

TECHNICAL PROCUREMENT SPECIFICATION

For

200kW(min) ON-GRID ROOFTOP SOLAR PV SYSTEM FACT-UC

TPS NO. : FACT-UC-SLR-2023-24

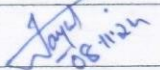
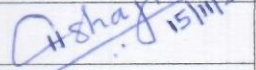
PREPARED BY:	CHECKED BY	APPROVED BY:	ISSUED ON:	REVISION
 Anu Vyshnavi.R AMD (Electrical)	 Faizal Latheef K.A SMM (E)-SS&SP	 Shajan V.A DGM (E) UC	23.12.2023	R0

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1. INTRODUCTION

- 1.1 This specification covers the minimum user requirements for installation of 200kW grid-connected leak proof Rooftop Solar Photovoltaic system at rooftop of FACT Head Office (two storied building), Udyogamandal Complex (FACT-UC), Kochi, Kerala.
- 1.2 The Fertilizers And Chemicals Travancore (FACT) is a Government of India Enterprise engaged in Manufacture of Fertilizer, Chemical & Petrochemical products, Engineering consultancy and Engineering fabrication. FACT-Udyogamandal Complex (FACT-UC) is a division of FACT located at Udyogamandal, Kochi, Kerala that manufactures intermediates and products like Sulphuric acid, Ammonia, Ammonium Phosphate, Ammonium Sulphate, Caprolactam etc.
- 1.3 We intend to install a truss roof with solar panels on our Head Office building to prevent rain water from leaking through its concrete terrace. The system should also be capable of harvesting optimal solar power to meet our electricity requirements. Hence, the scope of the bidder is to design, manufacture, install and commission a suitable truss roof with solar panels in an aesthetic manner, in compliance with all safety and statutory regulations. The scope of work also includes providing necessary operation and maintenance training for our employees, and shall be inclusive of five-year service warranty as detailed in sections that follow.
- 1.4 The entire work shall be carried out in turnkey basis, adhering to all relevant standards, regulations and the best engineering practices, utilizing best quality materials. Workmanship shall be of highest quality and the entire construction shall be in accordance with the best modern engineering practices.
- 1.5 Bidder is advised to visit the site and collect / obtain all relevant details prior to submitting the Bid and the bids which qualify Pre-Qualification Criteria (PQC), will only be considered for Technical Evaluation & further processing.
- 1.6 Once the tender is floated, FACT will arrange a pre- bidding meeting before the bid submission due date.
- 1.7 The Bidder shall inform the Purchaser in the event of any conflict between data given in this specification and the requirements with respect to statutes/standards/regulations. The Purchaser will provide his resolution in such cases and the Bidder shall follow the same without any impact on cost or time schedule.

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2. SCOPE OF WORK

Vendor's scope includes, but not limited to supply of truss roof with rooftop solar PV system of 200kW minimum capacity as described in this specification.

- 2.1 Site survey, preparation of drawings & reports in all respect.
- 2.2 Design, manufacture, inspection, testing, supply, civil work, truss work, installation & commissioning, training, preparation of documents required, five-year service warranty for the supplied Rooftop mounting Solar PV System.
- 2.3 The structural design for the truss roof with solar panels must be in accordance with good engineering practice and applicable design codes. All safety and statutory regulations must be complied within the design without compromising the aesthetic beauty of the Head Office building.
- 2.4 At present, there is no staircase to the open terrace of the proposed two-storied Head Office building except an old monkey ladder for emergency use. Therefore, providing an appropriate outdoor metallic staircase from the ground to the open terrace (for the two-story Head Office building) and ladders for access to PV installation over the roof is also within the scope of the bidder.
- 2.5 The bidder's structural design for the truss roof with solar panels including staircase shall be vetted by a competent structural consultant from IIT/NIT, not below the rank of Assistant Professor and same shall be submitted within 30 days of receiving the LOI/PO.
- 2.6 Supply of materials for Grid connected Solar PV system of 200 kW(min) power capacity including spares, tool & tackles, display boards etc. for the rooftop of the proposed building.
- 2.7 Installation & Commissioning of Complete package including on site testing & commissioning. Performance Guarantee test is also part of subject contract as detailed in section 10.
- 2.8 All the necessary approvals and liaison work with the concerned KSEBL/ Central Electrical Inspectorate, and any other relevant statutory authorities for project approvals shall be under the scope of contractor. This includes feasibility study, net metering and arranging all the necessary inspections from KSEBL/ Central Electrical Inspectorate as part of commissioning of the solar power plant. However, the payment for the registration of the solar plant with KSEBL falls under the scope of FACT.
- 2.9 The bidder is required to specify the product warranty for both the solar modules and the PCU/inverters of the offered PV system. Furthermore, a power output warranty for the solar modules must be provided. The bidder should also provide a list of mandatory spares as detailed in Section 4.10.
- 2.10 The Solar PV system shall have local monitoring & remote access facility (web-based monitoring feature as well as mobile alert feature). Real time data to be provided online with

communication though data logger installed.

- 2.11 Integration with available grid supply (415V AC, 50Hz) and AC load panel is in bidder's scope (if required). Provision of grid supply to AC load panel is under FACT's scope. However, required number of MCCBs/ACBs for providing grid supply is under the scope of vendor.
- 2.12 Bidder shall also provide Levelized cost of electricity (LCOE) and Power temperature Coefficient for installed unit.
- 2.13 Training at site for solar plant operation and maintenance is included in bidder's scope as specified in Section 8.
- 2.14 Providing a suitable Solar PV module cleaning & water washing arrangement and providing adequate number of water taps with isolation is also under the scope of the contractor.
- 2.15 The entire work shall be executed on turnkey basis. Any item/service required, but not specifically mentioned in the scope/ technical specification shall be supplied without extra cost to FACT-UC.
- 2.16 Bidder shall provide customized and suitable installation based on wind speed and corrosive environment study and submit certificate/report as applicable.
- 2.17 Bidder is strictly advised to visit site in order to assess the available infrastructure and other requirements, before submission of their offer.
- 2.18 The supply materials shall be delivered to the FACT Udyogamandal stores. The transportation of all supply items from the FACT stores to the location, as well as loading the items onto the rooftop, falls under the scope of the contractor.
- 2.19 Bidder to ensure that solar installation should comply to all relevant IEC/BIS standards.
- 2.20 The testing and commissioning of the Solar PV System shall be carried out in the presence of FACT representative. The major parameters like DC Voltages of strings, DC Power, AC Voltages, current and Power etc. shall be recorded in a format/commissioning document. The commissioning documents shall be submitted to FACT-UC as reference documents.
- 2.21 The estimated open terrace area available for the work is around 1500sqm with proposed minimum installation capacity of 200kW. The estimated area is based on preliminary survey by FACT-UC, however bidder shall ensure by carrying out the same through site visits, survey and shadow analysis / simulations studies with the help of proven software for arriving possible installation capacities on indicated site.
- 2.22 The bidder has the liberty to offer a higher capacity solar PV system with more efficient panels/ technologies that is suitable for the total usable terrace area of 1500 sqm. The bidder who has the lowest cost per unit of guaranteed annual generation of electricity, will be selected as the L1 bidder. The criteria to evaluate L1 bidder is detailed in Annexure-5.



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- 2.23 The maximum area of the concrete terrace that can be used is 1500sqm. The bidder can offer a truss roof with solar panels mounted on or over it, or a solar roof system in which solar cells are integrated into cement roofing panels. In both cases, it is necessary to shield the entire terrace area of the building from rainwater falling.

3. PERIOD OF COMPLETION

- 3.1. The bidder shall successfully complete the supply, testing, inspection, installation & commissioning within 20 weeks from the date of drawing approval. The drawings as per vendor data requirements shall be submitted for approval within 30 days from the date of LOI. Comments/Approval on drawings will be given by purchaser within 15 days from the submission of drawings. Revised final drawings for final approval, after incorporating the all comments/changes from Purchaser, if any, shall be submitted within 10 days from the date of receipt of comments. However, total days taken for drawing approval shall not exceed 45 days from LOI which shall be inclusive of vetting by a competent structural consultant from IIT/NIT, not below the rank of Assistant Professor. Hence, total lead time for supply from date of issue of LOI shall not exceed 28 weeks. The vendor shall complete the supply of the solar PV system within the time specified above. In case delivery is delayed beyond the period stipulated above, LD @ 0.5% of the total basic supply order value for every week delay, limited to a maximum of 7.5% of the total basic order value will be deducted from the bill.
- 3.2. Installation, testing and completion shall be completed within 60 days from date of supply of materials at FACT stores. In case commissioning is delayed beyond the period stipulated, LD @ 0.5% of the total basic service order value for every week delay, limited to a maximum of 7.5% of the total basic order value will be deducted from the bill.

4. TECHNICAL SPECIFICATION-

Grid connected rooftop Solar PV system shall consist of following equipment/ components:-

- Solar Photo Voltaic (SPV) modules consisting of required number of Mono Crystalline PV modules.
- Inverter/PCU
- Module Mounting structures
- Data Monitoring
- Array Junction Boxes
- AC Distribution Box
- Cables
- Cleaning & Water washing Arrangement for Solar PV Panels

4.1 SOLAR PV MODULE-

- 4.1.1 The PV modules and Solar Cell used should be made in India.
- 4.1.2 The PV modules used shall qualify to the latest edition of the following IEC standards or equivalent BIS standards, i.e.

IEC 61215/ IS 14286	Crystalline silicon terrestrial photovoltaic (PV) modules-design qualification and type approval
IEC 61730-1	Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction
IEC 61730-2	Photovoltaic (PV) module safety qualification - Part 1: Requirements for testing
IEC 61701	Photovoltaic (PV) modules - Salt mist corrosion testing

- 4.1.3 The rated power of solar PV module shall have maximum power tolerance up to $\pm 3\%$.
- 4.1.4 The PV system shall have minimum (annual) Capacity Utilization Factor (CUF) of 17% for a period of first five years of operation at the output of the inverter. Bidder to provide self-declaration at the time of bidding.
- 4.1.5 The peak-power point current of any supplied module string (series connected modules) shall not vary by $\pm 1\%$ from the respective arithmetic means for all modules and/or for all module strings (connected to the same MPPT), as the case may be.
- 4.1.6 The peak-power point voltage of any supplied module string (series connected modules) shall not vary by $\pm 2\%$ from the respective arithmetic means for all modules and/or for all module strings (connected to the same MPPT), as the case may be.
- 4.1.7 The temperature co-efficient of power of the PV module shall be equal to or better than $-0.45\%/^{\circ}\text{C}$.
- 4.1.8 Solar PV modules of minimum capacity 500 Wp to be used.
- 4.1.9 The PV Module efficiency should be minimum 16%.
- 4.1.10 Solar PV modules of minimum fill factor 75%, to be used.
- 4.1.11 All electrical parameters at Standard Test Conditions shall have to be provided.
- 4.1.12 The PV modules shall be equipped with IP 65 or better protection level junction box with required numbers of bypass diodes of appropriate rating and appropriately sized output power cable of symmetric length with MC4 or equivalent solar connectors.



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4.1.13 The bidder is required to submit a self-declaration stating that all offered PV modules must carry a performance warranty of greater than 90% during the first 10 years, and greater than 80% during the next 15 years. Further, module shall have performance warranty of greater than 97% during the first year of installation, with degradation of the module not exceeding 2.5 % per annum in the 1st year and not exceeding 0.7 % per annum for the 2nd to 25th year. If the module degradation exceeds the specified limits, the bidder is obligated to replace or rectify the modules.

4.1.14 The manufacturer should warrant that the solar modules are free from specified defects for at least twelve (12) years and that the Inverters are free from specified defect for at least seven (7) years from commissioning covering:

- a) Defects and/or failures due to manufacturing
- b) Defects and/or failures due to quality of materials.
- c) Nonconformity to specifications due to faulty manufacturing and/or inspection processes.

If the solar Module(s) fails to confirm to this warranty, the manufacturer will have to repair or replace the solar module(s), at the Owners sole option.

4.1.15 PV modules must be tested and approved by one of the NABL accredited and BIS approved test centers.

4.1.16 Modules deployed must use a RF identification tag laminated inside the glass as per MNRE guidelines. The contractor shall supply suitable RFID reader to read the RFID tag. The following information must be mentioned in the RFID used on each module:

- a) Name of the manufacturer of the PV module.
- b) Name of the manufacturer of Solar Cells.
- c) Month & year of the manufacture (separate for solar cells and modules).
- d) Country of origin (separately for solar cells and module).
- e) I-V curve for the module Wattage, Im, Vm and Fill Factor for the module.
- f) Unique Serial No and Model No of the module.
- g) Date and year of obtaining IEC PV module qualification certificate.
- h) Name of the test lab issuing IEC certificate.
- i) Other relevant information on traceability of solar cells and module as per ISO 9001 and ISO 14001.
- j) Nominal wattage.

k) Brand Name, if applicable.

4.1.17 Other details as per IS/IEC 61730-1 clause 11 (Marking of Solar Module) should be provided at appropriate place. In addition to the above, the following information should also be provided:

- The actual Power Output P_{max} shall be mentioned on the label pasted on the back side of PV Module.
- The Maximum system voltage for which the module is suitable to be provided on the back sheet of the module.
- Polarity of terminals or leads (colour coding is permissible) on junction Box housing near cable entry or cable and connector.
- Unique Serial No, Model No, Name of Manufacturer, Manufacturing year, Make in India logo and module wattage details should be displayed inside the laminated glass.

4.2 INVERTERS/POWER CONDITIONING UNIT

4.2.1 Inverters/PCU should comply with latest edition of applicable IEC/equivalent BIS standard for efficiency measurements and environmental tests as per standard codes

IS/IEC 61683	Photovoltaic systems-Power conditioners- Procedure for measuring efficiency
IEC 61727	Photovoltaic (PV) systems - Characteristics of the utility interface
IS 16169 /IEC 62116	Utility - Interconnected photovoltaic inverters - Test procedure of islanding prevention measures
IEC 60068-2(1,2,14,30)	Environmental Testing

4.2.2 Maximum Power Point Tracker (MPPT) shall be integrated in the inverter/PCU to maximize energy drawn from the array. The junction boxes/ enclosures should be IP 65 or better (for outdoor)/ IP 42 or better (indoor) and as per IEC 529 Specifications.

4.2.3 The PCU/ inverter shall have overloading capacity of minimum 10%.

4.2.4 A minimum of two inverters shall be provided for the total offered capacity.

4.2.5 Typical technical features of the inverter shall be as follows-

- Switching devices: IGBT/MOSFET



- b) Control: Microprocessor/DSP
- c) Nominal AC output voltage and frequency: as per CEA/State regulations
- d) The inverter output voltage shall be 415 VAC, 3 phase
- e) Voltage Band- Between 80% and 110% of V nominal
- f) Output frequency: 50 ± 2.5 Hz
- g) Grid Frequency Synchronization range: as per CEA/State Regulations
- h) Ambient temperature considered: -10°C to $+60^{\circ}\text{C}$
- i) Humidity: 95 % Non-condensing
- j) Protection of Enclosure: IP-42 (Minimum) for indoor and IP-65(Minimum) for outdoor.
- k) Grid Frequency Tolerance range: as per CEA/State regulations
- l) Grid Voltage tolerance: as per CEA/State Regulations
- m) No-load losses: Less than 1% of rated power
- n) Inverter efficiency (Min.): $\geq 97\%$ at full load
- o) Output Voltage THD: $< 3\%$
- p) PF: > 0.9 (lag or lead)
- q) Should not inject DC power more than 0.5% of full rated output at the interconnection point and should comply to IEEE 519 (Harmonic Control in Electric Power system).

4.2.6 The output power factor of inverter should be suitable for all voltage ranges or sink of reactive power, inverter should have internal protection arrangement against any sustain fault in feeder line and against the lightning on feeder.

4.2.7 All the Inverters should contain the following clear and indelible Marking Label & Warning Label as per IS 16221 Part II, clause 5. The equipment shall, as a minimum, be permanently marked with:

- a) The name or trademark of the manufacturer or supplier;
- b) A model number, name or other means to identify the equipment,
- c) A serial number, code or other marking allowing identification of manufacturing location and the manufacturing batch or date within a three-month time period.
- d) Input voltage, type of voltage (a.c or d.c), frequency, and maximum continuous current for each input.
- e) Output voltage, type of voltage (a.c or d.c), frequency, maximum continuous current, and for ac outputs, either the power or power factor for each output.

f) The Ingress Protection (IP) rating

- 4.2.8 Marking shall be located adjacent to each fuse or fuse holder, or on the fuse holder, or in another location provided that it is obvious to which fuse the marking applies, giving the fuse current rating and voltage rating for fuses that may be changed at the installed site.
- 4.2.9 Inverter/PCU shall be capable of complete automatic operation including wake-up, synchronization & shutdown.
- 4.2.10 The Inverter should have a provision of remote monitoring of inverter data through sim card. Required website/mobile app platform, where the user (Consumer) can access the data, should be provided/explained to consumer while installation. Additionally, if inverter has the facility of in-built wi-fi module, that should also be explained to the consumer. On demand, Inverter should also have provision to feed the data to the remote monitoring server using relevant API/protocols. All the inverter data should be available for monitoring by giving web access.
- 4.2.11 Integration of PV Power with Grid & Grid Islanding:
- The output power from Solar PV would be fed to the inverters/PCU which converts DC produced by PV array to AC and feeds it into the main electricity grid after synchronization.
 - In the event of a power failure on the electric grid, it is required that any independent power-producing inverters attached to the grid turn off in a short period of time. This prevents the DC-to-AC inverters from continuing to feed power into small sections of the grid, known as "islands." Powered islands present a risk to workers who may expect the area to be unpowered, and they may also damage grid-tied equipment. The Rooftop PV system shall be equipped with islanding protection. In addition to disconnection from the grid (due to islanding protection) disconnection due to under and over voltage conditions shall also be provided, if not available in inverter.
 - MCB/MCCB or a manual isolation switch, besides automatic disconnection to grid, would have to be provided at utility end to isolate the grid connection by the utility personnel to carry out any maintenance. This switch shall have provision to be locked by the utility personnel.
- 4.2.12 Protections- Over voltage: both input and output, Over current: both input and output, Over / Under grid frequency, Over temperature, Short circuit, Lightning, Surge voltage induced at output due to external source, Islanding.
- 4.2.13 Recommended LED indications- ON, Grid ON, Under/ Over voltage, Overload, Over

temperature.

- 4.2.14 Recommended LCD Display on front Panel- DC input voltage, DC current, AC Voltage (all 3 phases), AC current (all 3 phases), Frequency, Ambient Temperature, Instantaneous power, Cumulative output energy, Cumulative hours of operation, Daily DC energy produced, system fault including temperature and active faults with time stamp of fault history.

4.3 MODULE MOUNTING STRUCTURE (MMS)

- 4.3.1 Supply, installation and erection of module mounting structure (MMS) with all necessary accessories, auxiliaries and spare part shall be in the scope of the vendor. Construction of suitable outdoor metallic staircase/ladder for the two storied building for access to the solar PV installation also comes under the scope of the vendor.

- 4.3.2 The bidder may offer either one of the following types of solar panel installations-

- a) A truss roof with solar panels mounted on or over it with adequate spacing between panel frames and rows to facilitate personnel safety, ease of installation, panel replacement, cleaning and electrical maintenance. Powder coated Aluminium roofing sheet shall be used to achieve the specified spacing with proper structural design.

OR

- b) A solar roof system with solar cells integrated into cement roofing panels, designed to allow safe walking over the entire roof surface for cleaning and maintenance purpose.

In both cases, the roof must shield against rainwater infiltration, establish a leak-proof canopy, and remain completely watertight.

- 4.3.3 Truss Roof shall be made up of Aluminium material and shall be elevated structure with minimum ground clearance of 9 +/-1 feet. Suitable ladder and platforms shall be provided on the mounting roof structure for access and cleaning of the PV panels. Handrails for sideward protection during movement for maintenance shall also be provided.

- 4.3.4 Civil work shall include the roof truss work and construction of suitable outdoor metallic staircase for the two storied building for access to the solar PV installation.

- 4.3.5 The base frame of the roof truss shall be anchored to the concrete floor and surrounded by 1:2:4 grade concrete following suitable chipping.

- 4.3.6 Module mounting structures can be made from three types of materials. They are Hot Dip Galvanized Iron, Anodized Aluminium and Hot Dip Galvanized Mild Steel (MS). However, MS will be preferred for raised structure. The structure shall support SPV modules at a given orientation, absorb and transfer the mechanical load to the roof uniformly.



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- 4.3.7 In case MMS is made of hot dip galvanized, the main frames and complete leg assemblies of the array structures shall be made of MS hot dip galvanized. MMS Steel shall be as per latest IS 2062:2011 and galvanization of the mounting structure shall be in compliance of latest IS 4759. In case the MMS is of Aluminium type, Aluminium shall be as per AA6063-T6. For Aluminium structures, necessary protection towards rusting needs to be provided either by coating or anodization.
- 4.3.8 All bolts, nuts, fasteners shall be of stainless steel of grade SS 304 or hot dip galvanized, panel mounting clamps shall be of aluminium and must sustain the adverse climatic conditions. Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts.
- 4.3.9 The module mounting structures should have angle of inclination as per the site conditions to take maximum insolation and complete shadow-free operation during generation hours. The tilt angle can vary from 9 degree to 12 degree based on the location's latitude. (Latitude- 10.07475, Longitude- 76.29839). However, to accommodate more capacity the angle of inclination may be reduced until the plant meets the specified performance ratio requirements.
- 4.3.10 Staircase / ladder from the ground to the open terrace (for the two-story Head Office building) shall meet the following minimum specification:
- 4.3.10.1 Width shall be minimum 1000mm
- 4.3.10.2 Suitable landings to be provided
- 4.3.10.3 Handrails shall be provided
- 4.3.10.4 Shall be fabricated using ISMC/ISMB materials with checker plates as platforms
- 4.3.10.5 Sufficiently rated civil foundation to be constructed
- 4.3.10.6 The design and drawing should be duly verified by a competent structural consultant from IIT/NIT, not below the rank of Assistant Professor as specified in clause 2.5.
- 4.3.11 Neatness and Tidiness must be observed while installing the system and should meet aesthetically appealing aspects.
- 4.3.12 The Mounting structure shall be so designed to withstand a wind velocity of 150km/hr unless specified for dedicated requirements. The PV array structure design shall be appropriate with a factor of safety of minimum 1.5.
- 4.3.13 The upper edge of the module must be covered with wind shield so as to avoid build air ingress below the module. Slight clearance must be provided on both edges (upper & lower) to allow air for cooling.
- 4.3.14 Suitable fastening arrangement such as grouting and calming should be provided to secure the

installation against the specific wind speed.

4.3.15 The structures shall be designed to allow easy replacement, repairing and cleaning of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels. Necessary testing provision for MMS to be made available at site.

4.3.16 The structure shall be designed to withstand operating environmental conditions for a period of minimum 25 years.

4.4 MATERIAL STANDARDS:

- i. Design of foundation for mounting the structure should be as per relevant IS standards which clearly states the Load Bearing Capacity & other relevant parameters for foundation design.
- ii. Grade of raw material to be used for mounting the structures shall be as per relevant IS standard so that it complies the defined wind loading conditions Design Validation:

The Structure design and drawing should be duly verified by a competent structural consultant from IIT/NIT, not below the rank of Assistant Professor before installation for all types of structure arrangements including the extension made, as per specification.

4.5 DATA MONITORING

The plant monitoring shall have following.

- 4.5.1 Measurement of Solar PV parameters at PCU / String Inverter level: PCU / String Inverter shall have provision of measuring and displaying actual value of AC & DC Voltage, AC & DC Current, and AC Power & Energy Generated by the Solar PV system. These PCU / String Inverter parameters shall have provision of data logging through wireless / wired & web based connectivity.
- 4.5.2 Solar Irradiance: An integrating Pyranometer (Class II or better) shall be provided, with the sensor mounted on a Horizontal plane at a shadow free suitable location near solar arrays.
- 4.5.3 Temperature: Temperature probes for recording the PV Cell temperature shall be provided.
- 4.5.4 The above data has to be made available at local as well as remote terminal through web/ internet.
- 4.5.5 Bidder can utilize the available mode of data transmission at site. Any hardware/ software required shall be included in the scope of work by the bidder. Desk top Terminal is not envisaged in the scope of work.



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4.5.6 Bidder have to supply & install following Energy Meters of 0.2 class for generation monitoring as per KSEBL requirements (meter shall be fixed at a distance of 200 m away from the installation), however solar generation will be measured by inverter & shall be accounted towards guaranteed generation. Supply, laying and termination of cable from solar plant to Energy meter is under the scope of supplier.

- a) Net meter: To record import and export units
- b) Generation meter: To keep record for total generation of the plant. The installation of meters including CTs & PTs, wherever applicable, shall be carried out by the Empanelled Bidder as per the terms, conditions and procedures laid down by the concerned SERC/CERC.

4.6 ARRAY JUNCTION BOXES

- 4.6.1 The junction boxes are to be provided in the PV array for termination of connecting cables. The Junction Boxes (JBs) shall be made of GRP/FRP/Powder Coated aluminum /cast aluminum alloy/SS with full dust, water & vermin proof arrangement. All wires/cables must be terminated through cable lugs. The JB's shall be such that input & output termination can be made through suitable cable glands. Suitable markings shall be provided on the bus-bars for easy identification and cable ferrules will be fitted at the cable termination points for identification.
- 4.6.2 Junction boxes and solar panel terminal boxes shall be of the thermo- plastic type with IP 65 or better protection for outdoor use, and IP 54 or better protection for indoor use as per standard IEC 60529.
- 4.6.3 Copper bus bars/terminal blocks housed in the junction box with suitable termination threads Conforming to IP 65 or better standard and IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry, Single /double compression cable glands should be provided.
- 4.6.4 Polyamide glands and MC4 Connectors may also be provided. The rating of the junction box shall be suitable with adequate safety factor to interconnect the Solar PV array.
- 4.6.5 Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification.
- 4.6.6 Junction boxes shall be mounted on the MMS such that they are easily accessible and are protected from direct sunlight and harsh weather.

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4.7 AC DISTRIBUTION BOXES

- 4.7.1 AC Distribution Panel Board (DPB) shall control the AC power from inverter, and should have necessary surge arrestors. Interconnection from ACDB to mains at LT Bus bar while in grid tied mode are also required (maximum length of 50m). An SLD of ACDB to be submitted along tender documents. Grid incomer cable that is to be connected to ACDB is under scope of FACT
- 4.7.2 All switches and the circuit breakers, connectors should conform to IEC 60947.
- 4.7.3 The isolators, cabling work should be undertaken as part of the project.
- 4.7.4 All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air -insulated, cubical type suitable for operation on 3- ϕ , 415, 50 Hz.
- 4.7.5 LT switchgears shall be rated for 50kA.
- 4.7.6 The panels shall be designed for minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.
- 4.7.7 All indoor panels will have protection of IP 54 or better, as per site conditions. All outdoor panels will have protection of IP 65 or better, as per site conditions.
- 4.7.8 Should conform to Indian Electricity Act and CEA safety regulations (till last amendment)
- 4.7.9 All the 415 V AC devices / equipment like bus support insulators, circuit breakers, Surge Protection Devices, Voltage Transformers (VTs) etc., mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the following supply conditions.
- a. Variation in supply voltage: as per CEA/State regulations
 - b. Variation in supply frequency: as per CEA/State regulations
- 4.7.10 The inverter output shall have the necessary rated AC surge arrestors along with MCB/ MCCB. RCCB shall be used for successful operation of the PV system, if inverter does not have required earth fault/residual current protection.

4.8 CABLES

- i. All cables should conform to latest edition of IEC/equivalent BIS Standards-as applicable.
- ii. Cables should be flexible and should have good resistance to heat, cold, water, oil, abrasion etc.



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- iii. Armoured cable should be used and overall PVC type 'A' pressure extruded insulation or XLPE insulation should be there for UV protection.
- iv. Cables should have Multi Strand, annealed high conductivity copper conductor on DC side and copper/FRLS type Aluminum conductor on AC side. For DC cabling, multi-core cables shall not be used.
- v. Cables should have operating temperature range of -10°C to +80°C and voltage rating of 660/1000 V.
- vi. Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop less than 2% (DC Cable losses).
- vii. The size of each type of AC cable selected shall be based on minimum voltage drop. However; the maximum drop shall be limited to 2%.
- viii. The electric cables for DC systems for rated voltage of 1500 V shall conform to relevant IS standards.
- ix. All cable/wires are to be routed in a RPVC pipe/ GI cable tray and suitably tagged and marked with proper manner by good quality ferule or by other means so that the cable is easily identified.
- x. All cable trays including covers to be provided.
- xi. Thermo-plastic clamps to be used to clamp the cables and conduits, at intervals not exceeding 50 cm.
- xii. Size of neutral wire shall be equal to the size of phase wires, in a three phase system.
- xiii. The Cable should be so selected that it should be compatible up to the life of the solar PV panels i.e. 25 years.

4.9 CLEANING & WATER WASHING ARRANGEMENT FOR SOLAR PV PANELS

An appropriate Solar PV Module cleaning & water washing arrangement -GI pipes, valves, hose pipes, wipers, mops etc. shall be provided for regular cleaning and water washing of the rooftop Solar PV modules. Minimum two sets of Microfiber based cleaning tool is to be provided. The system shall be specifically designed to take care of the harsh & dusty environment. Drainage for this system shall be arranged by the bidder. Water shall be made available at the nearest point from where bidder to make necessary piping arrangements for water washing of PV modules.

4.10 CRITICAL SPARES

Bidder shall mention in the Bid Critical spares, consumables & various components of solar PV plant O&M along with their quantity and specification.

- a) Solar PV modules - 1% of the total population (rounded off to next higher whole number, if in decimals)
- b) Solar DC cable- Minimum 20m
- c) DC side surge arrestor, if applicable- 6 Nos.
- d) Inverter Cooling Fan- 4 Nos. of each type.
- e) Power and Communication cards of string inverter-1 No. of spare card for each type

And any other spares felt necessary during pre-bid stage by discussion between bidder and FACT-UC. The above spares will be preserved by FACT for usage after warranty and service warranty period. The bidder shall replace faulty items on their own, during service warranty period / warranty period for panel and inverters.

4.11 DRAWINGS & MANUALS

Drawings, documentation, installation, operation, and maintenance manuals shall be delivered along with the supply of solar panels. The detailed of the following shall be supplied.

- i. Operation & Maintenance manual/user manual including Bill Of Materials (BOM) , Engineering and Electrical Drawings.
- ii. Routing diagrams of cables and wires.
- iii. The Manual should also include all the Dos & Don'ts of grid connected rooftop PV System along with Graphical Representation with indication of proper methodology for cleaning, Operation and Maintenance etc.
- iv. Step by step maintenance and troubleshooting procedures shall also be given in the manuals.
- v. Maintenance registers.

4.12 MISCELLANEOUS

4.12.1 Connectivity: The maximum capacity for interconnection with the grid at a specific voltage level shall be specified as in the SERC regulation for Grid connectivity.

4.12.2 Safety measures: Electrical safety of the installation(s) including connectivity with the grid must be taken into account and all the safety rules & regulations applicable as per Electricity



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Act, 2003 and CEA Safety Regulation 2010 etc. must be followed.

4.12.3 Shadow analysis: The shadow analysis report with the instrument such as Solar Pathfinder or professional shadow analysis software of each site should be provided and the consumer should be educated to install the system only in shadow free space. Lower performance of the system due to shadow effect shall be liable for penalty for lower performance.

4.12.4 Firefighting system - Portable fire extinguishers/sand buckets shall be provided wherever required as per norms and manufacture's standard.

5. PROTECTION

The system should be provided with all necessary protections like earthing, Lightning, and Surge Protection, as described below:

5.1 EARTHING PROTECTION-

- i. The earthing with earth pits shall be done in accordance with latest Standards.
- ii. Each array structure of the PV yard, Low Tension (LT) power system, earthing grid for switchyard, all electrical equipment, inverter, all junction boxes, etc. shall be grounded properly as per IS 3043-2018.
- iii. All metal casing/ shielding of the plant shall be thoroughly grounded in accordance with CEA Safety Regulation 2010. In addition, the lightning arrester/masts should also be earthed inside the array field.
- iv. Earth resistance should be as low as possible and shall confirm to standards.
- v. For 10 KW and above systems, separate three earth pits shall be provided for individual three earthings viz.: DC side earthing, AC side Earthing and Lightning arrestor earthing

5.2 LIGHTNING PROTECTION

- i. The SPV power plants shall be provided with lightning & over voltage protection. The main aim in this protection shall be to reduce the overvoltage to a tolerable value before it reaches the PV or other sub system components. The source of over voltage can be lightning, atmosphere disturbances etc.
- ii. The entire space occupying the SPV array shall be suitably protected against Lightning by deploying required number of Lightning Arrestors (LAs). Lightning protection should be provided as per NFC17-102:2011/IEC 62305 standard.
- iii. The protection against induced high-voltages shall be provided by the use of Metal Oxide

Varistors (MOVs)/Franklin Rod type LA/Early streamer type LA.

- iv. The current carrying cable from lightning arrestor to the earth pit should have sufficient current carrying capacity according to IEC 62305. According to standard, the minimum requirement for a lightning protection system designed for class of LPS III is a 6 mm² copper/ 16 mm² aluminum or GI strip bearing size 25*3 mm thick). Separate pipe for running earth wires of Lightning Arrestor shall be used.

5.3 SURGE PROTECTION

Internal surge protection, wherever required, shall be provided as per manufacture's standard.

It shall consist of three SPD type-II/MOV type surge arrestors connected from +ve and -ve terminals to earth.

6 LIST OF ACCEPATABLE MAKES

- 6.1 Solar Modules: Adani/ Waaree/ RenewSys/ ATUM/ Vikram Solar/ EVVO/ Tata Solar/ Goldi Solar
- 6.2 Inverters: Waree/ SMA/ SolarEdge / Sofar / Enphase/ EVVO/ Power One/ Growatt / Goldi Solar/ ABB
- 6.3 LV Switch gears: L&T/ Siemens/ Alstom/ Schneider/ Bussmann/C&S/Legrand/Havells/ ABB
- 6.4 Cables: Delton Cables Ltd/ Brooks cable Works Ltd/ KEI Industries Ltd/ General Instruments Consortium/ Universal Cables Ltd/ Toshniwal Cables/ Associated Cables Pvt. Ltd./Cable Corporation of India/Finolex Cables/Fort Gloster Industries Ltd./KEC International Ltd./TRACO Cable Co. Ltd./Torrent Cables Ltd./NICCO Corporation Ltd./APAR Industries Ltd./Skytone Electricals(I) Ltd./Polycab Wires Pvt. Ltd./TCL Special Cables/GEM Cables & Conductors/Radiant-RSCC Speciality Cable/INCAB Industries Ltd./Havells India Ltd./Prestige Cable Industries/Govind Cable Industries/Chandresh Cables/Veena Enterprises/BMI Cables Pvt. Ltd./Gemscab
- 6.5 Relays & timers : L&T/ Schneider/ Legrand/ Omron/ Honeywell Automation India Ltd./ OEN India Ltd/ General Electric/ABB/Siemens

7 INSTALLATION AND COMMISSIONING

7.1 TERMS & CONDITIONS OF ERECTION AND COMMISSIONING OF SOLAR PLANT:

- i. All manpower, general Tools & tackles, consumables etc required for erection, testing & commissioning would be in the scope of vendor.

- ii. If any special tool is required for erection & commissioning work, party shall arrange the same free of cost.
- iii. Boarding, lodging and Local conveyance shall be arranged by the party.
- iv. Custody & safety security of all supplied materials of Grid Connected Solar PV system for erection purpose would be in the scope of bidder till the complete system is handed over to FACT-UC after final commissioning.

7.2 SAFETY DURING ERECTION /COMMISSIONING:

- i. Safety is the first priority. Supervisor must ensure all safety precautions before starting of any work/activity.
- ii. Contractor, supervisor and all gang involved in erection /commissioning must follow all safety instruction and safety rule.
- iii. If any unsafe condition observed, Contractor representative shall immediately inform the same to FACT-UC engineer. No work will be carried out in unsafe condition.
- iv. The contractor shall be fully responsible for the safety of his workers and will take all the necessary safety precautions to avoid any accident while working at all site/elevations.
- v. Contractor has to strictly adhere to the permit to work system as applicable at FACT-UC and confirm isolation before starting of any work. Contractor must use temporary earthing rod for earthing of electrical system under maintenance before starting work.
- vi. Contractor shall arrange proper & sufficient number of safety equipment such as electrical hand gloves, Chemical hand gloves, helmets, safety shoes, Earplug, nose mask and safety belts etc required during work execution at his own cost as per the rules in force from time to time during contract period.
- vii. All erection /commissioning shall be carried out in strict supervision of the contractor or their authorized supervisor for the safety of the personnel and plant equipment. Contractor is advised not to carry out any work without supervision.

8 TRAINING

Training shall be provided by the bidder at site free of cost for the engineers and technicians of FACT-UC for minimum of three MDY (24 hrs) after the installation and commissioning of rooftop solar PV system.



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9. VENDOR DATA REQUIREMENT-

After the letter of Intent, the Bidder has to carry out the detailed survey of the sites and submit the calculation, and complete detailed engineering document for the approval of FACT-UC. The list of indicative documents is mentioned below. The Documents required to be submitted are as follows-

Sl. No.	Description	With offer		After LOI/PO		Final	
		No.of copies	Date	No.of copies	Date	No.of copies	Date
1	Duly signed Technical Procurement Specification Document	1	With tech bid				
2	Duly filled-in ,signed and stamped Technical Particulars	1	With tech bid				
3	Solar Layout Sketch including wiring arrangement.	1	With tech bid	1	30 days from LOI	1P+S	Along with Supply
4	Technical data sheets/Details of the equipment planned i.e. PV modules (panels), inverters, Data loggers, earthing systems, cables, AC panels and accessories of the plant system.	1	With tech bid				
5	Single line diagram of the offered AC Distribution board	1	With tech bid				
6	Test Certificates / Reports from IEC / NABL accredited laboratory for the solar modules and solar grid tied inverters as per relevant IEC / equivalent IS standard.	1	With tech bid				
7	Product warranty certificate of solar modules and inverters along with Self-declaration as detailed in clause b of Section 10.	1	With tech bid				
8	Power output warranty certificate along with Self-declaration as detailed in clause a of Section 10.	1	With tech bid				

9	Self-declaration stating that the PV system shall have minimum (annual) Capacity Utilisation Factor (CUF) of 17% for a period of first five years of operation at the output of the inverter.	1	With tech bid				
10	Duly filled and signed Compliance statement as per format attached (Annexure-III)	1	With tech bid				
11	Unpriced copy of price bid (Annexure-II)	1	With tech bid				
12	Detailed survey, engineering report including detailed shadow analysis, PV system Report, Generation details, calculations, routing diagrams of cables and wires.			1	30 days from LOI	1P+S	Along with Supply
13	Tentative installation time schedules with activities break up including statutory approvals.			1	30 days from LOI		
14	Method statements for various major activities, simulations data etc. and any other detailed desired by FACT-UC Engineer in charge or its representative.			1	30 days from LOI		
15	Structural design and drawings shall be duly vetted by a competent structural consultant from IIT/NIT, not below the rank of Assistant Professor before installation for all types of structure arrangements including the extension made, as per specification.			1P	30 days from LOI		
16	Bill of materials with quantity, type, make, etc.			1	30days from LOI	1P+S	Along with Supply

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17	Installation, operation and maintenance manual. The Manual should also include all the Dos & Don'ts of grid connected rooftop PV System along with Graphical Representation with indication of proper methodology for cleaning.					3P+S	Along with Supply
18	Maintenance register					1P	Along with Supply

P: Printouts ; S: Softcopy

10. PRODUCT WARRANTY AND PERFORMANCE GUARANTEE

- a. The bidder must provide a self-declaration confirming that the solar PV modules will be warranted for their output peak watt capacity, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years from the date of commissioning of the system. Further, module shall have performance warranty of greater than 97% during the first year of installation, with degradation of the modules not exceeding 2.5 % per annum in the 1st year and not exceeding 0.7 % per annum for the 2nd to 25th year. If the module degradation exceeds the specified limits, the bidder is obligated to replace or rectify the modules.
- b. All the supplied solar modules must be warranted against any manufacturing, design and installation defects for a minimum period of 12 years from the date of commissioning. The PCU / String Inverters etc of the Solar PV plant must be warranted against any manufacturing, design and installation defects for a minimum period of 7 years from the date of commissioning.
- c. Vendor shall have full defect liability during the warranty period. It shall be obligatory on the part of vendor to modify / replace any hardware, free of cost, in case defect/ shortcoming/ malfunction are noticed during the warranty period.
- d. The vendor shall provide a performance guarantee for the system including software.
- e. Performance-Ratio test:
 - i. The performance Ratio test shall be carried out after successful full commissioning of the solar PV project. PR Test shall be carried out by measuring Performance Ratio (PR) and comparing to the Guaranteed PR. The vendor is requested to provide Guaranteed PR during the bidding stage.

- ii. The installer shall be required to meet minimum guaranteed generation with Performance Ratio (PR) at the time of commissioning and related Capacity Utilization Factor (CUF) as per the Global Horizontal Irradiance (GHI) levels of the location.
- iii. PR should be shown minimum of 80% at the time of inspection for initial commissioning acceptance on selected samples mutually agreed by supplier and purchaser.
- iv. Minimum Capacity Utilization Factor (CUF) of 17% should be maintained for a period of first five years (from date of commissioning of the project) or as mutually agreed at the time of commissioning.
- v. The PR will be measured at Inverter output level during peak radiation conditions.
- vi. Bidder will be responsible to conduct the PR test only after achieving the physical completion and synchronization of the plant and complying with the relevant requirements from utility, if required.
- vii. Method for calculating Performance Ratio (PR):-
 - a) The PR test of the power supply facility shall be conducted over a period of 30 consecutive days from the date of commissioning of the solar system. This test is binding on both parties to the contract and serves to verify compliance of the equipment with the guaranteed performance parameters.
 - b) The test will involve confirming the correct operation of the plant on an individual basis over the 30-day period, based on the performance ratio (PR), which is calculated using the energy produced and the average incident solar radiation. The PR shall be calculated according to the following formula:
$$PR = \frac{\text{Actual Measured Plant Output (kWh)}}{\text{Irradiance (kWh/m}^2\text{)} \times \text{Efficiency} \times \text{Area}}$$
 - c) The vendor is responsible for providing the measuring instruments necessary for on-site data recording, including a calibrated pyranometer with data logger, a temperature sensor, and other required devices. Calibration sheet for test equipment to be submitted if insisted by FACT
 - d) During the PG test, any equipment failure or interruption will result in the affected day or part thereof being excluded from the test period. The test will resume once the system has been fully repaired and is operating correctly. The test duration will be extended by the exact number of days lost to breakdowns.

- e) The daily PR will be calculated as the average of valid 15-minute time blocks across the 30-day test duration.
- f) Irradiance criteria for daily PR calculations: the irradiance measured in the plane of the array must exceed 600 W/m² for at least three continuous hours each day, and the daily total irradiance must exceed 3,000 Wh/m². If these minimum irradiance criteria are not met on certain days, the test period may be extended until 30 days meeting these criteria have been recorded.
- g) If the bidder fails to achieve the guaranteed performance levels, the vendor, at its own cost, shall rectify all defects identified during the test and take necessary steps to pass the PR test within a two-month period. After rectification and notification to FACT-UC, the PR test will need to be conducted again.
- viii. If the PR values are below the guaranteed performance levels, the vendor will be liable to pay LD to FACT-UC. Applicable LD shall be 110 % of the shortfall capacity. Formula shall be as follows:
- $$L.D = [1.1 \times \text{Shortfall in PR \%} \times \text{Total Contract value}] / 100.$$
- A sample calculation
- a) Guaranteed PR= X
- b) Measured PR= Y
- c) % shortfall in PR, $Z = [(X - Y) / X] \times 100$
- d) Contract value= R (In Rs)
- e) Applicable LD = $[1.1 \times Z \times R] / 100$

11. SERVICE WARRANTY

- a. The vendor shall provide service warranty free of cost for the supplied Solar PV system for the entire solar photovoltaic system, for a period of five years effective from the date of commissioning. Replacement / repair of any hardware of the plant during the service warranty period shall be under the scope of vendor. Arrangements for replacement/repair of panels and inverters which are already covered under warranty shall be under the scope of vendor.
- b. The service rates quoted shall be valid and firm for the entire five year period of Service warranty.

- c. The service shall include the following:
- i. Technical support round the clock over telephone, e-mails etc. to facilitate the first level maintenance by engineers/technicians of the purchaser.
 - ii. Service engineer shall attend the system failure/fault within 24 hours of receipt of service call from the purchaser.
 - iii. The vendor shall make quarterly Preventive Maintenance (PM) visits at an interval of three months for the preventive checking of the system, and ensure
 - a) Healthiness of the system.
 - b) Addressing of faults seen during the PM.
 - c) Routine maintenance activities.
 - d) The preventive maintenance checks shall be carried out online without the shutdown of the system.
 - e) The vendor shall restore the defective system within 72 hours, counting from the intimation of the fault. If the total system is down for more than 72 hours due to reasons attributable to the vendor, 0.5% of the service charges will be recovered for each such occurrence (multiple of 72 hours). There is no limit allowed for the number of breakdown calls.
 - f) Vendor shall ensure sufficient stock of all required spares ready at disposal, including the bought out items to facilitate fast recovery of the fault.
 - g) The faulty/damaged parts and components, which have been replaced during the maintenance, will be the absolute property of the Contractor.
 - h) Cleaning of the solar panels as per clause 4.9.

12. PAYMENT TERMS AND CONDITIONS.

- a) 25% of the total order value will be paid within 30 days after delivery of all supply items and acceptance by FACT.
- b) 65% of the total order value will be paid after successful installation and commissioning of the system as per the specification.
- c) The remaining 10% of the order value will be paid after verifying that the performance



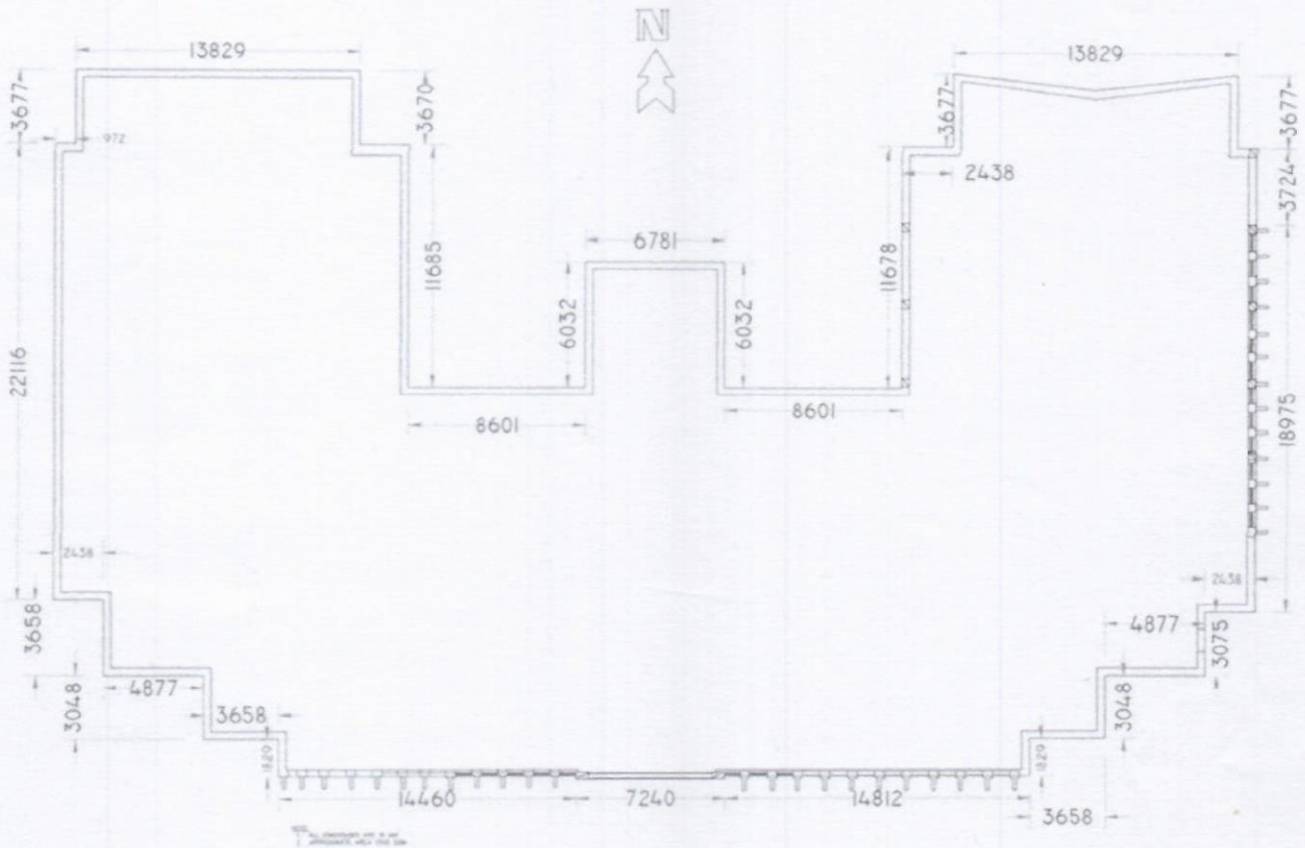
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ratio of the solar installation meets the guaranteed PR offered by the vendor during the bid (Vide section 10)

- d) The security deposit will be released only after the completion of the five year service warranty for the entire solar installation.
- e) The bidder shall provide a performance guarantee for the system including software. An amount equivalent to 10% of the order value shall be retained towards performance guarantee and shall be released only after successful completion of the five year service warranty period. Alternatively the supplier can submit a bank guarantee for 10% of the order value from a scheduled/ nationalized bank with validity till end of the five year service warranty period.

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ANNEXURE I
ROOFTOP LAYOUT



Total available roof area- 1500sqm

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ANNEXURE II
PRICE BID FORMAT

Sl No	Item Code	Description	Unit	Quantity
1.	672502550	Design, supply, installation, testing, commissioning, training and performance analysis of Truss roof with on-grid rooftop solar photovoltaic system of minimum 200kW capacity comprising of solar photovoltaic module, support structure, junction boxes, power conditioning unit and inclusive of five year service warranty as per attached TPS No: FACT-UC-SLR-2023-24	Set	1
2.	672502551	Supply of critical spares for 200kW(min) solar photovoltaic system as per TPS No:- FACT-UC-SLR-2023-24	LS	1

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ANNEXURE III

COMPLIANCE STATEMENT

ENQUIRY No: _____

We state that our Quotation No is in full compliance with the documents issued against the Enquiry No: _____ except for the deviations listed below.

LIST OF DEVIATIONS:

Sl. No.	Description	Reason for deviation

Name of Vendor:

We have read, understood and accepted the terms and conditions of the enquiry as given in the Technical Procurement Specification, Annexure, Terms and Conditions for Purchase attached with the tender documents, except for the deviations distinctively listed above.

Date:

Name & Designation

Seal & Signature

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ANNEXURE IV

TECHNICAL PARTICULARS (TO BE FILLED BY VENDOR)

1.0	SOLAR PV MODULES	
1.1	Make	
1.2	Maximum Power output of each module at Standard Test Conditions (STC)	
1.3	Maximum System Voltage of module	
1.4	Maximum Power output tolerance- Pmax (%)	
1.5	Open Circuit Voltage (V _{OC})	
1.6	Short Circuit Current (I _{SC})	
1.7	Maximum Power voltage-V _{mpp} (V)	
1.8	Maximum Power Current- I _{mpp} (A)	
1.9	Maximum Over-Current Protection Rating	
1.10	Levelized cost of Electricity	
1.11	Power temperature coefficient	
1.12	Solar module efficiency	
1.13	Minimum Fill factor of solar module	
1.14	Solar cell (Monocrystalline/Polycrystalline)	
1.15	Solar cell shape and dimensions	
1.16	Total no. of solar cells required to obtain required power	
1.17	Module weight	
1.18	Module Product Warranty (in years)	
1.19	Module Power output warranty (in years)	
2.0	INVERTER/POWER CONDITIONING UNIT	
2.1	Make	
2.2	No. of inverters offered with capacity of each unit	
2.3	Nominal AC output voltage and frequency	
2.4	Output Voltage range	

2.5	Grid frequency Synchronization range	
2.6	Switching device used for Inverter	
2.7	Control unit used (Microprocessor /DSP)	
2.8	Min/Max input DC voltage	
2.9	Inverter efficiency	
2.10	Total Harmonic Distortion (THD) of inverter output.	
2.11	Output Power factor of inverter	
2.12	IP rating of Enclosure	
2.13	Protection of inverter against lightning provided?	
2.14	Provision for remote monitoring of inverter data provided? (Vide Clause 4.2.9)	
2.15	Islanding Provision provided?	
2.16	Manual isolation facility provided at utility end to isolate grid connection manually? (Vide Clause 4.2.10)	
2.18	Inverter Product Warranty (in years)	
3.0	TRUSS ROOF	
3.1	Material of Truss roof	
3.2	Details of outdoor metallic staircase and ladders provided for access to PV installation.	
4.0	MODULE MOUNTING STRUCTURE (MMS)	
4.1	Material of mounting structure	
4.2	Solar panel installation type- Solar roof or Solar panel with adequate spacing in between.	
4.3	Details of wind withstanding capability and Load bearing capacity of the structure	

5.0	AC Distribution Board	
5.1	Make	
5.2	Fault level	
5.3	No. of MCB/MCCB Outlets and rating	
5.4	IP rating	
6.0	OTHER DETAILS	
6.1	Guaranteed Performance Ratio	
6.2	Free Service warranty tenure	
6.3	Roof Area required for the solar installation	
6.4	Web based data logging and monitoring feature provided (Yes/No). If yes, specify the details.	
6.5	Energy meters for generation monitoring considered as per clause 4.5.6	
6.6	Details of cleaning and washing arrangement provided for solar modules? If yes, specify the details.	
6.7	Details of warranty and Performance guarantee.	
6.8	Earthing, Lightning and surge protection provided for the entire solar PV system as per clause 5	
6.9	Signed and sealed TPS (Yes/No)	
6.9	Signed and sealed Compliance Statement (Yes/No)	
6.10	Technical literature, Pamphlets and brochures relating to the various equipment used attached (Yes/No)	
6.11	Critical Spares as per clause 4.10 considered. (Yes/No)	

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ANNEXURE V
SELECTION CRITERIA FOR L1 BIDDER

Month	Average Insolation(kWh/sqm/day)
Jan	5.80
Feb	6.46
Mar	6.83
April	6.24
May	5.57
June	4.83
July	4.91
August	5.26
Sept	5.74
Oct	5.24
Nov	4.94
Dec	5.30

Table 1 Average Annual solar Insolation in Kerala in kWh/m²/day

Calculation for L1 Bidder

Table 1 shows the average annual solar insolation in Kerala, measured in kWh/sqm/day. Bidders must provide the guaranteed Performance Ratio (PR) and the utilized rooftop area during the bidding process.

The **Guaranteed Monthly Generation (kWh/sqm/month)** is calculated for all 12 months using the formula below:

$$\begin{aligned} &\text{Guaranteed Monthly Generation (kWh/month)} \\ &= \text{Average daily insolation} \times \text{No. of days in the month} \\ &\times \text{Area requirement (Sqm)} \times \text{Guaranteed PR} \end{aligned}$$

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The Guaranteed Annual Generation of Electricity (GAGE) is determined by adding up the monthly generation values for all 12 months.

The cost per unit of the guaranteed annual generation of electricity (X) is calculated as:

$$X = \frac{\text{Total Project Cost}}{\text{GAGE (kWh)}}$$

The bidder offering the minimum value of X, i.e., the lowest cost per unit of guaranteed annual generation of electricity, will be selected as the L1 bidder.

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