Project Conditions

A. Follow (standards) service conditions before, during and after transformer installation.

B. Indoor ventilated oil-type transformers shall be located in well-ventilated areas, free from excess humidity, dust and dirt and away room hazardous materials. Ambient temperature of area will be plus (50) degrees C.

1.10 Warranty:

Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of handing over the Project.

1.11 Field Measurements

A. Make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in the British Standard.

Part 2 - PRODUCTS

2.01 Manufacturer

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to the following: Siemens Schneider Or approved equal by EDL

B.

2.02 Manufactured assemblies

A. Furnish ventilated oil-type secondary transformers as indicated in drawings.

B. Refer to drawings for actual layout and location of equipment and components; current ratings of devices, bus bars, and components, voltage ratings of devices components and assemblies, and other required details.

2.03 Primary (incoming / line) section

The transformer shall have one integrally mounted air-filled primary terminal compartment with compression type terminals. Refer to the drawings for specific wire size and type. The terminals shall be radial feed. A set of surge arrestors shall be installed directly on the transformer MV connection terminals and the arrestors shall be in accordance with standards IEC 994.

2.04 Finish

A. Finish shall be ANSI 61 gray paint or approved equal form BS, IEC or DIN.

2.05 Testing

A. Each transformer shall receive the following standard commercial test with test results available by transformer serial number upon request.
   1. Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating on this project.
   2. Ratio tests on the rated voltage connection and on all tap connections.
   3. Polarity and phase-relation tests on the rated voltage connection.
   4. No-load loss at rated voltage on the rated voltage connection.
   5. Exciting current at rated voltage on the rated voltage connection.
   6. Applied potential test.
   7. Induced potential tests.

B. The following special tests shall be performed on each transformer.
   1. Impulse test on the high voltage winding.
   2. Temperature test at self-cooled rating.
   3. Temperature test at maximum cooled rating.
   4. Sound level test at self-cooled rating.
   5. Insulation Resistance (megger) test.
   6. Partial Discharge test.

C. All the tests shall be as per the IEC 60076-1, 2,-3,-5,-6,-7.

Part 3 - EXECUTION:

3.01 Examination

A. Verify that ventilated oil-type secondary substation transformers are ready to install.

B. Verify field measurements are as instructed by manufacturer).

C. Verify that required utilities are available, in proper location and ready for use.

D. Beginning of installation means installer accepts conditions.

3.02 Installation

A. Install per manufacturer's instructions.

B. Install required safety labels.

3.03 Field Quality Control

A. Inspect installed transformers for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible mechanical and electrical connections (with calibrated torque wrench). Minimum acceptable values are specified in manufacturer's instructions.

3.04 Adjusting

A. Adjust all access doors and operating handles for free mechanical operation as described in manufacturer's instructions.
B. Adjust primary taps as required to obtain proper secondary voltage.

C. Return “odd” Kirk Keys to Engineer before energizing equipment.

3.05 Cleaning

A. Clean interiors to remove construction debris, dirt, shipping materials.

B. Repaint scratched or marred exterior surfaces to match original finish.

SECTION 262300
LOW VOLTAGE SWITCHGEAR AND SWITCH BOARDS

Part 1 - GENERAL

1-1 SUMMARY

Section Includes: Procurement, installation, testing and commissioning of the electrical distribution equipment complete with switches, circuit breakers/fuses, relays, meters and other accessories and component equipment, all as indicated on the drawings and/or as specified herein and in accordance with the requirements of the Contract Documents. Work includes:

- Main Low Tension Panel for solar system.

1-2 REFERENCES

The installation shall comply with the following Standards, including all amendments:

1	IEC 61439-1 LV	Switchgear & Control Gear Assemblies-General rules
2	IEC 61439-2	LV Switchgear & Control Gear Assemblies - Power Switchgear and Control gear Assemblies
3	IEC 61641	Enclosed LV Switchgear & Control Gear Assemblies - Guide for testing under conditions of arcing due to internal fault
4	IEC 60947-1	LV Switchgear & Control Gear - General rules
5	IEC 60947-2	Circuit breakers
6	IEC 60269	Specification for Cartridge Fuses for voltage up to and (Part 1 to 4), including 1000V A.C. and 1500V D.C. BS 88
7	IEC 60051	.Direct Acting Indicating Analog Electrical .(1 to 9 parts) Measuring Instrument & their accessories
8	IEC 60068	.Environmental Testing

2. PRODUCTS

2-1 MANUFACTURERS

A. Subject to compliance with requirements and specification, provide products by the following:
- ABB Power Distribution Italy/Europe
- Schneider Electric France / Europe
- Approved Equal

B. Approved Switchboard/Panel Manufacturers:
- ABB
- Schneider
- General Electric
- Approved Equal

C. The products and manufacturers specified herein are specified for the purpose of establishing minimum quality standards. Products fully complying to this specification, equal in quality and better than those specified, will be acceptable. The decision of acceptability rests with the Engineer.

2-2 GENERAL

a. Provide complete distribution equipment which shall comprise main low tension panel boardpanel boards, main and sub main panel boardpanel boards, distribution boards, busbar system, breakers, isolators, switch fuses, etc from one manufacturer to ensure proper protection co-ordinations and easy substitution.

b. The supply and distribution arrangement shall be as indicated on the schematic diagrams Drawings.

B.

c. Product Data: Provide electrical characteristics and connection requirements, proof of compliance with specified IEC standards, Type Test certificates as requested under respective clause for LV Switchboards, MCCB, outline dimensions, voltage, current and breaking current ratings.

C.

d. Compliance Clause: The contractor must submit a complete specification compliance statement for the proposed switchgears

D.

e. Electrical characteristics:
   1. Rated insulation voltage: 1000 Vac
   2. Rated operational voltage: up to 690 Vac

3. Rated current of main bus bar: up to 630A

2-3 MAIN DISTRIBUTION BOARD

1. General
    1. The main low tension panel board shall be of Form 3b indoor construction cellular type, dead front, metal enclosed multi-cubicle type, free standing, dust and vermin protected, front operated and of clean and modern appearance.
    2. The MLTB shall integrate all major components (enclosure, busbar system, circuit breakers) from a single approved manufacturer. The MLTB shall be designed, manufactured and tested in facilities authorized by the principal manufacturer..
    3. The panel boards shall be made of folded EGI (Electro galvanized iron). Steel construction, minimum 2mm thickness, fully rust proofed and epoxy polyester painted.
    4. Fabricate enclosure with removable rear cover panels to allow access to rear interior of switchgear.
    5. All exposed bolts or screw heads shall be chrome or cadmium plated.
    6. All doors and removable covers or plates shall be provided with suitable neoprene gaskets to prevent the ingress of dust, vermin and insects.
    7. The panel boards shall be of IP 54 construction in accordance with IEC 60529 switchboards.
    8. Each unit of the panel board shall be housed in its own cell fitted with a hinged door mechanically interlocked in such a manner that the cell door can only be opened when the switch is in the 'OFF' position.
    9. Switching units shall be arranged in separate compartments or sections to protect against accidental contact with adjacent equipment when handling the elements in the section and to prevent the spreading of faults from one section to the other.
    10. The section construction shall be so designed that sheet steel barriers shall be provided between each vertical sections, breaker compartments, control and power compartments. Each compartment sheet walls shall provide protection against direct contacts with live parts and guarantee a degree of protection IP2X. The sections shall be of modular construction with its functional unit having its own door, mounting plates, side partitions and horizontal partitions. This type of functional arrangement ensures the compartment design I sizing is identical to the type tested configuration. Common mounting plates for different functional units within the same vertical section will not be acceptable.
    11. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section

12. Adequate cable ways shall be provided in the panel board accessible by hinged lids or removable covers.

13. The equipment in the panel board shall be accessible with indicating instruments mounted not higher than 1.8 m and the centre lines of operating devices not higher than 1.8 m above panel board base. The panel board shall be properly fixed to the floor with foundation bolts grouted in the floor or bolted to channels laid across the cable trench.
14. The panel boards shall have top or bottom cable entry as required. Basically main incoming cables shall be bottom entry and outgoing cables bollom or top entry.
15. Gland plate for compartment with single core cable shall be made of aluminum. (To avoid eddy currents)
16. The panel boards shall contain the air ACB circuit breakers, busbars, MCCBs, instruments, protection relays, earth bus, etc., as specified hereunder with ratings and arrangement as shown on the Drawings and shall be complete with all internal wiring and connections.
17. All low-voltage switchboards must be a Type Tested Assembly (TTA), compliant with IEC 61439· 1 and 2. The switchboard type-test certificates shall be originated by a worldwide known third-party certification organization such as ASEFA ASTA or KEMA. The manufacturer shall provide complete type test certificates for each rating proposed for the project.
18. Switchboards shall be made of identified free standing vertical structures, suitable for installation side by side and designed to be connected with cables. Access to operators should be available either from front or rear side.
19. All switchboards shall be completely factory assembled. wired and tested according to the routine tests outlined in IEC 61439-1.
20. Depending on cable connection way, the following shall be foreseen:
    - Connection from top shall provide at least 600mm to allow cable connection,
    - Connection from bottom shall provide at least 600mm on either a trench or a false floor.

2. Busbars
    1. Busbars shall be of electrolytic hard drawn tinned copper to B.S. 159 with rating as indicated on the Drawings, air insulated and rigidly supported by suitable non hygroscopic, anti-tracking insulators so as to withstand forces due to thermal expansion under normal operating conditions and 100 KA fault currents specified and neatly

arranged for 500 V, 50 Hz, 3 Phase, 4 Wire operation. It shall be 99.9% purity HDHC electrolytic copper to 1501190-1.

2. All phase and neutral busbars shall extend throughout the length of the board with the same cross section.
3. Busbars bracing shall maintain the same mechanical strength and current carrying capacity under normal operating conditions and fault conditions as indicated on the Drawings.
4. Busbars shall be housed in separate airtight compartment which shall not contain any wiring or apparatus other than that required for connection to busbars. Access to busbars and busbar connections shall be gained only by removal of covers secured by bolts or studs and internal shrouding plates at all sides. Bus links/feeder links shall be colour coded for phase and neutral identification.
5. Main bus bar shall be located on the top or bottom of the section and shall enable an easy connection to the bus bar in the adjacent vertical section. The main busbar should be made of copper bars spliced at each column level in order to achieve simplicity and flexibility in transportation, installation and maintenance. Sliding fishplates should be used to make the connection of the copper bars between columns.
6. Main bus bar design shall allow for front or back cables connection, via the top or bottom plates and all these interfacing possibilities should remain available even with no busbar position change. Bars shall not exceed the section width.

3. Current Transformers: Current transformers shall be of the bar primary type, air cooled and suitably insulated. They shall be of Class 1 accuracy for measurement and of Class 1OP1 0 accuracy for protection in accordance with IEC 1B5. The secondary windings shall be rated at 5A and the rated output shall be suitable for the burden.

4. Instruments
    1. The measuring instruments shall include ammeters, voltmeters. power factor meter, maximum demand indicators and selector switches as indicated on the Drawings.
    2. The instruments shall have anti-glare glass fronts. anti-parallax scales and white faces with black numerals and markings. The instrument cases shall be semi-flush mounted and shall be approximately 100 x 100mm square. Accuracy shall be one per cent of full scale deflection. Moving elements shall be provided with zero adjustments external to the cases.
    3. Ammeters shall be moving iron type, complying to IEC 60051-1, IEC 61010-1 and IEC 61000-4 scaled for 0-250A (160 KVA), 0-400A (250 KVA), or 0-600A (400 KVA) for main incoming supply.

4. Voltmeters shall be moving iron type complying to 60051-1 , IEC 61010-1 and IEC 61000-4 scaled 0-500V and provided with 7-position selector switches allowing reading of line to line, line to neutral voltages and off position.
5. Maximum demand indicators shall be of the thermal type with a 20-minute time delay.
6. Digital meters for above mentioned measuring instruments may be provided subject to the Engineer's approval.
7. Surge protection device

5. Molded Case Circuit Breakers:

A Moulded case circuit breakers shall be air break type, quick make and quick break, having free toggle mechanism ensuring full contact pressure until time of opening, whether actuated automatically or manually conforming to International Standard IEC60947.2. MCCBs shall have rated operating voltage (Ue) of 690V, rated insulation voltage (Ui) of 800V (AC 50Hz.) and rated impulse withstand voltage (Uimp) shall be 8kV. MCCBs including and up to 630A shall be of utilization category 'A' having rated service breaking capacity (Ics) as indicated on drawings and shall be made with a double rotary contact to greatly limit let through energy on the installation. They shall comprise a device, designed to trip the breaker in the event of high value short circuit currents. This device shall be independent of the thermal magnetic or electronic trip units. MCCB mechanism shall be completely enclosed in a compact moulded bakelite case, sealed to prevent tampering. The moulded case circuit breaker shall provide Class II insulation (in accordance to IEC 60664-1) between the front and internal power circuits. For frame rating higher than 250A, MCCBs shall be fined with metallic filters to reduce effects perceptible from outside during current interruption.

B Circuit breakers shall have inverse time tripping characteristics with automatic release secured through action of a combination thermal magnetic or electronic trip element which shall trip free of the handle and operate in response to an overload or short circuit. For any MCCB rating frame given, it's dimensions shall be the same for all ultimate breaking capacities. All breakers shall have Ics=lcu (Ultimate breaking capacity).

C Breaker contacts shall be non-welding and non+cotTodible silver tungsten composition. Circuit breaker handle shall have three

positions, 'OFF', 'ON' and 'TRIP' , thus indicating clearly abnormal conditions of the circuit. Single pole circuit breakers with handle tie or bar equivalent construction are not acceptable for a multiple breaker. Moulded case circuit breakers shall be of the bolted type. Plug-in type breaker connections are not acceptable

D The MCCB's shall have the provision for padlocking in the "OFF" position and shall be designed for adding auxiliary contacts, shunt or under voltage releases after installation at site. Auxiliary function and location shall be clearly indicated inside the MCCB. The auxiliaries shall be separated from power circuits. It shall be possible to install auxiliary contacts at field without any modification on the MCCB for signalizing different functions, as : open/closed position, Fault signal, Electrical fault (including electrical leakage) signal.. These auxiliary contacts shall not increase the volume of the MCCB. Provide auxiliary contacts for interfacing with building Management system (BMS) according to BMS Schedules. Refer to specification Section 15976 Point Schedules.

E The breakers shall be of inbuilt current limiting type

F The breaker shall be designed for both vertical and horizontal mounting and it shall be possible to supply power either from the upstream or downstream side without any adverse effects on the electrical performance

G Evidence of the service breaking capacity (ICS) shall be produced by test certificates from the internationally recognized high voltage laboratories (ASTA, CESI, ESEF/ASEFA, KEMA)

H It shall be possible to include earth fault protection of MCCB's by adding a residual cutTent device directly to the circuit breaker case, it shall operate without an auxiliary power supply and shall not exclude some other module or accessories. The add on RGD's shall comply with appendix B of lEG 60947-2 standard. They shall be immunized against nuisance tripping as per IEC 60255 and IEC 61004 standards

I MCCB with ratings including and up to 250A shall be equipped with thermal magnetic or electronic trip units which are fully interchangeable types without removing the breaker from panel. Thermal magnetic trip units shall have adjustable thermal protection in amps from 70% to 100% of current rating (In). Adjustable magnetic protection at least 5 to 10 times of In shall be provided for breakers above 200A. It shall have minimum electrical & mechanical durability of 20000 cycles

J MCCB with ratings over 250A shall be equipped with electronic trip units having adjustable thermal protection from 40% to 100% of cutTent rating (In). Electronic trip unit shall withstand temperature upto 105° G. Electronic trip units shall comply with appendix F of lEG 60947+2 standard and shall be fitted with thermal memory

K It shall be possible to fit lead seals to prevent unauthorized access to the settings of the electronic and thermal magnetic trip units

L Trip units shall not increase the volume of the MCCB. Protection settings shall apply to all circuit breaker poles

M The following monitoring functions shall be integral parts of electronic trip units as minimum

N a. 1 LED for load indication lighted above 105 % of lr

b. A test connector shall be installed for checks on Electronic and tripping mechanism operation using an external device

O Residual Current Relays: Residual current relays shall comply with IEC 60755, IEC 50102 and be used either in conjunction with circuit breakers for tripping the breakers or for giving alarm signal only by an indicator lamp and alarm bell in cases of earth leakage. The leakage relays shall consist of a core balance current transformer and a trip coil. All components shall be enclosed in a casing of moulded plastic. A reset button shall be provided for resetting the relay. The relays shall have 30 or 300 mA sensitivity as indicated on the Drawings and the tripping time shall be within 200 millisecond. Residual current relay shall have test function to test periodically. On occurrence of a earth leakage fault, there shall be in build LED indication and the change over contact of relay shall stay latched until a reset button pressed to acknowledge the fault and reset the relay. It shall be have Glass II insulation on the front face. It shall be possible to fit lead seals to prevent unauthorized access to the settings. The relays shall be protected against nuisance tripping caused by switching surges or by lighting surges.

P Earth Bus: The earth bus shall be 50 x 6 mm copper extending throughout the length of the panel board and fixed to brass nuts brazed to the steel members of the panel board. The earth bus shall be extended at the ends for connection to the earth electrodes and shall have provision for terminating earth continuity conductors

Q All outgoing circuits shall have separate compartment and/or be screened so that equipment for anyone circuit can be maintained without risk of contact with live connections on any other circuit

R For feeders rated more than 63A copper links shall be suitably extended from the busbar, rigidly supported and covered with coloured PVC sleeves or painting for phase identification

S All feeders shall be provided with cable lugs and brass cable glands

T All small wiring shall be of stranded copper, not less than 2.5 mm2 with PVC insulation to B.S.6231 . Control wiring shall be neatly bunched and cleated in harness form, or shall be enclosed in purpose made plastic trunking or troughing. Wiring cleated to metal surfaces shall be insulated from the metal. Where wiring runs through sheet steel panels holes shall be grommeted with suitable grommets

U c. Control wiring associated with external circuits shall be connected to terminal strips conveniently arranged.

SECTION 263100
SOLAR SYSTEM

Part 1: GENERAL

1-1 SERVICE REQUIREMENTS

All equipment supplied shall have properly function under the site conditions, e.g. ambient air temperatures, humidity, and seismic loads, specified in "Technical Requirements for Connecting Small Scale PV (ssPV) Systems to Low/Medium Voltage Distribution Networks" by the Electric Utility and Consumer Protection Regulatory Agency.

1-2 DESIGN REQUIREMENTS

1-2-1 General

- The Photovoltaic system of phase one and two shall be off grid for network 1 and 2; 3; 4 with Chiller
- The Photovoltaic system shall be designed to efficiently use the available space to generate the maximum output kWp DC at standard testing conditions STC and to generate the maximum allowable annual energy.
- The PV. Panels must be installed in lot one and two, these PV panels will feed respectively the networks 1 and 2; 3; 4 with Chiller.
- The contractor is responsible for site survey and Takes, the necessary measurements to perform the calculation, and Photovoltaic system sizing and response for building safety against mechanical loads of the PV system.
- The Contractor shall determine the most efficient mounting parameters of the PV arrays (Tilt, the orientation …etc.) to maximize the solar energy exposure, and minimize the shade from the other equipment.
- The PV arrays shall be uniformly arranged, and any cabling, raceways, junction boxes and other balance of system equipment shall be arranged and installed considering the access ways for maintenance requirements as recommended by the manufacturer.
- The mounting of the PV array's shall take into consideration the requirement of the maximum allowed air circulation for the PV modules natural cooling as required by the PV modules specifications.
- For safety, the equipment specifications and the system installation shall meet the requirements of NEC articles 690 and 705.
- The photovoltaic system arrangements shall be designed for easy maintenance.

1-2-2 Photovoltaic modules and Array system

- PV modules shall be according to IEC 61215, IEC 61730.
- The solar panels shall consist of a series of monocrystalline or monocrystalline silicon cells, N-Type assembled in an aluminum frame with low-iron thermal coated glass that is glued with a special layer of EVA (Ethylene-Vinyl Acetate) for protection and good adhesion. The cells shall be provided with a back support to protect it against shocks and climatic conditions TPT (Tedlar-polyester-Tedlar) and the panels are generally protected and impermeable from the inside and are manufactured by a reputable company in this field (Jinko - JASOLAR, DAH or the equivalent), holding a certificate issued by internationally accredited bodies.
- The connection to a module shall be arranged so that removal of a module or panel from a photovoltaic source circuit does not interrupt a grounded conductor to other PV source circuits.
- PV arrays combiner junction box shall be provided for termination (if required in case using 6.6.1 as the distribution company requirement).
- The combiner box should have a provision for opening for replacing the cables.
- PV modules shall be dust repel and capable of resisting damage/water penetration when subject to varying weather conditions including dust, sand, rain, washing liquids and similar intermittent external conditions.
- PV modules must be warranted for their output peak watt capacity, which should be with linear degradation not less than 90% at the end of 10 years and 80% at the end of 25 years starting from operating date of the PV system.
- The solar panels shall be new and not refurbished.
- All solar panels provided shall have the same model, capacity and manufacturer.
- The solar panels shall meet the following nominal specifications:

  a. The VOC not less than (50V).
  b. The VMP not less than (40.2V).
  c. The ISC not less than (14.14A).
  d. The IMP not less than (13.3A).
  e. The maximum system voltage: 1500Vdc
  f. The αIsc: 0.046%/°C
  g. The βVoc: -0.25%/°C
  h. The γPmp: -0.30%/°C
  i. The Snow load / Wind load: 5400Pa/2400Pa
  j. The nominal capacity is not less than (600 Watt) at a temperature of (25 degrees Celsius).

k. Solar Irradiance (1000 W/m2) according to STC tests, at a temperature of 25°C and a spectrum of 1.5 AM.
l. The number of panels is sufficient to provide a minimum total capacity as specified above in the site's conditions, noting that the highest is preferred.
m. The solar panels can be connected to each other in a (serial-parallel) manner to provide the appropriate nominal voltage to supply the inverter.
n. The solar cells must operate within the temperature range of -5°C to +85°C.
o. The nominal yield of solar cells must not be less than 22.36%, and the yield of solar cells should not be less than 90% of their nominal yield within (12 years), 30-Year linear power output and this is indicated in the bulletins and technical specifications submitted by the contractor.
p. The change in the capacity of the solar panel at standard conditions is from 0~+5W
q. Number of cells not less than 155.
r. Anti-Reflection coating front glass not less than 3.1mm.
s. Not less than a 12-year of product warranty and 30-year on linear product warranty with not more than 1% for the first year and 0.4% of annual degradation.
t. The work also includes providing all installation and connection equipment (cables, screws, lug nuts, metal connections, galvanized grounded metal bases that are stainless and non-corrosive… etc).
u. The junction box of the solar panels with 3 bypass diodes and a degree of protection of IP68.
v. It is the responsibility of the examining body to provide all the diagrams and technical specifications of the metal structure in order to install the structures carrying solar panels as indicated in the construction and metal works items of the Technical Terms booklet, provided that the execution is carried out with a high technical quality, making it ready for investment.

- **The bidder shall clarify in his technical bid the technical specifications, internationally approved test certificates. (IEC61215, IEC6173, CE, INMETRO, ISO14001, ISO9001, ISO45001)**

1-3 Supporting structure : Refer to structure specifications

1-4 Inverter(s)

- Inverter shall be in compliance with IEEE-1547, IEC 62093 and IEC 62109-1, 2, and shall be listed for the PV application as per NFPA 70
- The inverters must be On-Off grid
- Contractor shall submit conversion efficiency data tested by an International Recognized Testing Laboratory, at least 98 % efficiency is required.
- The inverter shall be equipped with the following:

  A. Input and output disconnecting means, including integrated circuit breakers and sub combiners.

  B. Maximum Power Point Tracking (MPPT). (The Maximum Power Point tracking (MPP) range of the inverters should incorporate the MPP points of the arrays l-V curve at different temperatures). The Maximum Power Point tracking (MPP) efficiency should be at least 98%.

  C. Anti-islanding features.

  D. IP65 enclosure for outdoor applications with sun shed and IP54 for indoor application.

  E. For each inverter there should be communication interface via Bluetooth und providing a modern laptop with the corresponding program installed on it.

  F. The Inverter shall be provided with build in UI monitor display the electrical parameters. In addition, environmental data - like ،nodule temperature, ambient temperature, solar radiation, wind speed shall also be logged, stored and analyzed.

  - The operating range of the inverter should match the 1-V characteristic of PV arrays.
  - The inverters shall be capable of producing three phase true sine wave at an output of 400/230 volts with maximum * 10% variation and 50 Hz frequency (48.5 -51 Hz). The inverter maximum efficiency shall be at least 97% and the tenderer should indicate the loading corresponding efficiency range. The Total Harmonic distortion shall be limited to 5%. The injected direct current and shall be limited to 0.5% the alternating current nominal value.
  - Inverter shall be installed within the electrical room or within a special cabinet.
  - If the inverter protected with password to manage the software, then Distribution Company should be provide with this password.

- Inverter shall be operating and withstanding ambient temperature from -5:60 degree Celsius.

- The inverters should operate normally taking into consideration the presence of step up and step down transformers (must be enable to operate under the connection with medium voltage transformers).
- The inverter warranty is 5 years.
- The inverter size must be in accordance with the Design drawings.
- Also PV inverter main function and advantage main functions :
  a. Power reduction.
  b. Built In EMS and fuel save controller function for private diesel generator grid
  c. Reactive power management and dynamic grid support.
  d. Low voltage ride through.
  e. Ground fault monitoring.
  f. Metering for current, voltage and power at DC side with an error tolerance less than ±1%.
  g. Metering for current, voltage, power and power factor at AC side are be Class 1 with an error tolerance less than ±1%.
  h. Dynamic Adjustable output power factor
  i. Communication interface with the PV monitoring and control system.
  j. RS485 Communications protocol.
  k. LED display screen to display system parameters.
  l. Reverse polarity.
  m. Shortcircuits and overloads at the output.
  n. Anti-islanding with automatic disconnection.
  o. Insulation faults.
  p. Input and output overvoltages with type II surge arresters.
  q. 98.6% effiency
  r. DC and AC surge arresters type II and an integrated DC switch

G- Inverter (On- Off) Grid (hybrid) 150 KW

Product Model	150 KW
AC (Grid connection)	
Rated power (KW)	150
Rated voltage (V)	400
Rated Current (A)	216
Voltage range (V)	320~460
Rated frequency (Hz)	50/60
Communication format	Three-phase four-wire + ground wire (3 w + N + PE)
AC (off-grid)	
Rated output power (KW)	150
Rated current (A)	216 A
PV input	
Maximum PV input voltage (V)	850
Maximum photovoltaic power (KW)	120/180
MPPT operating voltage range (V)	250~850
MPPT full load voltage range (V)	450~850
Display	LCD
BMS communication	RS485, CAN
EMS communication	RS485, TCP/IP

Inverter (On- Off) Grid (hybrid) 250 KW

Product Model	250 KW
AC (Grid connection)	
Rated power (KW)	250
Rated voltage (V)	400
Rated Current (A)	360
Voltage range (V)	320~460
Rated frequency (Hz)	50/60
Communication format	Three-phase four-wire + ground wire (3 w + N + PE)
AC (off-grid)	
Rated output power (KW)	250
Rated current (A)	360
PV input	
Maximum PV input voltage (V)	850
Maximum photovoltaic power (KW)	300/360
MPPT operating voltage range (V)	250~850
MPPT full load voltage range (V)	450~850
Display	LCD
BMS communication	RS485, CAN
EMS communication	RS485, TCP/IP

Inverter (On- Off) Grid (hybrid) 500 KW

Product Model	500 KW
AC (Grid connection)	
Rated power (KW)	500
Rated voltage (V)	400
Rated Current (A)	722
Voltage range (V)	320~460
Rated frequency (Hz)	50/60
Communication format	Three-phase four-wire + ground wire (3 w + N + PE)
AC (off-grid)	
Rated output power (KW)	500
Rated current (A)	722 A
PV input	
Maximum PV input voltage (V)	850
Maximum photovoltaic power (KW)	600/660/720
MPPT operating voltage range (V)	250~850
MPPT full load voltage range (V)	450~850
Display	LCD
BMS communication	RS485, CAN
EMS communication	RS485, TCP/IP

- Approved materials:
  - WECO (Italy)
  - Ingecon (Spain) or approved equal
  - SMA- Germany
  - Fronious- Europe

1-5 Protection and metering system

1-5-1 A blocking diode shall be provided to block reverse flow of current into a photovoltaic source circuit (if required) according to distribution company requirements.

1-5-2 Suitable circuit breakers should be provided for isolating the PV system from the loads both in the DC side and the AC side.

1-5-3 The PV system shall be protected against overcurrent and short circuit by using suitable circuit breakers these circuit breakers are certified to either IEC60898-2 or IEC 60947-2.

1-5-4 The Contractor is responsible to set the protection setting point according to the equipment manufacturers' specifications

1-5-5 The cables from the array strings to the solar grid inverters shall be provided with DC fuse protection. Fuses shall have a voltage rating and current rating as required. The fuse shall be housed in thermoplastic IP65 enclosures with transparent covers.

1-5-6 Provide a coordinated surge-protection scheme:

a) Type I SPD at the main LV service entrance (incoming side of MSB).

b) Type II SPD at each inverter AC output and at downstream distribution panels.

c) PV DC side SPD shall be Type II or I+II in accordance with IEC 61643-31 (photovoltaic DC SPDs).

d) Coordination and MCOV ratings shall comply with IEC 61643-11/-31 and the system overvoltage category.

e) Bond SPDs to the site earthing network with conductors sized per short-circuit duty and keep leads as short and straight as practicable.

1-6 Cables and raceways

1-6-1 DC PV array cables shall comply with IEC 62930 (PV1-F) or EN 50618 (H1Z2Z2-K), UV- and ozone-resistant, halogen-free LSZH, rated ≥ 1.5 kV DC (where applicable). Installation practice shall follow IEC 62548."

1-6-2 The overall voltage drop from the most remote module in the array to the terminals of the application circuit should not exceed 2% of the PV array voltage at its maximum power point.

1-6-2-a: AC feeders from inverters to the main LV board: total voltage drop at full-load shall not exceed 1.5 %.

1-6-3 Contractor shall design, furnish, install and test all power and control cables between Contractor's equipment/panels.

1-6-4 Contractor shall install all raceway systems (cable trunk, exposed conduits…etc.) for all cables and wiring furnished by the Contractor. All raceway system including cable trunks and conduits shall be hot dipped galvanized steel. (Minimum height froth ground level should be 10cm).

1-6-5 Do not use HO7RN-F for PV DC strings. Route DC strings using PV1-F/H1Z2Z2-K in UV-resistant conduits, trays with covers, or suitably rated raceways; underground runs shall be in buried conduits with pull-boxes as needed. AC power and control cables shall be XLPE insulated, LSZH sheathed, UV-resistant where exposed.

1-7 Lithium Battery

It shall meet the following technical specifications:

a. The batteries shall be Lithium-Ion – with BMS.
b. The total capacity of the batteries shall ensure continuous feeding of electrical loads with a maximum capacity as indicated on the Design drawings (Rack mounted).
c. Nominal voltage 51.2V.
d. Discharge voltage 44.8V.
e. Charge Voltage 58.4V.

f. The depth of discharge shall not exceed 80%. (approved class A battery)
g. Communication Ports RS485/RS232/CAN
h. Battery discharging working temperature between -10°C and +50°C.
i. Battery charging working temperature between -0°C and +50°C.
j. Batteries shall technically be Rack Mounted while providing all the installation and connection supplies so that the work is carried out with high technical quality and according to the directives of the monitoring team.
k. LFP capacity Li-Ion battery with fire retardant wire.
l. Built-in BMS, Complex Protection, Safe and Reliable, Long Cycle Life > 6000, More than 15-year design life.
m. LCD Screen display the battery voltage, current, temperature, SOC detail information.
n. Minimum 10 years warranty.
o. Shall have a CE Certification and test result.
p. Approved materials:
   - WECO (Italy)
   - Ingecon (Spain) or approved equal

- **The bidder is required to provide internationally approved test certificates for the inverters provided, technical specifications**

MANUFACTURERS

All equipment shall be free from rust, scale, manufacturing residue and foreign material to the extent that it can be put into operation without further cleaning. All work performed at the job site on the equipment in connection with repair or replacement of defective materials or components shall be performed by Contractor or others under the supervision of the Contractor.

SPARE PARTS

The contractor shall submit in his offer the recommended spare parts for different system components, based on his previous experience with similar system, the spare parts list should include as Distribution Company required of the total supplied modules and as Distribution Company required of the total supplied MCCB, MCB and fuses of both the AC and D.C including surge protection devices (SPD).

Safety & Compliance (BESS):

The supplied battery system (cells, racks, cabinets/containers, BMS, PCS) shall be UL 9540 certified and supported by UL 9540A test reports for cell/module/unit demonstrating mitigation of thermal-runaway propagation. Installations shall comply with NFPA 855 and IEC 62619 and be shipped in compliance with UN 38.3. Coordinate ventilation interfaces with Mechanical Sections.

SECTION 264113
LIGHTNING PROTECTION

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Design, engineering, procurement, installation and testing of a complete lightning protection system shown on the drawings, specified herein or reasonably inferred there from.

1.02 REFERENCES

Comply with the following applicable standards and codes.

A. Local Code for Lightning Protection (if any).

B. National Fire Protection Association (NFPA)
   1. NFPA 70 - National Electric Code (NEC)
   2. NFPA 780 - Lightning Protection Code.

C. Underwriters Laboratories Inc. (UL)
   1. UL 96 – Standard for Lightning Protection Components.
   2. UL 96A – Standard for Installation Requirements for Lightning Protection Systems.
   3. UL 467 – Standard for Electrical Grounding and Bonding Equipment.

D. Franch Standard:
   1. Standard for Lightning Protection
   2. Lightning Protection Components
   3. Part 2 - Requirements for Conductors and Earth Electrodes.

E. IEC 62305 (Parts 1–4) and IEC 61643-11/-31 (SPDs) shall also apply.

Where difference arise between the specified standards and codes, the installation shall comply with the more rigorous and demanding requirements, whether or not shown on the drawings. Similarly, comply with the more stringent requirements of this specification and drawings.

1.03 SUBMITTALS

A. Detailed shop drawings indicating location, layout and details of the lightning protection system, showing conductor routing and accessories layout.

B. Product data: Submit product data for each component.

C. Contractor shall submit complete risk analysis and calculation sheet. Verifying and conforming the proposed lightning system layout along with spacing / dimensions of air terminals and number of down conductor. The use of risk analysis method of BSEN 62305 is authorized.

D. Certification: Upon completing installation, system shall be inspected and certified.

E. LPS–SPD Coordination Study: Demonstrate coordination between LPS, Type I service SPD, inverter AC Type II SPDs, and PV DC SPDs (per IEC 61643-31), including earthing layout and separation distances (IEC 62305-3).

1.04 WARRANTY

Lightning protection equipment shall be guaranteed against defective design, materials, and workmanship for the full warranty time, which is standard with the manufacturer or supplier, but in no case less than one year from the date of system acceptance.

1.05 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lightning protection equipment, of types and sizes required, whose products have been in use for not less than 3 years. All components of the lightning protection systems shall be new and suitable for the application in accordance with the specified standards and shall be UL listed and labeled.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with lightning protection work similar to that required for this project. The installer shall be a current UL listed company.

C. Underwriters' Laboratories, Inc. Certification

1. All Structures with lightning protection systems require a UL "Inspection Letter Report"

D. Field Measurements

1. Resistance-to-ground measurement shall be made using the “three points” or “fall of potential” method.

2. Measurements shall be taken for lightning protection systems to confirm that the resistance-to-ground is not greater than 5 ohms.

Part 2 - PRODUCTS

2.01 MANUFACTURER

A.

1. Furse – U.K.
2. A.N. WALLIS – U.K.
3. DEHN – Germany
4. Duval Messien
5. Satelit
6. Approved equal.

B. The products and manufacturers specified herein are specified for the purpose of establishing minimum quality standards. Products equal in quality to, or better than those specified, will be acceptable. The decision of acceptability rests with the Engineer.

2.02 GENERAL

A. Materials used in the manufacture of the lightning protection system components shall comply with BS EN 50164. No combination of materials shall be used to form an electrolytic couple causing corrosion in the presence of moisture unless moisture is permanently excluded from the junction of such materials. Where unusual conditions exist which would cause corrosion of conductors, suitable protective coatings shall be used. Where mechanical hazard is involved, suitable protection shall be provided by enclosing or covering conductors in PVC conduits or other non-magnetic material.

B. Provide a complete lightning protection system as per franch standard using copper conductors and consisting of an air termination network, down conductors, test clamps, earth termination and all other fixing materials and accessories.

C. Bond all exposed metalwork on the roof structure must be connected to the main earth bus bar.

D. Engage a specialist Lightning Protection Installer to undertake the design, installation, testing and commissioning of the lightning protection system without any additional cost to the Client. The cost shall be included in the tender sum. Submit all drawings and calculation for Engineer's approval.

2.03 SYSTEM CONSTRUCTION

A. The system shall consist of but not be limited to the following major components:
   1. Air Termination: Early streamer Emission (ESE) to cover the whole lot, with the appropriate level of protection using the enough number of air rods the cover the lot one and the lot two.
   2. Down Conductors
      a. Down conductors shall be 70 mm^2 copper conductor connecting the air termination network to the earth electrodes at the locations shown on the Drawings. Each down conductor shall be separately connected to an earth electrode through a test clamp.
   3. Earth Electrodes
      a. The earth electrodes shall be min. 19mm diameter copper clad steel rods driven to a depth of min. 3.6m in ground inside manholes and connected to the down conductors by purpose made clamps. The manhole covers shall match the external finishes and the Contractor shall obtain prior approval from the Engineer for the same.
      b. The earth electrodes shall be as specified for earthing.
      c. The overall resistance to earth of the lightning protection system shall not exceed 3 ohm. If this value is not obtained with one electrode per down conductor, then additional electrodes shall be installed and connected in parallel by 25 x 3mm copper strips until required resistance is obtained. Distance between such parallel conductors shall not be less than 3000mm.
      d. Ground enhancement materials, some with a resistivity of less than 0.12 Ω m (about 5% of the resistivity of bentonite), are typically placed around the rod in an augured hole or around grounding conductors in a trench, in either a dry form or premixed in a slurry. Some of these enhancement materials are permanent and will not leach any chemicals into the ground. Other available ground enhancement materials are mixed with local soil in varying amounts and will slowly leach into the surrounding soil, lowering the earth resistivity.
   4. Test Clamps
      a. Test clamps shall be suitable size conductors provided on each down conductor connecting the conductor to the earth electrode. They shall be rigidly fixed to the building structure at approximately 750mm above ground level. The earth bonding lead from the structural steel shall be bonded to the test clamp. Exact location of the test clamps shall be decided by the Engineer.
      b. The test clamps shall be made from phosphorous bronze, naval brass or approved equivalent. They shall incorporate facilities to enable a test conductor to be readily clamped to the down conductor and ensure good

electrical contact. The design of the clamp shall be such that the clamping screws/bolts shall not bear directly on the conductors.

c. The conductors shall protrude 25mm either side of the clamp. Dissimilar metals shall not be permitted at the test clamp position.

5. Earth Pits: Earth pits shall be reinforced concrete construction of size 320mm x 320mm to the depth of 300mm minimum or as approved by and Civil Defense. Earth pit cover shall be embossed with earth sign and the cover installation shall be according to the details shown in landscaping drawings for typical man-hole cover details.

Part 3 - EXECUTION

3.01 GENERAL

A. The Lightning Protection System shall be inspected by the Engineer to determine conformance with the requirements of the Specification. Before final inspection, measure the resistance to earth in the presence of the Engineer and submit in writing to the Engineer the measured earth resistance of each earthing electrode, as well as the total resistance indicating the location of the electrodes and the resistance and soil conditions at the time the measurements were made. Measurements of the earth resistance shall be made at least 48 hours after rainfall. On completion of the installation, the Contractor shall provide a Certificate of Compliance endorsed by the protection system's representative.

3.02 SYSTEM INSTALLATION

A. The Contractor shall furnish and install all earth continuity conductors and earth electrodes as required by and Civil Defense Regulations, and BSI whether or not specified or indicated on the drawings.

B. Earth tapes shall be securely fastened to walls and other building features in an approved manner. A clearance of 12mm shall be maintained between tapes and building features.

C. No portion of the lightning protection system shall be concealed until so authorized by the Engineer.

D. Jointing of lightning conductors shall only be undertaken where strictly necessary and with prior approval of the Engineer. Joints in down conductors will not be permitted except at test clamp positions.

E. Joints shall be mechanically and electrically sound and be riveted using a material whose electro-chemical potential is close to that of the conductor material. Contact surfaces should first be cleaned then inhibited from oxidization with a suitable non-corrosive compound. The joints shall be

protected with two coats of bituminous paint and wrapped with two layers of bituminous tape, half lapped and heat worked to seal off.

F. Complete waterproof protection of joints between dissimilar metals shall be provided, extending at least 75mm from the joint along the conductors in all directions.

G. The overlapping mating surface area of any joint shall not be less than 625mm².

H. Connections to equipment shall be made to terminals specifically provided for that purpose. Where such terminals are not available an approved bolted connection shall be provided. Care shall be taken to remove all paintwork immediately under all earth connections leaving bright metal. The lightning protection system shall be effectively bonded to the electrical installation earth system.

I. The final positions of air terminations and down conductors, test clamps and earth electrodes shall be marked out on site and approved by the Engineer before any work is carried out.

J. All tapes shall be installed so that there is sufficient movement to allow for thermal expansion and contraction and also movement during a lightning strike.

K. Any flexible connection to the roof metal works shall be complete with star-washers of proper size.

L. Bond all PV module frames, metallic supports, trays, inverter enclosures, and raceways into the main equipotential bonding network. Maintain separation distance s from down-conductors where required by IEC 62305-3; where s cannot be met, provide bonding conductors and coordinated SPDs.